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presents

Bioplastic Packaging Design: Safe, Sustainable and Recyclable

How to design bioplastic packaging to make it safe, sustainable, recyclable and also compliant? Which outstanding results have been produced in research in the last months?

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BIOPLASTIC PACKAGING DESIGN: SAFE, SUSTAINABLE AND RECYCLABLE

An in-person event for discovering the latest outstanding R&I results and exploring opportunities for scaling them up

1 December 2025
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About us

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Contributing projects

The projects E-OILE', BioPackMan, UPCYCLE, GRECO and Be-UP are funded by the European Commission under the European Union Research and Innovation Programme Horizon Europe. ReBioCycle and MoeBIOS is funded by the Circular Bio-Based Europe Joint Undertaking under the European Union's Horizon Europe research and innovation programme

Introduction

Biodegradable polymers for sustainable packaging materials

European Bioplastics: Chiara Bearzotti and Estela López-Hermoso

Five projects have been funded under a specific call of the Horizon Europe programme to collectively advance the next generation of biodegradable polymer materials and drive the transition toward sustainable packaging solutions across Europe: E-OILE', BioPackMan, UPCYCLE, GRECO and Be-UP. Building on the strategic priorities outlined in the funding call, these projects **will deliver innovative materials and robust evidence to support the packaging industry's shift away from conventional plastics toward environmentally responsible alternatives.**

The funded projects are designed to contribute to three key outcomes that will transform the packaging sector:

- First, the projects will provide the packaging industry with access to next-generation biodegradable polymer materials that can be recycled through novel organic processes. Through their research and development activities, they will enable materials producers to transition from PP, PE, and PET to biodegradable materials, thereby significantly reducing GHG emissions across the entire value chain.

- Second, the projects will support the packaging industry in implementing circularity-by-design business models and sustainable end-of-life approaches for plastic packaging materials. Their work will demonstrate the potential to substantially reduce landfill waste volumes and contribute to achieving the ambitious littering reduction targets outlined in the Horizon Europe Ocean and Waters mission, the plastic pollution reduction goals of the Single-use Plastics Directive, and the EU Circular Economy Action Plan (CEAP).

- Third, the projects will advance the development of testing standards and application-specific labels for biodegradability in open environments, providing the certification frameworks necessary for market adoption and regulatory compliance.

To achieve these outcomes, each funded project addresses at least four of the following integrated activities.

Development and Scale-up of Advanced Bio-degradable Polymers

The projects will develop, demonstrate, and scale up novel, advanced, biodegradable polymer materials and innovative production processes that enable large-scale production of these polymers with economies of scale comparable to those of existing production methods. The materials will demonstrate improved or comparable technical performance, production costs, and end-of-life characteristics relative to current PP, PE, PET, and conventional biodegradable polymers.

Production System Innovation

The funded projects will develop cost-effective additives and catalysts to support industrial-scale production of biodegradable polymers, ensuring that the manufacturing processes are economically viable and technically robust.

Life Cycle and Techno-Economic Assessment

The projects will provide extensive evidence through Life Cycle Assessment (LCA) and Techno-Economic Assessment (TEA) demonstrating that the costs of the novel, advanced biodegradable polymer products are not significantly higher than those of existing polymer products (PE, PP, PET) currently on the market. This analysis will provide the economic justification for industry adoption.

Pilot-Scale Production and Testing

The funded projects will scale up the production of packaging materials to pilot level, enabling practical demonstration and validation of the materials in real-world applications.

Biodegradability Pathway Characterisation

The projects will identify and rigorously test the biodegradability pathways in all environmentally relevant conditions for the application of the developed materials. This includes comprehensive assessment across various relevant forms (landfill, compost, soil, litter in marine environments, continental freshwater, and marine offshore environments), supported by extensive quantified risk analysis from both human and environmental perspectives.

