BIOMATTERS

Manufacturing technologies for bio-based materials

Contributing to a better Bioeconomy

The contribution of six Horizon Europe projects towards a new bioeconomy strategy for 2030

About BIOMATTERS: *in 2023, six projects funded by Horizon Europe (AMBIANCE, BIO-UPTAKE, GREEN-LOOP, NEW WAVE, VITAL and Waste2BioComp) have teamed up to form an awareness powerhouse, engaging stakeholders and the broader public in the journey toward sustainable manufacturing.*

As a collective, this cluster aims to spotlight and address today's pressing challenges, utilising bio-based materials to generate innovative solutions. With the present document, the projects are submitting their contribution to the New Bioeconomy strategy for 2030.

1. Economic obstacles

One of the most significant barriers is cost competitiveness: bio-based materials **are generally more expensive** than fossil-based or recycled alternatives. This is due to higher raw material costs, limited availability, and the need for additional pretreatment steps, all of which increase overall production costs. In many cases, manufacturing expenses make it feasible only for small-scale or exclusive applications. Furthermore, specialized equipment and software for production are costly, regardless of the material origin.

Cost Competitiveness Compared to Fossil-Based Alternatives: This is arguably the most pervasive obstacle. Bio-based plastics, due to factors such as smaller production scales, nascent supply chains, and often more complex processing requirements, frequently have a higher production cost per kilogram compared to conventional fossil-based plastics. For Mixcycling, this directly impacts their ability to compete on price with established petrochemical giants, even when offering superior environmental profiles. End-users often remain highly price-sensitive, making it challenging to pass on higher material costs.

Availability: While Europe has agricultural residues and industrial by-products, their collection, pre-treatment, and logistics can be complex and expensive. For Italian compounders, reliance on specific agricultural waste streams means fluctuating availability based on harvest cycles and local competition for biomass.

Consumer Awareness and Performance Perceptions: there is often confusion among consumers about what bio-based or biodegradable truly means, leading to skepticism or misperceptions. While bioplastics have advanced significantly, some end-users still hold outdated perceptions about their performance, believing them to be inferior to conventional plastics.

Another major issue is the lack of knowledge and experience with large-scale bio-based manufacturing, which demands further investment in research and development. Partners have also pointed out the high costs for certification, type testing, and the limited supply of bio-based resins, making the economic transition challenging. Customer expectations to reduce environmental impact are often not matched by a willingness to pay more, adding to the difficulty of scaling up sustainable solutions.

Recycled vs Biobased: current regulations tend to favour recycled polymers over bio-based alternatives, which creates an uneven playing field despite the sustainability benefits of bio-based solutions. Additionally, there is a persistent misconception that bio-based polymers lack performance and are only suitable for single-use applications, limiting their acceptance in durable, engineering-grade applications. Terminology confusion also contributes to market hesitation, with frequent misunderstandings between terms like bio-based, bio-sourced, and biodegradable, further complicating communication and commercial adoption.

Another significant barrier is the higher production cost of bio-based polymers compared to fossil-based materials. Even though certain bio-based polymers such as PLA are recyclable through mechanical and chemical means, the absence of widespread recycling infrastructure limits circular economy solutions, often relying on closed-loop systems.

Moreover, brands often show reluctance to adopt bio-based polymers derived from first-generation (1G) feedstocks due to concerns over land use competition with food and feed, despite clear data showing that bioplastics occupy less than 0.02% of global arable land. Finally, while second-generation (2G) feedstocks are preferable for addressing such concerns, they are currently not economically viable, presenting yet another challenge to scaling bio-based production.

1.1 What could be done

It's necessary to actively promote the adoption of bio-based products by formally acknowledging their potential to substitute fossil-based products within relevant legislation. This recognition is crucial for creating a more level playing field for bio-based industries. **Simply producing bio-based products isn't enough** for their widespread adoption; a robust market pull mechanism is essential for their commercial viability.

The current lack of a level playing field and explicit market demand incentives creates a significant disincentive for industry investment and innovation in the bioeconomy. A thorough review of the public procurement framework should be conducted to prioritize bio-based solutions over fossil fuel-intensive alternatives across all EU Member States. The emphasis on "**made in Europe**" in public procurement, coupled with the broader goal of strategic autonomy, suggests that promoting bio-based products is not just an environmental policy but a crucial industrial strategy aimed at strengthening domestic value chains and reducing external dependencies. Be aware that this provision implies preference, if the bio-based option is present, not a strict exclusion policy.

