Bio-based Industries Consortium

BIC 2023

Trend Report

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Message from the BIC Executive Director

The bioeconomy is an economic and societal model. In a circular bioeconomy, biological resources are renewable, sustainably-managed, recovered and reused as much as possible. Putting such a model into practice requires new paths for collaboration and innovation. The reason lies in the nature of the bioeconomy, and where many actors from different sectors and disciplines need to work together, even though they are often not used to collaborating.

BIC believes that taking a systematic approach is a distinct characteristic and benefit of the bio-based industry, allowing it to create new (industrial) ecosystems. Partners from across the bio-based chain collaborate from a project's start to end, and hence are able to design and implement projects in a systematic way, addressing economic, social and environmental impacts from sourcing to production and processing and to end-users.

In addition, certain challenges are specific to our sector e.g. a higher-than usual investment risk, long project investment cycles, regulatory uncertainty, and no "winner takes it all markets". In addition, a bio-based product is measured against its fossil-based counterparts, which often benefit from subsidies and efficiency gains achieved over decades.

BIC can be very proud of how far we have come, taking a systematic approach to create opportunities related to innovations and investments, as well as to address the sector-specific challenges. From our 35 initial members, we today have over 250 industry and 200 academia members. And BIC is again partnering with the European Commission to fund projects advancing competitive circular bio-based industries, currently in the €2 billion public-private-partnership called the Circular Bio-based Europe Joint Undertaking.

BIC's strategy extends beyond the partnership, into areas and activities including helping bio-based businesses access finance from private investment and/or regional funding, supporting more companies to form strategic partnerships and raising public awareness of the bio-based industries.

Over recent years, things have changed. In the beginning, BIC took an R&D driven approach. We can see now from our members that they are driven to find also new ways to be more sustainable, and to match consumers' demands and needs. There is no way to continue business as usual. Sustainability and mitigating climate risks are becoming core priorities for not only policy makers, but also many investors and corporate leaders.

We should now look to the future. It's impossible to fully anticipate what it will bring, but it is very likely that the progress in our sector will help to advance the green transition.

With the annual BIC Trend Report, we provide highlights of the innovation in our sector, and what it takes to bring bio-based innovation to the market.

Executive Summary

A circular bioeconomy powering a climate-neutral, sustainable, resilient and competitive Europe

In 2012, the world admired Europe as a global frontrunner for launching its EU Bioeconomy Strategy. One of the key reasons for such a strategy was the need for an EU-wide approach to overcome the so-called *innovation valley of death*. Europe was good at inventing new bio-based products and processes in the lab, but not so good at bringing them to market.

A decade later, progress has been made. One outcome of the strategy is the initiation of a public-private partnership between the European Union and the Bio-based Industries Consortium that has led to more than 160 projects and over 3 billion EUR in private investments and grants. The partnership focuses on the production of bio-based chemicals, materials, food and feed ingredients and soil nutrients in a circular way, whilst ensuring a high level of environmental performance.

However, since 2012 we see changes. The world and Europe look to other regions that are more forward-leaning in recognising the bioeconomy, in particular to the US with its recently launched bold plans, but also China, India and the G20.

In Europe, the Green Deal has been initiated to tackle the threats posed by climate change and environmental degradation. But we now face a geopolitical crisis including high inflation, high unemployment and low growth, with Europe remaining reliant on fossil resources. Consequently, there is renewed focus and greater ambition for strategic autonomy. This is why we must take a fresh look at the bioeconomy, and how it can enable, for example, circularity, climate change mitigation and resource efficiency, and drive reindustrialization.

Europe risks missing out on realising the full potential of the bioeconomy if EU policymakers do not act more strategically. The shift to a sustainable, low-carbon, circular bioeconomy represents an opportunity worth up to USD 7.7 trillion globally.

The EU must build on the technological and investment progress made so far. It is now time to design and adopt targeted policies for Europe's bioeconomy to serve people and planet. Notably to develop markets for sustainable and circular bio-based products and processes to reduce our dependence on fossil feedstock. The EU regulatory framework should promote and accelerate the market entry of bio-based innovations and boost the necessary investments. And the EU must develop its own new, bold bioeconomy action plan to respond to investments and incentives in the US, China and elsewhere.

