PROJECT

POLREC

EURO CLUSTERS

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D2.3
Report on results of completed mechanical recycling projects



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Glossary of terms, abbreviations, and acronyms

Partner short name	Partner	Country
POL	Polymeris	FR
CEN	Centro Tecnológico da Indústria de Moldes, Ferramentas Especiais e Plásticos	PT
MAV	Clúster de Materials Avançats de Catalunya	ES
PCD	Plast Center Danmark	DK
WFG	Wirtschaftsförderung Raum Heilbronn GmbH	DE

Table 1: List of partners

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The POLREC project is funded by the European Commission Joint Cluster initiatives for Europe's recovery (Euroclusters) under the Single Market Programme (SMP COSME) grant agreement number 101074434. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or EISMEA. Neither the European Union nor the granting authority can be held responsible for them.

1. Introduction

The POLREC project is a collaborative initiative involving five European clusters, as listed in Table 1. Its primary focus is on promoting sustainable development and the recycling of both high- and low-value polymers, contributing to the goals of the European Green Deal. Specifically, the project supports the ambition of achieving net-zero CO_2 emissions by 2050 and enhancing European strategic autonomy in sourcing raw materials for polymer production.

Over a three-year period, the POLREC consortium investigated how intensified cross-border and cross-sector collaboration among clusters and business networks could help address these environmental challenges. The aim was also to leverage the international business opportunities associated with polymer recycling.

Aim and Scope of the Innovation Open Call

One of the project's central actions was the launch of the POLREC Innovation Open Call, designed to financially support small and medium-sized enterprises (SMEs) with ambitions to reduce the environmental impact of their products. The call specifically targeted companies committed to shifting from traditional disposal methods - such as incineration and landfilling - to more sustainable solutions, including mechanical and chemical recycling of polymer waste.

To further support this transition, the call encouraged the integration of digital tools, as well as the development of improved mold designs and processing aids to optimize the handling and transformation of recycled polymers.

Implementation of the Open Call

Among several planned initiatives, one central activity was the organization and implementation of the open innovation call offering financial support for mechanical and chemical recycling projects. This was designed to stimulate innovation and adoption of best practices across the SME community.

This document constitutes POLREC Deliverable D2.3 – Report on Results of Completed Mechanical Recycling Projects. The document includes the main steps of the open innovation call but is concentrated on the Mechanical Recycling Projects:

Presentation of the Innovation Open Call – Mechanical Recycling

- Preparation of the call
- Launch of the Innovation Open Call
- Evaluation and selection of projects for funding

Summary of Project Outcomes

- Project findings (presented in tabular format)
- Experiences learned during implementation
- New business opportunities
- Future work planned
- Feedback on the POLREC funding support scheme
- Conclusion and reflections on impact

The results of the chemical recycling projects will be reported in a separate document, named POLREC Deliverable D2.5.

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2. Presentation of the Innovation Open Call – Mechanical Recycling

In this call the applicant could apply for a sub-grant targeting the testing of a recycling solution for mechanical recycling of plastic or rubber waste, which is presently not being recycled or not recycled effectively.

Any kind of mechanical recycling process could be selected. Moreover, any process improving the use of recycled material could be chosen. The desired service-provider(s) and an estimate of the cost for recycling the waste had to be indicated in the application.

The applicant could either indicate their selected service-provider(s) or choose one from the list of service-providers identified by the POLREC partners that was published on the POLREC partners' sites or in the POLREC deliverable: D2.2 Mapping of European plastic waste streams and of European plastic recyclers (figure 1).



Figure 1: D2.2 Mapping of European plastic waste streams and of European plastic recyclers

The sub-grant allocated should cover part of or the total cost of the service-provider(s). No other expenditure could be covered by the sub-grant.

2.1 Preparation of the POLREC Innovation Open Call

To initiate this work a package of working documents and procedures were developed by the POLREC consortium:

- Application form for the grant
- Guide for applicants
- Evaluation chart
- Sub-grant agreement
- Template for Work Plan
- Online interim interview at mid-term of the project period

D2.3 – Report on results of completed mechanical recycling tests

- Template for Final Technical Report
- Final review of the technical report forwarded
- Payment documents related to payments in two rates

2.2 Launch of the POLREC Innovation Open Call

The POLREC Innovation Open Call was open from 1 September to 7 November 2023. As sufficient applications were received, a second call was not needed.

SMEs could apply for up to €30,000 per project (maximum €60,000 per SME) based on quotations from service providers. Funded activities had to contribute to reducing CO_2 emissions by lowering the use of fossil-based raw materials.

2.3 Evaluation and Selection of Projects

An evaluation process was established where each application was reviewed by two POLREC partners from different countries. Applications were scored on criteria such as network participation, green business and innovation potential, scientific and technical quality, organisational capacity, scalability, and contribution to the European Green Deal.

3. The awarded and implemented Mechanical projects

Within the Mechanical category, 14 projects were fully completed, 1 project was only partly completed, and 1 was not implemented.