Environmental Impact Assessment

The funded projects will conduct a thorough assessment of all biodegradable intermediates and end products, including quantifying their contributions to GHG emissions. They will model the complete lifetimes of the developed polymers along their biodegradation pathways under environmentally relevant conditions across human, terrestrial, and marine environments, as well as in waste processing facilities.

Biodegradability Demonstration in Real Conditions

The projects will demonstrate complete biodegradability and compostability in all relevant conditions and environmental compartments, including landfill, compost sites, litter in marine and continental freshwater environments, and offshore marine environments. This work will identify the main environmental conditions influencing biodegradation rates and pathways and assess their impact.

Through this coordinated portfolio approach, the five funded projects will deliver the scientific evidence, technical innovations, and practical demonstrations needed to accelerate the adoption of truly biodegradable packaging materials across European markets.

Öast but not least, two additional projects will be present at this event: **MoeBIOS and ReBioCycle.**

Both MoeBIOS and ReBioCycle address the fundamental challenge of establishing **viable recycling pathways for biobased and biodegradable plastics within Europe's circular economy**. The projects address the critical gap between laboratory-scale recycling solutions and demonstration-scale implementation, advancing technology readiness levels from experimental phases to pilot and industrial integration within existing waste management facilities.
A central challenge both projects tackle is the sorting and separation infrastructure for bioplastics and their capacity to efficient recovery of biobased materials like PLA, PHA, PBS, and bio-composites from mixed waste streams. Both initiatives recognise that effective near-infrared sorting technologies and pre-treatment processes must be developed and validated at demonstration scale to enable the separation of specific bioplastic types from mixed municipal and industrial waste streams.

The projects address the technological challenge of recycling complex bioplastic materials through multiple innovative pathways, including **mechanical, chemical, enzymatic, and microbial recycling processes**. They aim to prove that biobased, biodegradable plastics can achieve the same or superior quality as virgin materials after recycling, thereby countering the widespread perception that biodegradable plastics cannot be effectively recycled and must only be composted or incinerated. This quality verification is essential for gaining acceptance from biopolymer producers, brand owners, and waste management operators who need assurance of material performance in real-world packaging applications.

Both MoeBIOS and ReBioCycle recognise the economic viability challenge: by establishing waste-processor-centric demonstration hubs across multiple European countries and integrating novel recycling processes into existing industrial facilities, the projects aim to demonstrate financial feasibility and scalability without disrupting current operations. This approach seeks to create compelling business cases that will attract investment from waste management companies and support the transition toward circular bioplastics value chains, ultimately contributing to European policy frameworks, including the Bioeconomy Strategy, Circular Economy Action Plan, and Packaging and Packaging Waste Regulation.

In this document, you will find an overview of these seven projects.
Happy reading and happy matchmaking!

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The projects

Sustainable end-of-life routes for single-use monodose packaging for oily products (E-OILE')

Near-market biodegradable packaging solutions for oily products

Fundacion Gaiker: Mª José Suárez, Coordinator

The packaging industry accounts for approximately 60 % of post-consumer single-use plastic (SUP) waste, much of which ends up as litter in natural environments. Rapid consumption patterns and safety concerns complicate effective recycling. The EU-funded E-OILÉ project will develop near-market biodegradable packaging solutions using novel biopolyesters and polysaccharides. These materials are designed to improve barrier and mechanical performance, replacing polyolefins and polyethylene terephthalate (PET) in single-use packaging. The project will focus on ecodesigned biodegradable monomaterials and coatings, following the SSbD (Safeguarding Sustainability by Design) framework. E-OILÉ's circular business model addresses food and cosmetic products through four use cases: olive oil, oily sauces, body oil, and oil serum, demonstrating complete biodegradability according to relevant standards.

