Interreg CENTRAL EUROPE

Co-funded by the European Union

GreenChemForCE

Deliverable D.1.2.1
PILOT ACTION REPORT

Interreg Central Europe project CE0200857 GreenChemForCE

Version 1

November 25

DELIVERABLE D.1.2.1
PILOT ACTION REPORT

Activity 1.2. Development of sustainable technologies for key plastic components and circularity in plastic production

CONTENT

Chapter 1 – Introduction and Background

1.1. Purpose and Scope of the Report

This report aims to support and describe Output 1.3: Pilot actions for sustainable plastic management in Central Europe. It provides a detailed overview of the pilot, including its structure, the collaboration network, roles and contributions of partners, obtained results, and implementation framework.

1.2. Definition of the output according to AF

Pilot actions jointly developed will include planning of experiments and testing of procedures and approaches in laboratory scale to identify the sustainable starting materials for nylon production and methods for recycling of nylon waste. This will lead to the outline of methods suitable for developing the solution in the next phase of the project and serve as a showcase for the implementation of sustainable technologies and circularity within plastic production.

1.3. Background

Plastic recycling in Central Europe is gaining importance as part of the shift toward a circular economy. Globally, only about 9% of plastic waste is recycled, while the European average reaches around 20%, with Central Europe slightly below this level. Chemical recycling, however is still at the low level. Despite progress, much plastic waste is still landfilled or incinerated. Improving sorting technologies, expanding recycling capacity, developing new technologies, and strengthening regional cooperation are essential to increase recycling rates and reduce environmental impacts across the region.

Nylon-6 is produced on a large scale worldwide and is especially important in sectors such as automotive engineering, electrical components, textiles, and packaging. It is the most common type of polyamide on the market. Industry analyses report that global manufacturing capacity reached roughly 6.8 million tons in 2018, reflecting strong growth—driven in particular by major capacity expansions in China over the previous decade. By 2024, worldwide capacity is expected to approach 8.9 million tons.2,3 Although nylon-6 is durable and therefore tends to accumulate in the environment, it also carries a comparatively high market value, significantly higher than that of common plastics such as polyethylene.4,5 These characteristics make the recovery and recycling of nylon-6 both economically attractive and environmentally necessary.

Chapter 2 – Pilot Description

2.1 Structure of the Pilot and Collaboration Network

The pilot action consists of two levels: technology development and connecting regional companies to engage into collaboration to boost circularity in the chemical recycling of plastic waste. The first level focuses on advancement of a circular technology for the chemical recycling of waste nylon 6 materials (old carpets, fishing nets, fabric scraps, etc.). The process involves depolymerizing post-consumer and pre-consumer nylon 6 waste into its monomer, ε-caprolactam, followed by repolymerization into new, high-quality nylon 6. This closed-loop approach enables continuous material recovery, reducing reliance on virgin fossil-based resources and significantly lowering the environmental impact associated with nylon production and disposal.

The initiative is jointly carried out by the University of Ljubljana (SLO, project partner) and AquafilSLO (SLO, associated partner), integrating academic innovation with industrial know-how to advance scalable recycling technologies. Within the framework of the pilot, the Association of the Czech Chemical Industry (CZ, project partner) plays a key role in identifying potential Czech partners who could adopt or collaborate on this technology by providing the suitable feedstock (waste material), representing the second level of the pilot action. This cross-border cooperation reinforces regional circularity, strengthens industrial symbiosis between Slovenia and the Czech Republic, and contributes to the broader transition toward a sustainable, low-carbon materials economy in Central Europe.

2.2 Technical Background of the pilot action

A key element of the pilot action is the industrial plant at Aquafil facility in Ljubljana where occurs the chemical depolymerization of waste nylon 6. In this process, the long polymer chains are broken down into their original monomer, ε-caprolactam. This monomer can then be reused to produce new nylon of the same quality as virgin material. Unlike mechanical recycling, which gradually degrades the polymer, chemical depolymerization enables continuous material recovery and supports a true circular approach to nylon production, turning waste into a high-value resource.

The developed technology is suitable for recycling a variety of nylon 6-containing waste, including old carpets, fishing nets, and fabric scraps, allowing post-consumer and pre-consumer materials to be reintegrated into the production cycle.

