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PLAN-C: DRIVING CIRCULARITY IN THE PLASTICS AND MACHINERY INDUSTRIES IN THE DANUBE REGION

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Introduction

The transition from a linear to a circular economy presents significant challenges for the plastics and machinery industries, particularly in the South/Eastern Danube Region, where recycling infrastructure and industrial expertise remain limited. The Plan-C project (Moving PLastics and mAchine iNdustry towards Circularity) brings together 14 partners from nine countries to address these challenges by fostering transnational cooperation, stakeholder engagement, and collaborative innovation. The project aims to transform plastics and machinery value chains through co-created solutions that promote reuse, repair, remanufacturing, and sustainable industrial practices, while supporting regional competitiveness.

Methodology

Plan-C is based on the five-stage Design Thinking methodology: Empathize, Define, Ideate, Prototype, and Test. Through transnational workshops, qualitative data were collected from experts, researchers, SMEs, and policymakers across the Danube Region. Iterative cycles allowed partners to identify key challenges, co-develop context-sensitive circular solutions, and refine scenarios for the plastics value chain. The resulting prototypes and guidelines provide practical, scalable solutions, directly informing the Transnational Plan-C Action Plan, a strategic roadmap for implementing circular principles in industrial practices and policy frameworks.

Results and conclusions

Recycling rates in the Danube Region remain below optimal levels. In 2020, only around 40% of polyethylene films were collected, while in 2023, collection of high-density polyethylene and polypropylene reached approximately 50%, and polyethylene terephthalate about 60%. As a result, merely 27% of plastic waste is effectively reprocessed, underscoring the need for innovative, multi-level solutions.

The application of the Design Thinking methodology allowed the identification of persistent challenges in plastics recycling across the Danube Region, highlighting gaps in collection, sorting, and material recovery. Based on the analysis of challenges and opportunities across legal, technical, economic, societal, and environmental dimensions, it is evident that while each partner country exhibits unique circumstances, there are significant commonalities. Key obstacles include outdated infrastructure, low recycling rates, regulatory gaps, and limited public awareness, whereas opportunities lie in adopting advanced recycling technologies, improving policy frameworks, leveraging EU funding, fostering cross-sector

collaboration, and promoting circular economy education. These insights provide a multi-dimensional understanding of the regional context, guiding the design of targeted interventions and scalable circular solutions for the plastics and machinery industries within the Plan-C framework.

To address these challenges, Plan-C partners developed a set of diverse, context-sensitive prototypes, ranging from methods to convert hazardous recycling sludge into building materials, to modular insulation panels from recycled plastics for construction applications, smart watering cans designed for easy disassembly and recycling, 3D printer extruders producing filament from recycled granulates, and processes to transform automotive production scraps into customizable plastic films. In addition, chemical recycling approaches, such as PET catalytic glycolysis (Figure 1), illustrate the potential for transforming plastic waste into new materials, further diversifying circular solutions.

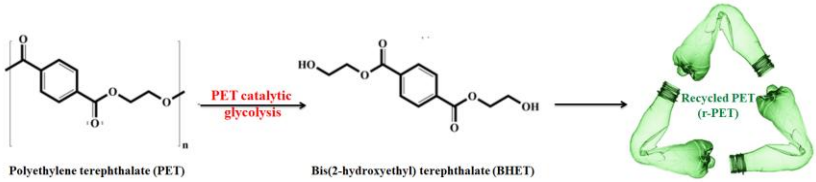

Figure 1. Schematic representation of PET chemical recycling by catalytic glycolysis into BHET, enabling the production of recycled PET (r-PET).

Complementing these innovations, Romania aims to develop CircularPlastHub, a digital ecosystem facilitating networking, knowledge exchange, and coordination among stakeholders engaged in circular plastics initiatives. While not a physical product, it enables collaboration, accelerates adoption of circular practices, and supports the scaling of solutions across the region.

These initiatives demonstrate a comprehensive approach—industrial, digital, and chemical—towards circularity. Finally, the Transnational Plan-C Action Plan is expected to consolidate these insights into actionable measures for SMEs, large enterprises, sectoral agencies, and policymakers. Once developed at the end of the project, it will aim to foster eco-innovation, regional clustering, and policy alignment, strengthening industrial resilience, resource efficiency, and sustainability, and providing a replicable model for circular economy implementation across the Danube Region.

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