Objective:

The packaging industry is responsible for around 60% of post-consumer SUP waste, which is most likely to end up as litter in natural environments. While factors such as rapid consumption patterns, safety concerns, or compact size hinder the effective recycling of packaging waste, the need for safe, biodegradable alternatives is imperative. E-OILÉ will address safe and sustainable biodegradable packaging solutions close to the market by:

a) demonstrating at TRL 7 cost-effective production of biodegradable materials based on novel biopolyesters and polysaccharides, engineered to enhance barrier and mechanical performance, to replace Polyolefin materials (PP and PE) and PET in monodose packaging solutions ecodesigned as biodegradable monomaterial structures or in combination with coating technologies and following the SSbD framework;

b) implementing a circular business model, food and cosmetic products, through 4 Use Cases (UC): Olive oil- UC1; oily sauces- UC2; Body oil- UC3 and Oil serum- UC4);

c) validating the packaging performance, shelf life, safety and sustainability along the whole supply chain (from material producers to end users) and demonstrating complete biodegradability following relevant standards and in environmentally relevant conditions and, therefore, sustainable End-of-Life (EoL) pathways for the new packaging solutions in combination with the use of Artificial Intelligence (AI) and advanced modelling mechanisms for digitally-assisted accurate prediction of degradation processes.

Connect: https://www.linkedin.com/company/e-oil%C3%A9-horizon-europe-project/

Biodegradable packaging materials advancing circularity, sustainability and ecoinnovation (BioPackMan)

Adaptable and recyclable biodegradable packaging materials

National Technical University of Athens (NTUA)
Tatjana Kosanovic Milickovic, Coordinator

Food and material packaging is dominated mainly by unsustainable solutions that often use materials like plastic, leading to large quantities of waste and requiring unsustainable manufacturing processes. This creates a strong need for green and sustainable packaging solutions. The EU-funded BioPackMan project will design and develop biodegradable compounds based on biodegradable polymer materials, enabling recyclable packaging with chemical resistance, thermal stability, gas permeability, and application-specific mechanical strength. Furthermore, to meet diverse packaging requirements, the project will develop compounds with tailored morphology, allowing them to meet specific needs. Finally, it will establish a complete value chain to maximise sustainability and innovation.

Objective:

The design of biodegradable polymer materials (BDPM) is at the core of BioPackMan, aiming to explore an extended material design space of Polyhydroxyalkanoates (PHAs), Poly(butylensuccinate) and its copolymers (PBS, PBSA) and Polylactic Acid (PLA) to develop tailored compounds that harness synergistic effects, leading to biodegradable, recyclable packaging with application-specific mechanical strength, thermal stability, chemical resistance and gas permeability. Biodegradable compounds will be developed with tailored morphology to meet diverse flexible & rigid packaging requirements and also embrace a 'biodegradation as a system property' approach from initial material and packaging design, considering specific environmental conditions for intended and unintended disposal pathways. By establishing a complete value chain (material producers, compounders, packaging converters, and end users), BioPackMan aims to provide a complete set of compounds, sustainable additives, and innovative processing technologies for the production of sustainable packaging demonstrators for the food, home care, and personal care sectors. The target is to achieve benchmark fossil-based product quality, ensuring compliance and safe use in packaging, and showcasing that BDPMs can be recycled. Circularity, safety, and sustainability are considered at all stages of development through the SSbD framework, and liaise with society and industry to assure interaction, knowledge exchange, and the adaptation of circular business models. To secure societal impact, stakeholders will be involved early in the project to identify barriers and facilitate the adoption of sustainable practices.

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BioPackMan

Sustainable plastic biorefinery for recyclable and biodegradable packaging (UPCYCLE)

A new biodegradable life for non-recyclable mixed plastic waste

Aalborg University: Cristiano Varrone, Coordinator

Green and sustainable technologies must be harnessed to combat climate change and reduce the impact of several environmental crises. Recycling has been leading this effort, yet some materials, such as mixed plastic waste, cannot be recycled and lack sustainable end-of-life solutions. The EU-funded UPCYCLE project aims to create circular value chains that transform non-recyclable mixed plastic waste into biodegradable and recyclable packaging materials for packaging applications. The project will address key scalability hotspots to achieve economic feasibility. It will also follow a safe-and-sustainable-by-design framework to reduce GHG emissions as it scales up its plastic biorefinery and ecopolymers.