The distribution of the fully and partly completed mechanical projects by country was as follows:

- France 5
- Spain 4
- Portugal 1
- Denmark 1
- Ireland 3
- Sweden 1

4 projects came from countries outside the POLREC partnership in terms of 3 projects from Ireland and 1 project from Sweden.

All projects were fully or partly completed by the end of July 2025.

Please see table 2 for further details.

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	Fully and partly completed mechanical projects				
No.	**Company Name**	**Country**	**Name of project - Application**	**Project start**	**Project end**
1	**ALTHEORA**	France	ALTHEORA - New recycled composite material	19.02.2024	14.02.2025
2	**Berbetores Industrial S.L.**	Spain	Berbetores Industrial - Innovation approach to the development of additive manufacturing BAAM process by recycling and integration of ABS & HDPE scrap	15.02.2024	15.11.2024
3	**CAMY SAS**	France	CAMY SAS - Closed loop recycling of expanded EVA footwears	01.02.2024	31.07.2024
4	**Earth Protex Portugal**	Portugal	Tex2Tex´s cutting-edge green solution - Elastane dissolution in advanced polyester recycling	15.02.2024	15.08.2024
5	**GAVIPLAS, S.L.**	Spain	Gaviplas - Ink removal technology for food contact applications	01.04.2024	01.04.2025
6	**José Combalía, S.A.**	Spain	Polyethylene in the loop. All for crown cork process	01.04.2024	31.03.2025
7	**Mälarplast AB**	Sweden	Mälarplast - Maximizing sustainability by recycling bioplastics	09.02.2024	09.11.2024
8	**PDC-plast**	Denmark	PDC-Plast: Production of component in recycled plastics	01.01.2024	01.10.2024
9	**RecyOuest**	France	RecyOuest - PCR monofilament feasibility	01.03.2024	01.03.2025
10	**Rezero**	Ireland	Rezero - Recycling of filters from cigarette industry	16.02.2024	16.05.2024
11	**SPORTS CARBONE**	France	SPORTS CARBONE - Recycling of carbon fiber sports equipment	01.03.2024	01.03.2025
12	**Total Plastic Solution**	Ireland	Total Plastic Solution - Transition to a Circular Economy	04.03.2024	28.02.2025
13	**Waste Prevention SL (Prewaste)**	Spain	Prewaste - Open-loop recycling of mixed plastic waste to produce non-structural components	15.10.2024	30.06.2025
14	**BIOWRAP/GBBC** *(Partly completed)*	France	BIOWRAP - Recycling scraps from compostable stretch film	01.11.2025	30.06.2025
15	**Polymer Alloy Technologies (Paltech)**	Ireland	Paltech - rPET matrix development for the production of glass fibre reinforced composites for use in the manufacture of utility poles	10.10.2024	01.03.2025

Table 2: Overview of the fully and partly completed mechanical POLREC projects

3.1 Presentation of project results

All fully and partly completed mechanical projects are presented in Appendix 1. Due to confidentiality reasons the projects are not presented in full length and technical details are omitted. In table 3 a short overview of the projects is given.

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	Fully and Partly Completed Mechanical Projects			
No.	**Company Name**	**Country**	**Name of Project**	**Short Summary**
1	**ALTHEORA**	France	ALTHEORA - New recycled composite material	ALTHEORA is developing a mechanical recycling process for end-of-life SMC composite cabinets to recover glass fibers and reduce virgin material use. Recovered fibers are remixed with polyester resin to produce new molded composites.
2	**Berbetores Industrial S.L.**	Spain	Berbetores Industrial – Innovation approach to the development of additive manufacturing BAAM process by recycling and integration of ABS & HDPE scrap	Berbetores Industrial tested recycled ABS and HDPE in large-scale 3D printing, finding HDPE unsuitable and ABS limited in printability. Injection molding proved more effective, highlighting material stability and shape as key to reuse in circular production.
3	**CAMY SAS**	France	CAMY SAS – Closed loop recycling of expanded EVA footwears	CAMY SAS explored closed-loop recycling of EVA hospital shoes by developing new recyclable thermosplastic EVA formulations without cross-linkers. While lab tests showed 100% recyclability, current injection equipment is incompatible. A follow-up project is planned to adapt molds and processes for full-scale implementation.
4	**Earth Protex Portugal**	Portugal	Tex2Tex´s cutting-edge green solution - Elastane dissolution in advanced polyester recycling	The Tex2Tex STOMP process enables selective, eco-friendly dissolution of elastane from polyester textiles, preserving PET fiber quality. Lab trials confirmed solvent efficiency, recyclability, and process scalability. This provides a viable, circular solution for recovering pure polyester from blended post-consumer textiles.
5	**GAVIPLAS, S.L.**	Spain	Gaviplas - Ink removal technology for food contact applications	Gaviplas and Cadel developed a deinking process to recycle LDPE diaper packaging into food-safe plastic, achieving full decontamination and EU compliance.
6	**José Combalía, S.A.**	Spain	Polyethylene in the loop. All for crown cork process	The project aimed to mechanically recycle crown cap liners and shrink films from José Combalía for reuse in production. Recycled liners matched original properties, while shrink films required thickness adjustments to achieve comparable performance.
7	**Mälarplast AB**	Sweden	Mälarplast - Maximizing sustainability by recycling bioplastics	Mälarplast and CemeCon used PVD coatings to reduce tool wear and enable efficient moulding with 100% recycled bioplastics. Cleaning time and maintenance were significantly improved.
8	**PDC-plast**	Denmark	PDC-Plast: Production of component in recycled plastics	PDC-Plast used PVD coatings to overcome demoulding issues and enable production of golf discs with 30% recycled TPU, reducing scrap from 85% to 2%. The success led to applying the same method to a second product line with recycled polypropylene.
9	**RecyOuest**	France	RecyOuest - PCR monfilament feasibility	RecyOuest tested recycled HDPE for melt spinning and achieved successful mono-filament production at 25% rHDPE with filtered material. Multifilament spinning remained unfeasible due to contamination, highlighting the need for cleaner input.
10	**Rezero**	Ireland	Rezero - Recycling of filters from cigarette industry	The project recycled cellulose acetate from cigarette filters into nonwovens, successfully producing 14 sample materials for applications like wipes and insulation. Key challenges included paper separation and maintaining fibre length for industrial scaling.