Europe must build on the strength of its bioeconomy. With a turnover EUR 2.5 billion (of which ca. 30% is in the bio-based industries), the sector provides employment to nearly 18 million people. The bioeconomy, with biorefineries at its core, supplies bio-based products which are largely sourced, manufactured, used and recycled in Europe. The science is excellent across academia and universities. Thousands of European companies are active and at the forefront of bio-based innovation.

The bioeconomy in 2023: BIC insights from workshops series

The Bio-based Industries Consortium (BIC) hosted from April to June 2023 four workshops to identify the policies needed to allow bioeconomy actors to drive forward Europe's resilience, innovation and growth, as well as to contribute to defossilisation and environmental protection. You can find in the following the outcome of this workshop series in the form of key take-aways and policy recommendations.

This document is a result of the discussions* we had with workshop participants, and which came from across the EU institutions, think-tanks and NGOs and industry.

* Workshops 1 to 3 focussed on a particular aspect of the bioeconomy, whereas workshop 4 took a birdseye view on global competition. In the workshops, BIC presented innovative case studies of the bioeconomy, followed by break-out sessions to discuss policy hurdles and potential solutions. Each participant received a detailed summary of each workshop and the slides of the case studies.

1. The EU must act to maximize the potential of the bioeconomy for a circular, climate-neutral and green economy

The bioeconomy can play a fundamental role in **defossilising the materials and chemicals sector** and in creating sustainable carbon cycles.

This **opportunity is currently underutilised** and could be increased by using (carbon from) a diverse range of renewable feedstock, including biomass, bio-waste, recycled bio-based materials and CO_2. To reduce the use of new virgin fossil feedstock, the current EU policy focus on recycling of fossil-based carbon is not sufficient.

The bioeconomy enables a truly circular and climate neutral economy by ensuring that the renewable **carbon is kept in the loop** over the entire product life cycle – and can be recycled again or returned to the soil.

The bioeconomy is **continuously innovating** to manufacture and recycle products more efficiently, thereby growing the green economy in the EU.

2. The EU must ensure the reliable supply of sustainably sourced biomass by providing a coherent, long-term policy framework for the circular bioeconomy

Biorefineries efficiently transform and valorise biomass into food, feed, products, and energy. They are at the core of the bioeconomy, delivering sustainable solutions, jobs and rural development, in line with society's needs.

Investing in and building new modern/innovative biorefineries is a long-term and capital-intensive undertaking. Their profitability is bound to their capacity to serve different markets across food, feed, and industrial sectors simultaneously, and to efficiently create value from all fractions of different renewable feedstocks.

The bioeconomy nurtures and preserves healthy and resilient ecosystems, which are crucial for the EU's transition to a climate-neutral economy and for safeguarding biodiversity. Virgin feedstock, by-products, recycled streams, and waste are all crucial feedstocks for the development of bioeconomy. They are complementary pathways to defossilising the EU economy.

3. The EU must create and expand market opportunities for bio-based products to spur innovation, sustainable growth and secure strategic autonomy

The bioeconomy supplies bio-based products which are largely sourced, manufactured, used and recycled in Europe. Growing the market for bio-based products enhances Europe's strategic autonomy.

For the bio-based industry to be able to meet European consumers' demands for a sustainable lifestyle and associated products, the EU regulatory framework should promote and accelerate the market entry of sustainable innovations and boost the necessary investments.

The EU must develop its own bold bioeconomy action plan to respond to investments and incentives in the US, China and elsewhere.