Objective:

UPCYCLE aims to demonstrate novel circular value chains that transform non-recyclable mixed plastic waste into biodegradable, recyclable materials for packaging applications. Building on the promising results of the H2020 UPLIFT project, UPCYCLE addresses specific scalability hotspots to reach economic viability. The project scales up its novel plastic biorefinery and ecopolymers with a strategy that leverages: (1) A Safe-and-Sustainable-by-Design framework to ensure safety (i.e., non-toxic materials), a reduction in GHG emissions (-30%), and economic viability (<40% selling price); (2) AI-powered fast-track innovation for process intensification; (3) A versatile biorefinery process to valorise mixed plastic waste (both fossil- and bio-based) and secondary biomass residues; (4) A smart polymerisation and formulation strategy using bio-based, degradable additives to tune biodegradability and enhance technical performance for four selected packaging use cases. Leveraging a multidisciplinary consortium of top-tier academic institutions and industry leaders, UPCYCLE is poised to create a significant impact in the packaging industry. UPCYCLE's ecopolymers, derived from plastic and biomass waste streams, promote a viable circular business model for European recyclers, polymer processors, compounders, and packaging producers. Moreover, our strategy demonstrates how renewable and upcycled building blocks and additives can be blended into commercially available polymers to deliver novel PHA-, PLA-, and Furan-based packaging formulations that successfully modulate degradability and technical performance, depending on the application. By providing tools to improve the properties and economic viability of polymer systems already on the market, we offer a fast-track pathway to impact.

Connect: https://www.linkedin.com/company/upcycle-plastics/

Innovative bio-based, biodegradable, recyclable,safe and circular food packaging (GRECO)

Recyclable bioplastic food packaging

Aristotle University of Thessaloniki:
Dimitris Bikiaris (Coordinator)
Represented by: Samira El Bir, IPC Centre Technique Industriel de la Plasturgie (partner)

The food packaging industry requires innovative, circular, bio-based solutions to replace complex, multi-material structures that rely on fossil fuels. The EU-funded GRECO project will demonstrate the life-cycle and economic feasibility of safer bioplastic value chains for food packaging through a safe and sustainable by design (SSbD) strategy. It will develop new biodegradable and recyclable packaging with PLA copolymers, coatings, additives, and surface treatments. The project will also ensure regulatory compliance, propose new standards and labelling guidelines, and use digital tools for simulation and modelling. Overall, the project aims to facilitate the introduction of sustainable products and to contribute to the Plastics Strategy, the Single-Use Plastics Directive (SUP), and the EU Circular Economy Action Plan (CEAP).

Objective:

GRECO aims to demonstrate the life cycle and techno-economic feasibility of greener & safer bioplastics value chains for the food packaging sector, based on a safe and sustainable by design (SSbD) strategy. To this end, innovative bio-based, biodegradable, and recyclable packaging will be developed using new PLA copolymers, coatings, additives, and catalysts, along with surface treatments. Regulatory compliance will be demonstrated while contributions to new or modified standards and proper labelling will be proposed. Digital tools will drive developments in simulation and modelling, while the social sciences and humanities (SSH) will provide relevant information on social perceptions and acceptance. All of them will pave the way for the introduction of new products into the packaging market and into our society. Contribution to the Plastics Strategy, the Single-use Plastics Directive (SUP) and the EU Circular Economy Action plan (CEAP) will be ensured. GRECO will introduce the food packaging industry to groundbreaking bio-based, SSbD, and fully circular PLA-based materials that meet diverse application needs. These alternatives aim to replace fossil-based, complex, and multimaterial structures prevalent in the industry, improving packaging end-of-life through biodegradation in various environments, including industrial and home composting, anaerobic digestion, marine environments, and soil. The design will ensure recyclability and prevent chemical interactions that hinder overall biodegradation.