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11	**SPORTS CARBONE**	France	SPORTS CARBONE - Recycling of carbon fiber sports equipment	The project explored recycling carbon fibre bike frames, finding 90% repairable and recovering fibres from the rest via steam thermolysis. Though costs remain high, it proved the technical feasibility of circular carbon fibre reuse in cycling.
12	**Total Plastic Solution**	Ireland	Total Plastic Solution - Transition to a Circular Economy	The project developed a water-based process to decontaminate polypropylene powder from cosmetic packaging, enabling its reuse. FTIR confirmed effective Trim removal, and tests showed maintained processability and improved mechanical properties.
13	**Waste Prevention SL (Prewaste)**	Spain	Prewaste - Open-loop recycling of mixed plastic waste to produce non-structural components	The project aims to valorise difficult-to-recycle plastic waste by blending it with mono-plastics to create sustainable urban elements. Through innovative recycling, it reduces landfill waste, cuts virgin plastic use, and lowers CO2 emissions. The initiative supports the circular economy, reduces material costs, boosts profitability, creates jobs, and promotes products that are reparable, durable, and recyclable.
14	**BIOWRAP/GBBC** *(Partly completed)*	France	BIOWRAP - Recycling scraps from compostable stretch film	BIOWRAP developed a compostable stretch film (FE23) in 2021 and began production in 2023. Recycling production scrap proved difficult, prompting trials with GBCC. Initial recycling attempts failed due to pellet stickiness, and a planned switch to twin-screw extrusion was abandoned after BIOWRAP entered liquidation.
15	**Polymer Alloy Technologies (Paltech)**	Ireland	Paltech - rPET matrix development for the production of glass fibre reinforced composites for use in the manufacture of utility poles	The project improved rPET composites for glass-filled utility poles by blending with rPETG to reduce crystallinity and enhance ductility. Glass fibers boosted strength, while optimized processing minimized voids. Challenges included brittleness from slow cooling, moisture issues, and high viscosities. The results emphasized the need for careful material selection, drying, and process control to produce durable composites.

Table 3: Overview of fully and partly completed Mechanical POLREC Projects

In Appendix I the summaries of the above projects can be found.

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4. Experiences learned during the project period

During the course of the project, the participating companies accumulated a number of valuable insights - ranging from highly technical and project-specific learnings to broader strategic takeaways.

One of the key lessons was the importance and added value of involving external experts. Their independent perspectives and specialized knowledge contributed significantly to the development and success of several project components.

A particularly illustrative example emerged from one of the sub-projects, where it was found that the recovery and repair of broken items can be more advantageous than recycling them for raw materials. While the principle of product recovery is not new, it is often neglected or underestimated by both manufacturers and recyclers in favor of more conventional recycling processes. In this case, the manufacturer recognized an untapped business opportunity: By repairing a high-value product, they could extend its lifecycle and create a more sustainable and profitable alternative to recycling.

Another major outcome of the project was the strengthened collaboration and networking among partners across national borders. Among the POLREC partners, it became clear that fostering cross-border relationships added significant long-term value - not only to the individual companies involved but also to the broader European recycling and manufacturing ecosystem. International networking opened doors to new markets, facilitated the exchange of ideas, and laid the groundwork for future cooperation.

However, for many small and medium-sized enterprises (SMEs), international collaboration still represents a considerable challenge. Cross-border partnerships can be hindered by language barriers, regulatory differences, logistical issues, or simply a lack of established connections. Recognizing these obstacles, POLREC partners took an active role in supporting SMEs by facilitating introductions, building trust between stakeholders, and helping to navigate the complexities of international cooperation.

Several successful examples illustrate the impact of these efforts. In one case, a French company using recycled PET (rPET), was connected with a German PET recycler through the coordinated efforts of Polymeris and PCD. In another instance, a Danish manufacturer working with polyamide (PA) was introduced to a reliable German supplier of recycled PA materials. These collaborations not only met immediate sourcing needs but also laid the foundation for sustained cross-border business relationships.