Case studies

Lignode® by Stora Enso

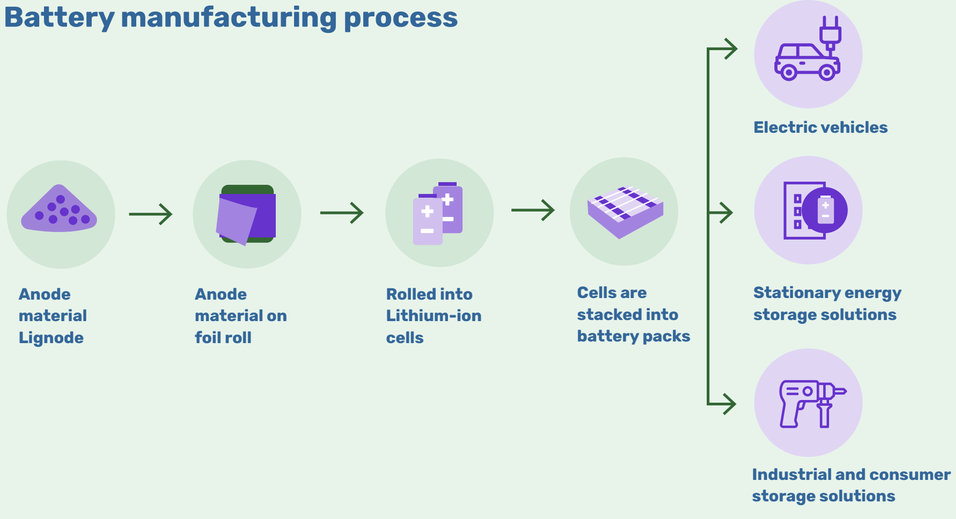
The future of electric cars powered by trees

Innovation that comes from the power of trees is what Stora Enso is all about. We help the world to transition towards more sustainable, more circular solutions that use renewable biomaterials in all kinds of industries and applications. Our latest innovation relates to the rise of the electric vehicle (EV).

Stora Enso has found a way to harness the power of trees to help make EV batteries more sustainable, more effective and more resistant to cold temperatures. Lignode® is a bio-based carbon that can be used for sustainable electrification.

Electrification is dependent on anode materials - a single electric car has 50-100kg of anode materials.

Battery manufacturing process



As a material, lignin is:

- **Renewable**
- **Bio-based**
- **From sustainably managed forests**
- **Fossil-free**

Europe needs its own anode material production. The demand for anode materials will be significant in Europe, but we depend on supply from outside Europe.

By 2040, Europe's demand for batteries is expected to be 1.2TWh per year. This corresponds to roughly 1M tons of anode materials. EU production needs to be 30X greater compared to today to be self-sufficient in this critical raw material.

Case studies

Novamont and the EMBRACED project

From waste to bioproducts

The Novamont Group is an industrial company with its roots in the Montedison School of Science of Materials, created to pursue the ambitious project of various researchers: the integration of chemistry and agriculture. Novamont was a partner in the EU funded EMBRACED project.

The project's objective was to demonstrate in a relevant industrial environment a circular model of integrated multipurpose biorefinery based on the valorisation of post-consumer Absorbent Hygiene Products (AHP) waste towards the production of biobased building blocks, polymers, and fertilizers.