Connect: https://www.linkedin.com/company/greco-project

Boosting the Industrial Uptake of Biodegradable polymers for packaging applications by implementing digital tools and advanced techniques (Be-UP)

Biodegradable polymers for a sustainable packaging sector

ITENE: Miriam Gallur and Amparo Verdu', Coordinator
Represented by: Cecilia Giardi, Novamont (partner)

The packaging industry is focusing on circular innovations to tackle economic losses from non-biodegradable plastics. The EU-funded Be-UP project will develop novel aliphatic-aromatic biopolyesters with increased renewable content, using bio-based building blocks such as 1,4-bis(2-hydroxyethyl) terephthalate (1,4-bio-BDO), along with innovative catalysts and additives. These biopolymers will be blended with commercial biopolymers (PLA, PBAT, PHA) and chain extenders to create bioplastic packaging materials. Advanced modelling tools will optimise blend design to achieve the desired performance and sustainability targets. Key production techniques, including blown film extrusion, injection moulding, and thermoforming, will be employed. The findings will guide the development of circular design tools, enhancing the standardisation of testing and labelling for materials and packaging.

Objective:

Within the Be-UP project, new synthesis and processing routes will be developed for novel aliphatic-aromatic biopolyesters with increased renewable content using biobased building blocks (e.g 1,4 bio-BDO), alongside innovative catalysts and additives. These components will be optimised through advanced digital modelling tools, based on Kinetic Monte Carlo (kMC) models, for synthesis and polymerisation. These biopolyesters will be blended with commercial biopolymers (e.g., PLA, PBAT, and PHA), biobased chain extenders, and mineral fillers to create bioplastic packaging materials. The design of these blends will employ advanced compounding modelling tools, supported by techniques such as screw design and inline rheology measurements, to achieve the target technical performance, sustainability, and biodegradation goals through multi-objective function evaluation. Processability will also be a key factor, with a focus on the primary production techniques used in the packaging industry, namely, blown film extrusion, injection moulding and thermoforming. A set of packaging product prototypes (TRL 7) will be manufactured to validate the developed materials. The biodegradability of these novel products will be assessed across different End-of-life (EoL) scenarios, including open environments and controlled conditions, thereby filling the gap between laboratory conditions and the real end-of-life behaviour of these materials. Additionally, the recyclability of the new products will be evaluated.

The data and conclusions of these assessments will help develop guidelines and tools for circular design, supporting the adoption of the Safe and Sustainable by Design (SSbD) Framework, and improving the standardisation framework for testing and labelling of materials and packaging products. Be-UP is expected to replace more than 50,000 tonnes of non-biodegradable plastics in 2032.

Connect: https://www.linkedin.com/company/be-up-project

Improving waste management of biobased plastics and the upcycling in packaging, textile and agriculture sectors (MoeBIOS)

ITENE: Miriam Lorenzo Navarro, Coordinator

The EU-funded MoeBIOS project aims to develop three bioplastics recycling value chains to enhance waste management efficiency across Europe. These chains will establish connections that address key stages, including sorting, conditioning, and valorising waste streams from packaging, agriculture, and textile industries. The project aims to maintain the same quality and functionality as the original bioplastic grades. Additionally, the MoeBIOS project will scale up recycling processes and seamlessly integrate them into pilot plants, ensuring they complement existing industrial recycling lines. The focus is on bioplastics that lack established recycling methods.

Objective:

MoeBIOS is an application of the circular (bio)economy concept: the development of three value chains incorporating separate recycling streams for bioplastics (BP's) to improve waste management efficiency throughout Europe. It is a systemic innovation: it will create linkages at the different key stages of the whole chain to solve a hierarchical challenge, from the collection of bioplastic waste (simulated streams) to the upcycling and validation of the final recycled end-products (holistic and coordinated solution).