Overall, the project demonstrated that targeted support, knowledge exchange, and international networking are essential to driving innovation and sustainability in the recycling and manufacturing sectors - particularly for SMEs striving to compete and grow in an increasingly interconnected European market.

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5. New Business Opportunities

The collective efforts of these 15 companies represent a robust and forward-thinking response to the pressing challenges of sustainability, resource scarcity, and environmental regulation in the industrial and manufacturing sectors. While operating across diverse markets - from plastics and textiles to footwear, construction, and consumer goods—each organization has taken concrete steps towards embedding circular economy principles into their core operations. Their initiatives underscore a clear shift from linear production models to systems that prioritize material recovery, waste reduction, and responsible innovation.

Several key themes emerge across these initiatives:

1. Circularity and Resource Efficiency: Most companies are investing in closed-loop systems, where production waste is recovered, recycled, and reintegrated into manufacturing. These strategies not only reduce raw material consumption but also significantly lower environmental impact. Projects like those from Gaviplas, José Combalía, and Mälarplast exemplify this shift by using in-house recycling or partnering with external actors to ensure material circularity.

2. Advanced Material Innovation: Companies such as ALTHEORA, CAMY SAS, and SPORTS CARBONE are exploring high-performance alternatives to conventional materials - ranging from recycled glass fibers to carbon composites and eco-modified polymers. These innovations often bring added value through improved functionality (e.g., fire resistance, antibacterial properties, or durability) while maintaining or exceeding current performance standards.

3. High-Potential Recycling Technologies: Several companies are developing or adopting specialized recycling methods (e.g., solvent-based separation, mechanical reprocessing of contaminated plastics, or composite fiber recovery). These technologies not only enable better resource recovery but also create new product categories and expand the scope of recyclable materials, as seen in the work by Earth Protex Portugal, Total Plastic Solution, and Rezero.

4. Sector-Specific Applications and Market Expansion: Many of these projects are unlocking new market opportunities by aligning material innovations with sector needs. For example, Berbetores Industrial is exploring applications in additive manufacturing and logistics; Rezero targets the hygiene, fashion, and insulation sectors; and RecyOuest develops ecodesigned agricultural solutions. These approaches are broadening each company's portfolio while reinforcing their relevance in emerging sustainable markets.

5. Collaborative Ecosystems and Partnerships: A critical enabler of these innovations is collaboration—across value chains, with technology providers, research institutions, and even clients. Companies like PDC-Plast, Mälarplast, and SPORTS CARBONE demonstrate how joint ventures and technical partnerships enhance capacity for both innovation and commercialization.

Collectively, these initiatives reflect a shared vision: to build a resilient industrial future that not only mitigates environmental impact but also drives long-term economic growth. These companies are leading by example, proving that sustainability is not a limitation but a catalyst for innovation, competitiveness, and market leadership.

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Moving forward, this collaborative and impact-driven mindset sets a strong foundation for broader adoption of circular practices across the European industrial landscape. It also opens the door for further synergies between sectors, as new business models, materials, and technologies continue to emerge. The success of these projects illustrates that the green transition is not only achievable - it is already underway.



6. Future Work

The collective future work planned by the fifteen companies highlights a dynamic and forward-thinking approach to tackling the technical, economic, and environmental challenges associated with plastic and composite material recycling. These initiatives reflect a strong commitment to transitioning from linear production models toward a circular economy, where material reuse, waste minimization, and product lifecycle optimization are at the forefront.

A key focus across multiple companies is material optimization—whether through improving the chemical and structural properties of recycled thermoplastics (as in Berbetores Industrial), enhancing the performance of recycled glass fibers (as in ALTHEORA), or tailoring polymer formulations for specific applications (as seen with CAMY SAS and Total Plastic Solution). These efforts aim to elevate recycled materials to a level of quality and consistency comparable to virgin alternatives, thus broadening their marketability and functional scope.

Another critical area of development involves the industrial scalability of recycling technologies. Companies like José Combalía and RecyOuest are moving from pilot-scale success to full-scale production by assessing process reliability, adapting industrial equipment, and conducting extensive mechanical and environmental testing. This scaling-up phase is crucial to ensure that recycled products can meet market demands both in quantity and performance.

Process optimization and control emerge as essential next steps for many companies. From improving injection molding parameters (Berbetores Industrial), to refining washing and drying systems (Total Plastic Solution), to enhancing solvent recovery and automation (Earth Protex Portugal), these improvements are vital for increasing operational efficiency, product quality, and environmental performance. These companies recognize that sustainability must be backed by economically viable and technologically robust operations.

Application-specific development is another common thread. Several firms are exploring new or expanded uses for recycled materials—such as acoustic panels (Rezero), shrink-wrap and strapping films (José Combalía), coated tools for complex plastics (Mälarplast, PDC-Plast), and reinforced composites for consumer products (ALTHEORA, SPORTS CARBONE). These efforts are often supported by mechanical, chemical, and performance testing to ensure suitability and compliance with market standards.