BBI JU contribution: €10.5M

Total budget: €16M + €4.1M IKAA

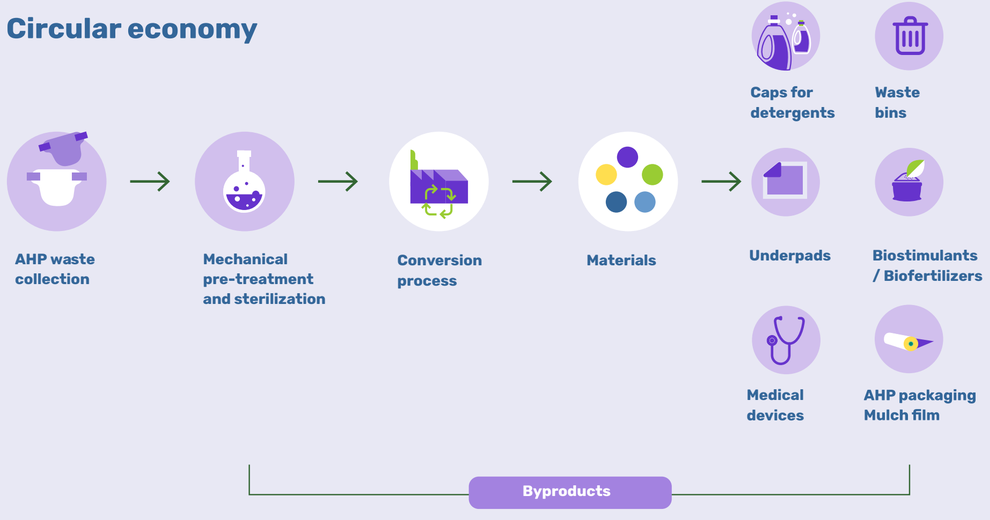
Duration: 2017-2022

From a troublesome waste to a valuable biobased feedstock

In Europe, 8.5 million tons per year (30 million tons worldwide) of used Absorbent Hygiene Products (AHP), representing 3-4% of total Municipal Solid Waste, end their life in landfills or incinerators. There is a quickly growing trend to separately collect AHP waste in some EU Countries for social needs when recycling rates > 65% are achieved, even if no recycling solutions are yet in place. In Italy, almost 16 million citizens are already served by separate collection services of AHP waste.

At the same time, in the complex reality we are living in, one of the main challenges is to guarantee the availability, sustainability, and security of feedstock supply in the long term in the EU while maintaining a uniform product (quantity & quality) and a resilient supply chain.

Circular economy



Main benefits achieved

Diverting AHP waste from landfill or incinerators (8.5 millions in Europe, 30 millions worldwide), **recovering high value secondary raw materials** (2.6 millions in Europe, 9 millions worldwide)

Lower overall environmental impact of the EMBRACED materials and products vs the corresponding fossil-based benchmarks according to the Product Environmental Footprint (PEF) single score index

84% of CO_{2eq} emissions savings for producing bio-based biopolyesters and PHB vs fossil-based benchmark; **CO_{2eq} savings between 270-443 kg** per ton of AHP waste recycled vs landfilling/ incineration scenario

Case studies

Cargill and the SUSBIND project

Sustainable biobinders for wood-based panels from renewable resources

SUSBIND is a collaborative European research & innovation project addressing the need for more sustainable bio-based binders used for wood-based panel boards in the European furniture industry.

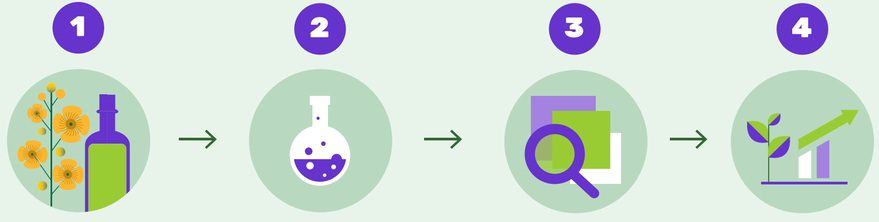
The SUSBIND Consortium develops, produces and tests bio-based binders as an alternative to fossil-based binders currently used in furniture mass products.

BBI JU contribution: €4.1M

Total budget: €5.5M

Duration: 2018-2023

Approach



1. Selection of sustainable feedstock
2. Lab-scale studies on chemical and enzymatic synthesis of epoxy type binder components and pilot essays
3. Industrial testing of new bio-based wood board binders and products
4. Economic and environmental sustainability assessments

Socio-economic and environmental impact

The overall impact of SUSBIND will be to benefit public health and help mitigate climate change by providing cost-efficient bio-based binders. It also aims to provide a boost to Europe's furniture industry with a competitive green advantage. Specifically, it expects to:

- Reduce the carbon footprint by 25% compared to current state-of-the-art
- Keep the cost of production increase of using the new binders to an acceptable level, ideally less than 15%
- Reduce formaldehyde emissions from particle and MDF board manufacture by 50-75%
- Establish two new cross-sector cooperations, supplying the new resins to both particle board and medium density fibreboard manufacturers, replacing current supply from chemical manufacturers to ingredients company
- Establish two new bio-based value chains; one from the source carbohydrates to wood based panel boards, the other from the source vegetable oils to wood based panel boards

Case studies

LanzaTech

Creating a Post Pollution Future

ArcelorMittal and LanzaTech have partnered on 'Steelanol', ArcelorMittal's commercial flagship carbon capture and utilisation ('CCU') facility in Ghent, Belgium. The €200 million' facility is a first of its kind for the European steel industry, deploying technology developed by leading carbon utilization company LanzaTech.