The new value chain will involve sorting, conditioning and valorising three types of waste streams from the packaging, agriculture and textile industries into three end-products, aiming to achieve at least the same quality and functionality as the original grades. At the same time, end-user acceptance will also be assessed. As cornerstone targets for maximising the project's impact, the upscaling of the recycling processes will: (1) be integrated in pilot plants on the premises of actual industrial recycling lines currently operating in waste management companies, not disrupting them, and reaching a final TRL = 6/7 or even beyond. (2) focus on bioplastics for which recycling processes are still not in place, excluding bio-based analogues ("drop-ins"): PLA and PLA blends, PHA and its blends, PBS and PEF, accordingly to the market. The use of PBAT will also be assessed.

A Multi-Actor Approach (MAA) and a transdisciplinary methodology will engage waste producers, waste managers, the bio-based and (bio)plastics industry, public authorities, standardisation agencies, citizens, and media multipliers, creating a co-creation and co-ownership innovation environment with +50 participants.

Connect: https://www.linkedin.com/company/moebios-eu-com/

A new European blueprint for circular bioplastics upcycling solutions (ReBioCycle)

University College Dublin/BiOrbic: Kevin O'Connor, Coordinator

Represented by: Pablo Ferrero Aguar (AIMPLAS)

Plastic pollution remains a pressing global issue, exacerbated by the widespread use of non-biodegradable plastics. Bioplastics, touted as an eco-friendly alternative, pose a unique challenge due to their complex composition and limited recycling infrastructure. Current recycling methods often fail to efficiently handle diverse bioplastic types, such as PLA, PHA, and Mater-Bi, resulting in environmental impacts and economic losses.

In response, the EU-funded ReBioCycle project aims to improve bioplastic recycling through innovative technologies and partnerships. Spanning across three strategic hubs in Italy, the Netherlands, and Spain, the project pioneers advanced recycling technologies.
By verifying industrial specifications and real-world applications, such as durable packaging, ReBioCycle charts a sustainable path forward.

Objective: ReBioCycle proves a portfolio of bioplastic sorting and recycling technologies within 3 complementary waste-processor-centric HUB at DEMO scale and in the real operational environment, the effective and efficient recycling of three types of bioplastics (PLA, PHA, Mater-Bi) to demonstrate higher impact of obtaining the same or superior grade recycled polymers and other higher value applications. The Dutch HUB chemical technology upscaling to TRL 6. Using TORWASH technology to recycle PLA & PHA polymers (500 kg each. KPI: at least 1 m3 solution of monomers from each of PLA/PHA, free of solids. The NCTP Group waste sorting site of Heerenveen (Friesland, NL) and TEC, PBM, and Corbion will be involved. The Italian HUB: chemical technology upscaling to TRL 7. NOVAMONT technology will be used to recycle 600 kg of mixed composites, including Mater-Bi. Also, PHA from the NL and ES Hub will be tested in the IT HUB to blend into further Mater-Bi bioplastic formulations. IREN Group's waste sorting site of Borgaro Torinese (Piedmont, Italy) and NOVAMONT's new dedicated bioplastics recycling section within its Terni (IT) plant will be involved. The Spanish HUB: Enzymatic recycling technology brought to TRL 6, producing 50 kg within reactors of 200 litres (CSIC, supported by AIMPLAS pre-treatment). Microbial recycling technology (by the AD "short-circuited" technology of GPB and UCD via pure culture fermentation) brought to TRL 7 resulting outcomes 100kg rPHA (PHBV & PHBHx) and 20 kg rPHBV. Mechanical Technology upscaling to TRL 7, with the KPI to be achieved: 250 kg of bioplastic recycled (TCD, AIMPLAS involved). HUB activities in SAV waste sorting site of Manises (Valencia, Spain).

ReBioCycle will verify industrial-grade specifications with biopolymer brand owners and demonstrate real-world products: durable (ARAPAHA: PLA) and multi-use packaging (SULAPAC: PHA and Mater-Bi). The LCA analysis by ARCHA and the tailored D&E plan by partners EUBP and MAGFI will facilitate the uptake of key exploitable results.

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ReBioCycle