Many companies also highlight the importance of partnerships and value chain integration. Whether collaborating with European mold makers, compounders, end-users, or academic and regulatory bodies, these partnerships aim to close the loop on materials by fostering shared knowledge, market access, and innovation within the European polymer industry. Rezero's push to engage manufacturers for nonwoven commercialization and RecyOuest's collaboration on industrial filament production are strong examples of this trend.

In parallel, there is a clear move toward environmental accountability and regulatory alignment. Life cycle assessments (LCAs), REACH-compliant testing, and exploration of eco-friendly alternatives (as mentioned by Rezero and Earth Protex) are all part of a broader strategy to ensure that recycled materials not only perform well but also meet environmental and safety standards.

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Lastly, some companies are addressing systemic barriers to circularity, including the design and collection of end-of-life products. SPORTS CARBONE, for instance, proposes the creation of an eco-designed, supply chain-supported recovery system for composite bicycle frames - illustrating the need for structural and policy-level changes to enable more effective recycling outcomes.

In conclusion, the future work identified across these companies marks a critical and ambitious phase in material sustainability. While technical challenges remain, the alignment of innovation, collaboration, and industrial readiness positions these initiatives to make a tangible impact on both the circular economy and the broader sustainability goals of the plastics and composites industries. The next few years will be decisive in transforming these innovations from promising pilots into impactful, scalable solutions.

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7. Feedback on POLREC funding support scheme

The POLREC cascade funding scheme has demonstrated substantial value as a strategic enabler of innovation in the field of plastic and composite recycling, particularly within the European SME and startup ecosystem. Across the wide range of projects and organizations involved, the program has been consistently recognized for lowering barriers to participation, fostering experimentation, and enabling the rapid development of novel solutions targeting sustainability and circular economy objectives.

A standout feature of the scheme is its administrative simplicity. By streamlining application and reporting processes, POLREC has made innovation funding more accessible to smaller companies and first-time applicants who may lack the experience or resources to engage with traditional, centralized funding calls. This democratization of R&D funding plays a critical role in nurturing grassroots innovation and accelerating early-stage technology validation.

Additionally, the scheme has excelled in facilitating collaboration across different parts of the value chain. Many beneficiaries noted that the funding helped establish or deepened partnerships between SMEs, large companies, research institutes, and technology providers. This collaborative environment not only enhanced the relevance and practical application of project outcomes but also laid the groundwork for future industrial synergies and scale-up opportunities.

POLREC has also proven effective in derisking innovation, providing financial security to explore experimental and potentially transformative technologies. In many cases, the funding was described as essential for project execution—without which research would have been postponed or abandoned. This aspect underscores the scheme's importance in supporting risk-taking and long-term thinking in areas where commercial returns are not yet guaranteed.

However, while the benefits are clear, the feedback also highlights areas for enhancement. Many companies expressed a desire for longer project durations and increased funding ceilings, which would allow them to pursue more ambitious research agendas and move beyond feasibility studies into pilot-scale testing or early commercialization. Others pointed to rigid budgeting rules and delays in fund disbursement, which can disrupt project timelines and limit adaptability during execution. A more flexible and responsive funding structure - including quicker fund releases and allowances for internal cost coverage or budget reallocations - would further improve project delivery.

Furthermore, the continued development of a centralized digital platform for communication, project tracking, and cross-project networking could strengthen transparency and foster greater collaboration between beneficiaries working on related challenges. This would amplify the collective impact of individual projects and promote shared learning across the broader POLREC ecosystem.

In summary, the POLREC scheme represents a highly valuable and efficient funding model for supporting innovation in plastics recycling. Its success lies in its simplicity, agility, and focus on practical outcomes. By addressing the highlighted constraints - particularly around scale, flexibility, and support for post-project upscaling - POLREC has the potential to become a flagship mechanism for advancing Europe's circular economy goals, fostering a more sustainable and interconnected innovation landscape in the years ahead.

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8. Conclusion of project work

In conclusion, the POLREC project has successfully fostered significant advancements in sustainable polymer recycling through intensive cross-border collaboration among European SMEs, research institutions, and industry stakeholders. The Innovation Open Call for Mechanical Recycling proved highly effective, resulting in 15 impactful projects that advanced mechanical recycling processes and highlighted innovative solutions for polymer waste management.

Critical insights gathered during the project's duration demonstrated the substantial benefits derived from integrating external expertise, international collaboration, and strategic cross-sector partnerships. These interactions not only optimized recycling processes but also spurred business innovation, market opportunities, and significant advancements in business process innovation, enhancing operational efficiency and organizational capacity. Such improvements directly reinforce the European Green Deal objectives to reduce CO_2 emissions and dependency on virgin fossil resources.

Moving forward, the participating SMEs plan to scale innovative recycling solutions, refine recycling technologies, and enhance their circular economy strategies. The identified opportunities for technical optimization, industrial scalability, and regulatory compliance are set to significantly strengthen the marketability and environmental performance of recycled materials.

The POLREC funding scheme notably simplified access to essential innovation funding, significantly lowering entry barriers for SMEs. Despite its successes, feedback indicated that improvements such as longer project timelines, increased funding limits, enhanced budget flexibility, and streamlined administrative processes could further amplify the program's effectiveness.