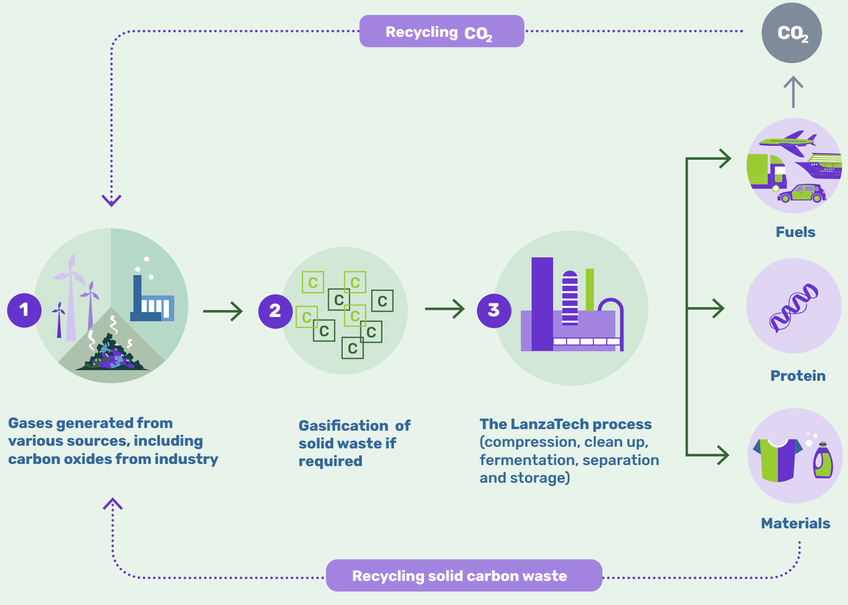
The Steelanol plant has the annual capacity to produce 80 million litres of advanced ethanol, around half of the total current demand in Belgium. It expects to reduce carbon emissions from the Ghent plant by 125,000 tonnes annually, thereby advancing the EU's 2030 Climate Target Plan to reduce greenhouse gas emissions by 55% by the end of the decade. Project partners include Primetals Technologies and E4tech with support from CINEA, the European Climate, Infrastructure and Environment Executive Agency.

↗ The Steelanol Facility in Ghent, Belgium

The LanzaTech process implemented at this site is fully flexible: not only can it use industrial gases from today's steel production methods but also it can adapt as the industry transitions to future steel production technologies with increased green hydrogen input. This versatility enables the carbon recycling application to evolve with available residue, waste streams, and green H_2.

LanzaTech's process is already employed by four operational commercial facilities around the world, with two additional commercial facilities expected to come online by the end of 2023.

LanzaTech's Process



The company is working to change how companies source carbon and build a "Carbon Smart™" circular economy across the supply chain. The technology ferments gases, instead of sugars, to primarily make ethanol which can be used and converted to make other sustainable chemicals with further downstream processing. Their carbon recycling technology licensing model enables companies across industries to capture and process carbon gases before they enter the atmosphere and cause environmental harm. With partnerships across the supply chain, LanzaTech is enabling a new ecosystem for sustainable chemicals production.

Case studies

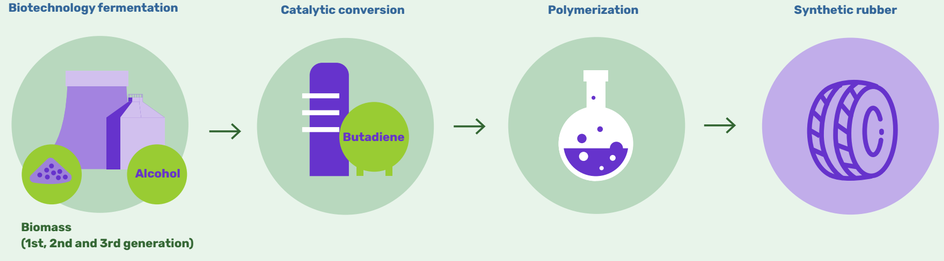
Michelin and the BioButterfly project

Butadiene from bioethanol

Since its launch in 2012, and till the end of the project in 2022, Michelin and its partners, IFP Energies Nouvelles and Axens, backed by the ADEME (French Agency for the Environment and Energy Management), will have invested nearly €70M. In the validation phase alone, the project will lead to the creation of over twenty jobs on the Bassens site.