It's recommended to develop clearer circularity standards and tailored incentives specifically for bio-based products, emphasizing their unique benefits such as renewability, biodegradability, and reduced carbon footprint. It's important to integrate cascading priorities for biomass use into market strategies to foster a truly regenerative economy. Finally, it's essential to establish a dedicated and comprehensive policy framework for bio-based chemicals and derived materials. This framework is vital to ensure fair competition with other sectors like food, feed, and bioenergy, which currently benefit from specific policy support.

Specific action points proposed

- **Revise** the EU waste framework directives and national waste management plans to explicitly recognize and facilitate the separate collection, sorting, and valorization of bio-based plastics.
- **Incentivize** the development of adequate industrial and home composting infrastructure across all Member States.
- **Mandate** the Use of Sustainable Materials: bio-based or recycled materials should be the default choice for new product development, with virgin fossil-based materials permitted only where there is a clear, technical justification.
- **Promote** design-for-circularity principles specifically for bio-based materials, ensuring their end-of-life pathways are considered from the outset.
- **Introduce** clear and enforceable **Labelling Regulations**: clear, harmonised EU rules on labelling and environmental claims are essential to prevent greenwashing. Strong enforcement of these rules will ensure that consumers and businesses can make informed choices and that genuinely sustainable products are recognised in the market.

Impact: This will close the loop for bio-based materials, prevent them from contaminating recycling streams of conventional plastics (where not compatible), and ensure their valuable resources are returned to the bioeconomy.

2. Finance and scalability

European companies often struggle when promising innovations fail to reach commercialization or can't progress beyond the initial growth phase. This critical phase frequently refers to the de-risking stage between Technology Readiness Level (TRL) 4 (laboratory validation) and TRL 6 (pilot scale).

This problem is also a direct consequence of a fundamental mismatch between the long-term, capital-intensive nature of bio-based industrial scaling and the predominantly risk-averse, often short-term investment horizons characteristic of European financial markets. This structural impediment actively prevents the translation of robust European scientific research into commercial leadership.

The EU suffers from a notable scarcity of large-scale venture capital (VC), specifically for the bioeconomy sector. European VC funds tend to be smaller and exhibit greater risk aversion compared to their counterparts in the United States.

Despite the existence of initiatives like Horizon Europe and the Circular Bio-based Europe Joint Undertaking (CBE JU), SMEs encounter significant obstacles in securing adequate financial investments. The largest funding gaps are observed in the crucial scaling phases, from transitioning pilot projects to demonstrative ones, and subsequently to "first-of-a-kind" (FOAK) and full-scale industrial plants.

There is an urgent need for targeted financial instruments and clear policy signals that specifically de-risk investments in the bioeconomy and highlight its long-term strategic value, moving beyond immediate financial returns to include strategic autonomy and climate mitigation.

2.1 What could be done

It's imperative to significantly increase the allocation of funding for pilot projects, demonstrator projects, and FOAK production facilities. This should include flexible, small-scale, and short-term funding mechanisms to rapidly explore and advance new ideas.

The persistent funding gap for scaling up, demands a multifactorial financial strategy that goes beyond traditional venture capital models. Strategic public funding and guarantees are crucial to de-risk early-stage industrial scaling, thereby attracting and mobilizing greater private capital, demonstrating commercial viability, and reducing perceived investment risks.

The inclusion of specific challenges related to biotechnology and biomanufacturing within the European Innovation Council (EIC) Accelerator work programme should be actively promoted. To mitigate investment risks, exploring the establishment of a substantial guarantee fund (e.g., €1 billion) for "limited partners" should be considered.

This would soften required rates of return and minimize potential losses through effective risk sharing. It's also crucial to enhance awareness and utilization of existing financial instruments like the European Fund for Strategic Investments (EFSI).

Specific actions

- Create dedicated EU funds or guarantee schemes specifically for scaling up bio-based production facilities, bridging the gap between R&D projects and commercialization.

- Offer tax incentives (e.g., reduced VAT or corporate tax) for companies investing in sustainable bio-based manufacturing and for the procurement of certified bio-based products by public and private entities.

- Prioritize blended finance instruments that combine public and private capital to de-risk investments in bio-based value chains.

Impact: this will attract the necessary capital, reduce the financial burden on pioneers like Mixcycling, and accelerate the transition to larger production volumes, which in turn can drive down costs.

3. Regulatory obstacles

A key issue is the lack of harmonized regulations for replacing fossil-based materials with bio-based alternatives. Discrepancies between EU-level and national regulations create uncertainty and inefficiencies, making it difficult to establish consistent strategies across member states. Additionally, there is a lack of dedicated standards and certification frameworks for bio-based materials, which limits their acceptance in regulated sectors such as construction, manufacturing, and sports.