Ultimately, POLREC has laid robust groundwork for continued sustainable innovation, contributing substantially to Europe's circular economy transition, strategic autonomy, and environmental sustainability goals. Sustaining and expanding these initiatives, including ongoing enhancements in business process innovation, will ensure ongoing progress toward achieving Europe's ambitious climate-neutral targets by 2050.

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PROJECT INFORMATION

Grant Agreement	Project 101074434 — POLREC
Programme	Single Market Programme (SMP COSME)
Call	SMP-COSME-2021-CLUSTER
Topic	SMP-COSME-2021-CLUSTER-01
Type of action	SMP Grants for Financial Support
Project Title	Supporting a green and resilient Europe through POLymer RECycling
Project starting date	1st September 2022
Project end date	31st August 2025
Project duration	36 months

PROJECT CONSORTIUM

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9. APPENDIX I – Summaries of POLREC projects

In this section a short presentation of all fully and partly completed mechanical recycling projects is given. Due to confidentiality reasons the projects are not presented in full length and technical details are omitted.

9.1 Summary of ALTHEORA - MOB-E-SCRAP Technology, for a better SMC cabinets recycling

ALTHEORA's idea is to recycle end of life composite cabinets. This is because the composite cabinets don't get reused when their task is done. The cabinets are made of composite SMC. The composite is made up of polyester, glass fiber and additives such as fire retardant and or anti-UV. They want to mechanical recycle the cabinet's glass fibers by delaminating them. This will reduce the amount of virgin glass fibers. The obtained results showed that glass fiber is being cut smaller than 70 mm. The fibers will undergo a new mixing with polyester resin which will give new molded composite material. The second run showed high influence from the following parameters being; air flow, rotation speed and second pass into the delamination machine, to obtain the best quality of recycled fibers.

9.2 Summary of Berbetores Industrial SL. – REAMSCRAP (Innovation and study of the development)

Berbetores Industrial explored the possibility of reusing ABS and HDPE plastic scraps in Big Area Additive Manufacturing (BAAM) to reduce environmental impact and support circular economy. Thermal and chemical analysis confirmed the materials' suitability, though challenges emerged during 3D printing trials. ABS showed limited printability due to its composition, while HDPE proved incompatible due to shrinkage from high crystallinity. A custom feeding system was developed, and demonstrators were produced despite printing limitations. Alternative methods like injection molding and hot-plate pressing were tested, with injection molding yielding strong results similar to virgin material. The project concluded that thermal stability and material shape are crucial for success in BAAM. Amorphous plastics perform better, and resin filling can improve printed part strength. Overall, the project supported Berbetores' Greendustrial strategy, showcasing how recycled plastics can be reintegrated into production and open new sustainable business paths.

9.3 Summary of CAMY SAS – Closed loop recycling of expanded EVA footwears from hospital activity

The project aimed to demonstrate closed-loop recycling of CAMY SAS's EVA hospital shoes using injection molding. Initial recycling of used foamed EVA shoes was limited to 20–30% due to cross-linking agents and existing patents, making full reintegration unfeasible. As a solution, a new recyclable thermoplastic EVA formulation without cross-linkers was developed using eco-friendly foaming agents. Two promising formulas - EVA18 + 2% EXP141/322 and QUEO + 1% EXP141/322 - were tested. Though effective in lab tests, these were incompatible with current injection setups. A new 2025 project is proposed to adapt molds and processes for hot material injection into cold molds. Plate-based recyclability tests showed both new materials could be 100% recycled without loss in performance.

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Key lessons included validated shredding and compounding processes and potential for performance enhancements. Limitations were mainly process incompatibilities with current equipment. The project sets the foundation for future innovation in recyclable medical footwear production.

9.4 Summary of Earth Protex Portugal - Tex2Tex's cutting-edge green solution - elastane dissolution in advanced polyester recycling

The POLREC project successfully developed and validated the Tex2Tex STOMP (Separation Technology of Mixed Polymers) process for the selective dissolution of elastane from polyester-based post-consumer textiles. The core objective was to identify and optimize environmentally benign solvents capable of dissolving elastane while maintaining the structural and chemical integrity of PET fibers. The solvent screening process encompassed biodegradability, process compatibility, recyclability, and adherence to REACH regulations (excluding SVHCs). A series of 16 solvent-based trials were conducted using gravimetric analysis, microscopy, and CIELAB colorimetry to quantitatively assess elastane extraction efficiency and dye removal. Laboratory-scale optimization was followed by semi-industrial trials that confirmed the scalability of the process, solvent recovery viability, and minimal polyester degradation. The system demonstrated the feasibility of integrated solvent recycling across multiple closed-loop cycles without compromising material quality. The resulting process represents a technically sound, sustainable solution for the recovery of pure polyester from blended textiles, with potential applicability in circular textile manufacturing systems.