> Taking into account the environmental impact of its activities is in the DNA of the Michelin group, pioneer and leader in sustainable mobility. By 2050, 100% of raw materials used in our tires will be sustainable, with biosourced butadiene representing nearly 20%.

Florent Menegaux, Michelin CEO



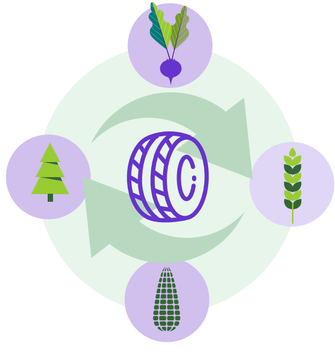
Reducing CO2 emissions linked to tire production

The BioButterfly project will help to reduce the use of butadiene derived from oil-based products by replacing it with butadiene produced from alcohol obtained through fermentation of plant biomass. In addition, this replacement will lead to a reduction in CO2 levels linked to tire production.

This project is part of the Michelin group's key objective to increase the rate of raw materials derived from sustainable development sectors in tire production.

Environmentally-friendly technologies

The demonstrator currently being set up in Bassens will be able to run on ethanol obtained from all types of biomass, namely ethanol 1G from, beets, corn and wheat and 2G ethanol produced from forestry and agricultural waste such as straw, wood chips, corn stalks.... This approach presents the added advantage of not using additional agricultural land, which could be used for food production.



Case studies

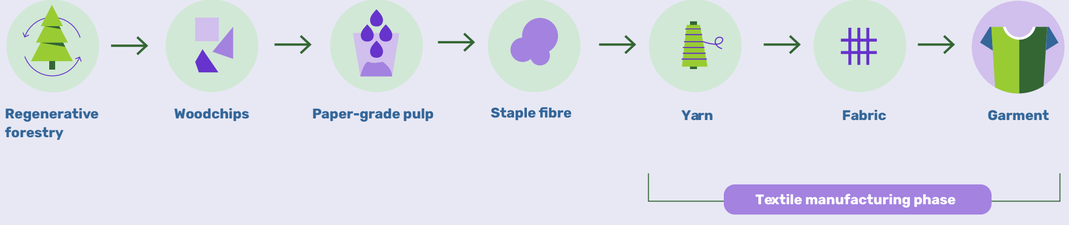
Metsä Spring and Kuura® project

Textile fibre from wood

Founded in 2018, Metsä Spring is Metsä Group's innovation company. Their vision is a thriving forest-based ecosystem that delivers the full value of sustainably grown Nordic wood.

Kuura is a project that aims to develop and demonstrate the feasibility of a new environmentally friendly concept in which paper-grade pulp is converted into a novel Kuura textile fibre (lyocell-type staple fibre). The pulp in question is made from sustainable northern wood by Metsä Group, and the concept is based on integrating the textile fibre production into the entity making the pulp (i.e. a bioproduct mill).

Overview of the process



Kuura product properties and attributes

Environmental responsibility and circular economy lie at the heart of producing this unique textile ingredient, Kuura, moving the world towards a more sustainable future. Kuura brings a responsible alternative to various end uses in the world of textiles and reduces environmental impact without compromising product quality.

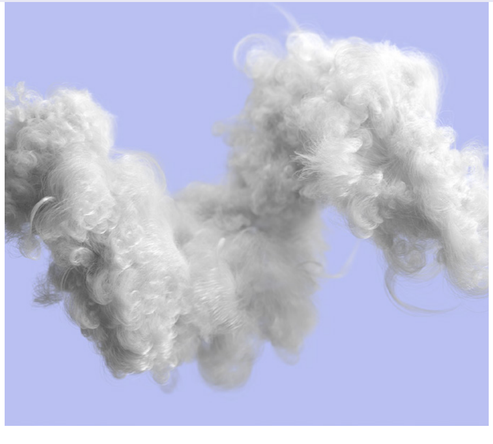
Traceable
The wood and fibre is 100% traceable to its forest source.