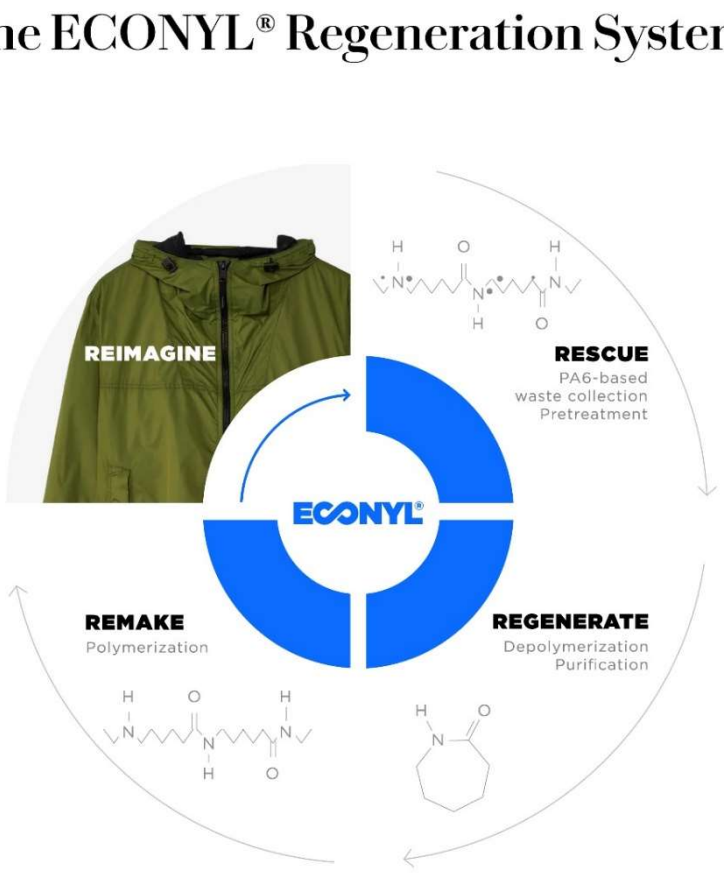

Figure 1. Circularity in the chemical recycling of nylon waste.

2.3 Reinforcing the Circularity in Chemical Depolymerization of Nylon 6 in the Region

Within the framework of the pilot, the Association of the Czech Chemical Industry (SCHP CR) conducted a search among its portfolio companies and in collaboration with other relevant associations, including the Czech Textile Association, to identify potential partners for cross-border collaboration. Following discussions with Aquafil representatives, it was clarified that the potential cooperation could take two forms: a) the provision of post-consumer textile waste from regional companies to Slovenia for depolymerization, or b) the introduction of recycled nylon 6 into the Czech market.

With the support of the Czech Textile Association, SCHP CR identified a Czech textile company TEBO a.s. interested in participating in the regional collaboration focused on the circular production of nylon 6. This company (amongst other) handles post-consumer textile waste and is capable of supplying material at a large scale (tons) to AquafilSLO. For the pilot, a representative one-kilogram sample of pre-consumer textile waste was sent to AquafilSLO, where it underwent an initial assessment to evaluate its suitability for the chemical depolymerization process. The analysis showed that the material contains 98% of PA6 (+/- 2%), the impurities both of polymers and inorganics are negligible. These values allow for further discussion regarding the possibility of regenerating the material in the Econyl® process.