9.5 Summary of Gaviplas – Ink removal technology for food contact applications

Gaviplas, in collaboration with Cadel, explored the use of deinking technology to recycle LDPE diaper packaging waste into food-contact quality plastic. The project aimed to produce high-quality recycled polyethylene by removing ink and contaminants from printed plastic films. The process included grinding, deinking, rinsing, drying, and regranulation. Analytical tests confirmed up to 100% decontamination efficiency, with minimal color difference ($\Delta L < 2$) between input and output material. Migration tests using TENAX® and acetic acid simulants showed that no harmful volatile substances were present and that non-volatile compounds remained well below EU 10/2011 limits. The recycled output material was confirmed safe for use in dry food packaging. Gaviplas envisions using this process to establish a closed-loop recycling model with its customers. A roadmap aligned with EU Regulation 2022/1616 outlines the steps for EFSA certification, to be led by EREMA, the technology's patent holder. This initiative positions Gaviplas to offer traceable, high-quality recycled products while reinforcing sustainability in hygiene and packaging sectors.

9.6 Summary of José Combalía - Polyethylene in the loop. All for crown cork process

The project focused on mechanically recycling two types of plastic waste from José Combalía: the inner layer of crown caps and shrink films. The aim was to reintegrate these materials into their production process to close the loop and reduce fossil-based resource use. For the crown cap liners, the recycled material had similar properties to the originals. However, for shrink films, performance varied based

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on thickness and recycled content, requiring further study. Two waste types were characterized for processability and thermal stability. Waste#2, the shrink film, underwent a complete recycling process including shredding, washing, flotation, drying, and extrusion. Recycled material was pelletized and used to produce films through a blown-film process. Tests showed optimal results at 220°C and varying recycled content levels. Mechanical performance of films improved with increased thickness. Films using up to 60% recycled content from waste#1 achieved comparable properties to virgin films, while waste#2 needed thicker films (approx. 35µm) to reach similar quality.

9.7 Summary of Mälarplast - Maximizing sustainability by recycling bioplastics

Mälarplast, together with CemeCon, sought to improve moulding of recycled bioplastics—especially PLA with 40% hemp fiber—by applying PVD coatings to reduce tool wear and maintenance. The uncoated tools suffered from rapid degradation and buildup, requiring chemical cleaning after as few as 2,000–5,000 cycles. With CemeCon's HiPIMS CrN coating, tool surfaces showed improved durability, reduced residue, and faster cleaning (30 min reduced to 5 min). This allowed successful moulding with up to 100% recycled PLA, meeting all product quality standards. Trials extended to other tools—the blender tamper (recycled PET) and the fäste part (recycled PP). The fäste tool saw clear gains in cleanliness and ease of maintenance, while the blender tamper still faced demoulding issues, prompting testing of a HyperSlip TAN coating. Mälarplast now aims to expand this solution across more products and source external recycled material, reinforcing its goal of reducing virgin plastic use and supporting circular production.

9.8 Summary of PDC-Plast A/S - Production of component in recycled plastics

PDC-Plast aimed to manufacture high-quality golf discs using 30% recycled thermoplastic polyurethane (TPU), but severe demoulding issues made this unfeasible with traditional tools. The company collaborated with CemeCon to apply Physical Vapor Deposition (PVD) coatings, specifically HyperSlip CrN, to improve tool performance. The coating enhanced hardness, reduced plastic adhesion, and improved wear resistance. After coating, production with virgin TPU showed a drop-in scrap rate from 85% to 2%. With recycled TPU, production—previously impossible—became feasible under the same parameters, also achieving a 2% scrap rate. Maintenance needs and cleaning effort were significantly reduced. PDC-Plast successfully produced around 30,000 parts with recycled content. Encouraged by these results, a second product line—plastic funnels made from polypropylene—was selected for similar coating treatment. This line aims to reduce scrap from 10% to 1% while integrating 30% recycled material. Tool coating was in progress at project conclusion, showing strong potential for wider application.

9.9 Summary of RecyOuest - Recyclability study of HDPE agricultural nets

RecyOuest, a startup focused on recycling agricultural bale nets, aimed to evaluate the feasibility of closed-loop recycling of high-density polyethylene (HDPE) for use in melt spinning applications. The project targeted the development of eco-designed collection bags by producing yarns incorporating at least 25% recycled HDPE (rHDPE). Three rHDPE material references were tested: Ref 2023, Ref 2024 (with 3% Adflex), and Ref 2024f (with advanced filtration). Initial characterizations revealed trace contaminants in all three, with spinning quality deemed too low without blending with commercial

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materials. Monofilament spinning was successful at 25% rHDPE, approaching RecyOuest's quality standards. However, multifilament spinning failed due to high contamination levels. The most promising material, Ref 2024f, was used for a full eight-month study, demonstrating that spinning monofilaments with recycled HDPE is technically achievable under certain conditions.

