REFLOW - Adaptive and Circular Manufacturing of Modular Filtration Systems from Thermoplastic Waste

Abstract:

REFLOW addresses the challenge of recycling cross-linked polyethylene (XLPE), with only 5% of the 250,000 tons generated annually in Europe being recycled. The project develops a low-temperature de-crosslinking process, reducing energy use by 25% and enhancing recycled XLPE properties to match virgin material (15–25 MPa tensile strength). IoT analytics ensure real-time quality control and process consistency. To validate the secondary material, REFLOW develops modular wastewater filtration systems from recycled XLPE, achieving over 90% pollutant removal, complying with the EU Water Framework Directive.

Countries involved

Application sectors
Consumer goods, Capital goods

Research and innovation domains
Advanced manufacturing processes, Sustainable manufacturing

Total cost in M€ (millions)
3.3 M€

Starting date
01/07/2026

Duration (in months)
36 months

Project leader
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Roto ECO podjetje za predelavo in trženje d.o.o.

Project participans
ROTO ECO (SI)
Brunel University of London (UK)
C4 Polymers Ltd (UK)
Peak to Peak Measurement Solutions Ltd (UK)
Gulsine Ltd (UK), Hidrostation (PT)

RATIONALE OF THE PROJECT

Cross-linked polyethylene (XLPE) is widely used in power cables, automotive components, and construction due to its chemical resistance and thermal stability. However, its dense covalent cross-link network makes it incompatible with conventional recycling. In Europe, over 250,000 tons of XLPE waste are generated annually, yet less than 5% is recycled — the remainder is incinerated or landfilled.Existing recycling methods — pyrolysis, grinding, chemical treatment — are energy-intensive, economically non-viable, and degrade polymer chains, yielding materials unsuitable for high-performance applications. Without real-time quality control, manufacturing systems cannot compensate for the inherent variability of recycled XLPE feedstock.These challenges result in manufacturers avoiding recycled XLPE entirely, reinforcing dependence on virgin fossil-based materials and blocking progress toward circularity. REFLOW addresses these technological, environmental, and economic bottlenecks by developing a scalable low-temperature de-crosslinking process, high-performance recycled XLPE compounds, IoT-enabled quality control, and modular smart filtration systems — creating a complete circular solution for one of Europe's most persistent plastic recycling challenges.

TECHNOLOGICAL INNOVATION, ACHIEVEMENTS AND RESULTS

REFLOW introduces four interlinked innovations advancing beyond the current state of the art: 1. Low-Temperature De-Crosslinking: A reactive extrusion process operating at ~250°C — compared to pyrolysis at >400°C — selectively cleaves XLPE cross-links while preserving polymer backbone integrity, reducing energy consumption by 25% and achieving ≥90% de-crosslinking efficiency.

2. High-Performance Recycled XLPE Compounds: Through compatibilizers and stabilizers integrated during extrusion, REFLOW produces compounds with tensile strength of 15–25 MPa and elongation of 60–80%, matching virgin XLPE performance — enabling use in structural, automotive, and infrastructure applications.

3. IoT-Enabled Real-Time Quality Control: Industrial-grade sensors measuring viscosity, temperature, pressure, and flow rate, connected to predictive analytics via edge computing, reduce manufacturing defect rates by up to 15% compared to conventional batch-based QA systems.

4. Smart Modular Filtration Systems: Modular filtration units manufactured from recycled XLPE achieve ≥90% removal of hydrocarbons and heavy metals — surpassing the ~70% industry benchmark — with integrated IoT monitoring ensuring compliance with EU Directive 2020/2184.

Project results will be demonstrated at TRL 7–9, including a validated pilot line processing 1,000 tons/year of XLPE waste.

MARKET POTENTIAL

REFLOW targets three converging markets: advanced polymer recycling, industrial water filtration, and IoT-enabled process control. In Europe, manufacturers currently pay €300–600/ton to dispose of XLPE waste, representing a €75–150M annual burden with no material recovery value. REFLOW converts this cost centre into a viable product stream. The accessible market for structural-grade recycled XLPE is conservatively estimated at €80–100M across Europe over 5–7 years. In filtration,

REFLOW targets industrial users facing compliance upgrades under EU Urban Wastewater and Industrial Emissions Directives — an underexploited €100–150M segment across Southern and Central Europe. Partners hold established market positions: ROTO ECO in sustainable polymer manufacturing, C4 Polymers in high-performance compounding, Hidrostation in Southern European water treatment, and Peak to Peak in industrial IoT. Combined projected revenue growth reaches €6–8M annually within four years post-project.

IMPACT POTENTIAL

REFLOW increases XLPE recyclability from ~5% to 7.5% by 2029, processing 1,000 tons annually at pilot scale and avoiding over 900 tons of CO□ emissions per year. Smart filtration systems achieve 90% removal of hydrocarbons and heavy metals, exceeding EU standards. The project supports EU Circular Economy Action Plan and Green Deal objectives, reduces landfill dependency, and decreases reliance on virgin fossil-based polymers. An estimated 50–70 high-skilled jobs will be created across Slovenia, UK, and Portugal, with commercialization projected to generate €6–8M in combined annual revenue within four years.