The absence of clear regulatory guidance on the **recycling**, reuse, and end-of-life management of bio-based products further complicates their integration into existing value chains. In many cases, sector-specific standards (e.g. from sport federations) do not yet recognize or include bio-based options, delaying adoption and market penetration.

Another major barrier is the complexity of **sustainability assessments**. There is currently a lack of standardized methodologies and datasets for conducting reliable Life Cycle Assessments (LCA) of bio-based products, particularly in relation to raw materials and the end-of-life phase. The absence of defined key performance indicators (KPIs) also undermines consistent evaluation and comparison of bio-based versus conventional alternatives. Moreover, the overall EU policy framework for the bioeconomy is fragmented across numerous policy areas (agriculture, forestry, fisheries, climate, circular economy, research), leading to persistent inconsistencies. There's a tangible risk of overlaps or even contradictory rules arising from existing and developing EU legislation, further complicating compliance.

The inherent tension between the EU's precautionary principle and the urgent need for rapid market entry of bio-innovations creates a fundamental policy paradox. While prioritizing safety is non-negotiable, the current application of this principle appears to disproportionately hinder new bio-based solutions, which often offer superior environmental profiles compared to fossil fuel-based alternatives. This inadvertently slows down the green transition that the EU aims to achieve.

A significant gap is found in the policy frameworks for **bio-based chemicals** and derived materials, unlike the established frameworks for food, feed, and bioenergy. This absence places the bio-based chemicals sector at a distinct disadvantage, negatively impacting investment flows in Europe. Finally, broader chemical regulations, such as updates to REACH, the Chemicals Strategy for Sustainability (CSS), and bans on substances like PFAS and microplastics, while crucial for safety, simultaneously increase the regulatory burden and compliance costs for chemical innovators. This necessitates a fundamental re-evaluation of materials at a molecular level. When it comes to **Bioplastic compounders**, there are several regulatory barriers in the EU

Lack of Clear, harmonized standards and definitions for Bio-based Products: This is a critical issue. For example, while there are standards for compostability (e.g., EN 13432), the definitions and testing methodologies for bio-based content or biodegradability in different environments; (e.g., soil, marine) are still evolving or inconsistently applied across Member States.

This creates market fragmentation and confusion for producers like Mixcycling, who need to clearly label and certify their products. It also allows for greenwashing by less scrupulous actors, undermining trust in genuine bio-based solutions. A second example is: The distinction between bio-based (derived from biomass) and biodegradable(able to decompose) is often blurred in consumer and even some regulatory discussions, leading to inappropriate disposal.

Waste Legislation Hindering Circularity of Bio-based Residues: Existing waste management frameworks are often designed primarily for conventional plastics and inorganic waste, sometimes overlooking the unique properties of bio-based materials.

For example, if a bioplastic is technically compostable but the local waste infrastructure in Italy (or another EU country) lacks industrial composting facilities or forbids the co-collection of bioplastics with organic waste, then the circularity potential is lost. This can lead to valuable bio-based materials ending up in incineration or landfill.

Regulations on end-of-life options for certain industrial bio-based residues might be overly restrictive, even if they could be safely valorized into new products (e.g., certain by-products from biorefineries).

3.1 What could be done

First and foremost, there is a strong need for clear and harmonized regulatory frameworks specifically addressing bio-based materials, including their certification, use, and end-of-life management. Establishing dedicated standards, such as those currently being developed within the AMBIANCE project for outdoor applications can provide much-needed structure and legitimacy for bio-based solutions across sectors.

It's necessary to systematically evaluate and streamline existing EU legislation and its implementation to reduce fragmentation and accelerate time-to-market for bio-innovations. This includes eliminating unnecessary or duplicate data requirements and addressing any non-transparent political influence in authorization processes. Calls for "simpler legislation" and "streamlining regulatory processes" don't advocate for deregulation, but rather for smarter, more targeted regulation for new bio-based products. This means moving away from a one-size-fits-all approach (e.g., applying chemical pesticide regulations to biocontrol) in favor of a differentiated and risk-proportionate framework that accelerates market access for sustainable innovations while maintaining high safety standards.

It's recommended to actively promote the use of "regulatory sandboxes" to allow controlled experimentation with new bio-solutions. A regulatory sandbox is a controlled environment where supervised entities are be able to test, for a limited period of time, technologically innovative products. The tests will take place in close liaison with the supervisory authorities and can eventually benefit from a simplified transitional regime. This solution is currently under testing in some member states and in sectors like Fintech, Europe should make a huge leap forward in this direction, augmenting the applications of the Regulatory Sandbox principle.

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