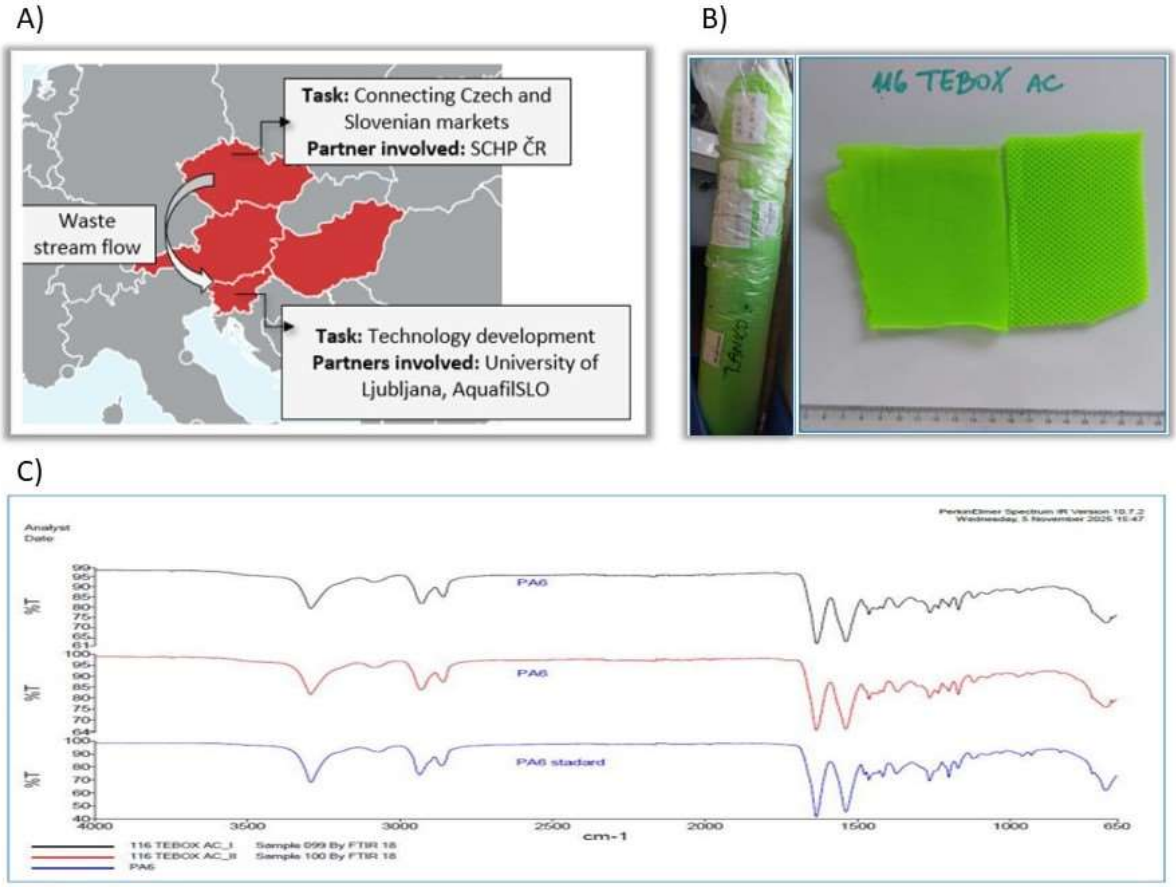

Figure 2. A) Overall structure of the Pilot Action. B) Tebo a.s. sample. C) FT IR Analysis demonstrating suitable composition of the sample.

Chapter 3 – Implementation Framework

The pilot results will be implemented by AquafilSLO, which will process post-consumer textile waste through chemical depolymerization to produce high-quality nylon 6, in close cooperation with regional companies supplying the waste. This approach highlights the local and cross-border dimension of the pilot, demonstrating how textile waste from the region can be reintegrated into the production cycle and supporting a circular economy in Central Europe.

Chapter 4 – Conclusions and Outlook

The pilot action demonstrates that cross-border cooperation, combined with advanced chemical recycling technologies, can significantly enhance circularity in nylon 6 value chains across Central Europe. The collaboration between research institutions, industry partners, and regional associations has proven effective in identifying suitable waste streams, validating their recyclability, and establishing pathways for their reintegration into high-quality material production. The successful assessment of Czech textile waste and its compatibility with the Econyl® process confirms the feasibility of expanding circular practices beyond national borders. Building on these results, the next phase will focus on scaling up of the procedure, improving material collection systems, and further optimizing depolymerization processes. Ultimately, the pilot provides a strong foundation for broader implementation of sustainable plastic management solutions within the region.

References

1. https://plasticseurope.org/knowledge-hub/plastics-the-fast-facts-2024/

2. Global nylon 6 production capacity reach to 8.86 million tons in 2024. HDIN Research, https://www.hdinresearch.com/news/56 (accessed 5/16/2024).

3. Ind. Eng. Chem. Res. 2024, 63, 40, 16953−16989

4. Pa6 (nylon 6) price index. business analytiq, 2024. https://businessanalytiq.com/procurementanalytics/index/pa6-price-index/

5. Ryba, A.; Youngman, A. US polyethylene price evolution and what to expect. McKinsey & Company, 2022. https://www.mckinsey.com/industries/chemicals/our-insights/us-polyethylene-price-evolution-and-what-to-expect