9.10 Summary of Rezero - Mechanical recycling of unused cigarette filters

The project aimed to recycle cellulose acetate (CA) fibres from cigarette filters for use in nonwoven applications like wipes, insulation, and garment wadding. Key objectives included fibre length analysis, sourcing European suppliers, fibre comparison, mechanical recycling optimization, and evaluating nonwoven properties—all of which were met except for physico-chemical analysis due to lab limitations. Mechanical recycling trials successfully extracted long fibres, especially from washed filters without paper. Tests using different nonwoven techniques (Airlay, carding, needle punching, etc.) confirmed the fibre's potential, especially when blended with PET or Lyocell. CETI produced 14 sample materials, demonstrating various application possibilities. Positive outcomes included successful fibre reuse, process flexibility, and valuable industry collaboration. Challenges included maintaining fibre length, complete paper separation, and the need for further process optimization for industrial scaling.

9.11 Summary of Sports Carbone - Recycling of carbon fiber sports equipment (bicycle)

The project aimed to develop recycling solutions for carbon fibre sports equipment, focusing on bicycles. It evaluated technical, economic, and environmental aspects of recycling carbon fibre frames. Major brands provided broken frames, and testing showed that 90% were repairable at a lower cost. However, the carbon fibre content in frames is relatively low due to embedded metals. For the remaining 10%, a steam thermolyzing process was used to recover fibres, though the cost remained higher than virgin material. Various depolymerization techniques were tested to preserve fibre quality, achieving 70% modulus and 40% stress retention. Key lessons included the need for trained facilities, the technical feasibility of fibre recovery, and the early-stage maturity of recycling technologies. The project successfully demonstrated a circular approach for carbon fibre reuse in cycling.

9.12 Summary of Total Plastic Solution - Innovative recycling of contaminated polypropylene from cosmetic packaging production

The project targets the recycling of contaminated polypropylene powder from cosmetic packaging, focusing on removing Trim C276 coolant and water residues. The goal is to enable reuse of this waste material, reducing reliance on virgin PP and promoting circularity. A major technical challenge was optimizing the drying process, which proved more complex than anticipated. Thermogravimetric Analysis confirmed that Trim evaporates fully at ~250 °C, guiding decontamination parameters. A series of analytical techniques were tested to detect Trim, with FTIR spectroscopy emerging as the most reliable method. A water-based washing process without detergents was developed, followed by sieving and drying. Washed PP was pelletized and mechanically tested. Results showed slight improvements in tensile strength and elongation, with minimal variation in Melt Flow Index, confirming retained processability. The approach proved both efficient and scalable, supporting broader goals of sustainable plastic recycling in industry.

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9.13 Summary of Prewaste - Open-loop recycling of mixed plastic waste to produce non-structural components

The project aims to transform hard-to-recycle mixed plastic waste into durable urban elements using open-loop mechanical recycling. By combining low-value post-consumer waste (minority part) with more stable polymers like PP and HDPE (majority part), the team developed optimized blends for injection molding. Tests showed that incorporating up to 50% of the minority part is feasible, improving impact resistance while slightly reducing stiffness and strength. The methodology included raw material pre-treatment, advanced chemical-mechanical characterization, and compatibility enhancement using a specialized additive. The blends met essential thermal and mechanical criteria, supporting their use in public infrastructure. Key challenges included contamination, variable flow properties, and analytical equipment downtime. These were overcome through flotation-based cleaning, parameter optimization, and strategic testing workarounds. A notable outcome was the high miscibility between LDPE and HDPE, enabling uniform material performance. Overall, the project demonstrated that undervalued plastic waste can be successfully valorized into functional, sustainable products for circular economy applications.

9.14 Summary of BIOWRAP - Recycling scraps from compostable stretch film

BIOWRAP is a company specializing in the production of bio-based and biodegradable products, such as bags and wrap films. In 2021, the company developed and patented a compostable stretch film known as FE23.

Production and commercial sales of FE23 began in 2023. However, one of the primary challenges encountered was the recycling of production scrap using conventional recycling partners, who typically handle other types of compostable films. These partners faced difficulties integrating FE23 waste into their standard processes.

To address these technical issues, BIOWRAP engaged the service provider GBCC to identify a viable recycling solution. Initial trials involved using single-screw extrusion to produce recycled pellets. Unfortunately, the resulting pellets exhibited stickiness due to additive migration, which compromised processing quality.

The next step was to transition to twin-screw extrusion, which promised better dispersion of additives and improved pellet stability. However, this plan was never fully implemented, as the project was halted following the compulsory liquidation of BIOWRAP.

9.15 Summary of Paltech - rPET matrix development for the production of utility poles

The project aimed to enhance the crystallinity control and mechanical performance of rPET in glass-reinforced utility poles through material blending and process optimization. Initially focused on rPET, the project expanded to include rPETG and polyolefin blends, as well as extensive DSC, rheological, and mechanical testing. Task 2 involved compounding, injection moulding, and compression moulding trials, showing that rPETG reduced crystallinity and improved ductility, while glass fibres significantly boosted strength. Moisture and cooling rate studies revealed critical influences on brittleness and void

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formation. Task 3 highlighted key learnings: slow cooling increased brittleness, undried materials led to cracking, and flake feedstock minimized voids. Unexpected high viscosities posed processing challenges, but optimized venting and temperature control yielded consistent results. The experience underscored the importance of moisture control, blend selection, and processing conditions for reliable rPET composites.



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