Circular
Recyclable fibre and a closed-loop production.

Biodegradable
Fibre comprises of natural, biodegradable carbohydrates.

Locally-produced
Wood, pulp and fibre production all within a 100 km radius.

Sustainable
Competitive in both ecological and social sustainability.



Moving forward

BIC Policy Recommendations

1

To achieve the maximum potential of the bioeconomy for a circular, climate-neutral and green economy, the EU should:

- Develop **a dedicated and long-term policy framework** for the circular bioeconomy to transition into a strategic industry sector, and contribute to the EU's ambitious policy objectives, in consideration of the EU Leads Market Initiative.
- Appoint a **high-level EU policy coordinator** reflecting the cross-sectoral nature of the bioeconomy, e.g., a dedicated European Commissioner, or a cabinet member of the European Commission President.
- Create a **level playing field** for the contribution of carbon from renewable feedstock, by accounting for their key contribution to the substitution of virgin fossil raw materials.
- Establish and use a science-based **definition for renewable carbon** consistently in EU legislation.
- Promote practical **evidence-based criteria** when meeting End-of-Waste status, and for extended producer responsibility (EPR) and labelling, and relevant to the product groups considered. Foster the collection and valorisation of **bio-waste**.
- Support **policies that focus on the safety and sustainability of the end-product**, not on the processes used to produce them. Policies should be **technology neutral** across production methods (such as biotech, fermentation, extraction) and in recycling options (mechanical, chemical, organic and/or a combination).
- Apply a holistic Life-Cycle Analysis approach, including scientifically sound **sustainability criteria**, that fully take into account the benefits of carbon from renewable feedstock e.g. in current methods used for Life Cycle Assessments and Product Environment Footprints.

Moving forward

BIC Policy Recommendations

2

The EU should unlock the innovation potential of the circular bioeconomy by:

- Undertaking a **systemic assessment** of legislation impacting the availability and use of biomass, including cumulative impacts, inconsistencies, and gaps.
- Ensuring a high-value use of biomass in line with the **cascading use principle**.
- Consistently applying scientifically sound **sustainability criteria** for using biomass.
- Harnessing reliable, comparable, and science-based data on **land use trends** to inform location-appropriate policymaking: the circular bioeconomy includes many diverse ecosystem services across the EU and beyond. One-size-fits-all solutions should be avoided.
- Establishing a regulatory framework for **reducing the dependence from virgin fossil feedstocks** in chemicals and materials including delivering proposals to achieve the 20% reduction target for plastics and chemicals in the EU Communication on Sustainable Carbon Cycles.

3

For Europe to fully capitalise on the opportunity to transition from fossil to renewable resources, we must:

- Create **incentives for the use of renewable feedstocks**, materials and products including financial instruments and public procurement; and through sustainability labelling and reporting.
- Ensure that the lifecycle effects of fossil-based production are fully accounted for and create a **level playing field** for renewable feedstock.
- Ensure targeted and coherent support for **scaling-up bio-based innovation**, including creating synergies between funding schemes (private, public, national, regional, EU) and faster permitting for first-of-a-kind biorefineries.
- Better enable deployment of bio-based innovation through specific forms of experimentation e.g. **regulatory sandboxes, living labs, test beds**, etc.

- Ensure **faster market-entry** of bio-based innovation through efficient product approval and evaluation mechanisms.
- Set-up **public-private partnerships** for the bio-based industry, for example under the 10th EU R&I Framework programme and/or via Important Projects of Common European Interest.

Conclusions

The bioeconomy is part of the solution to master the green transition

The bioeconomy has a much greater economic potential than the current share of the EU economy. New materials and products with unique properties can create new markets and growth opportunities. The bioeconomy can also contribute to other societal objectives, in particular to climate and environmental objectives by 2050. The circular bioeconomy is part of the solution, it can power a climate-neutral, sustainable, resilient and competitive Europe.

But this cannot happen by itself.

EU policymakers must take action to realise the full potential of the circular bioeconomy to reach the EU's environmental, economic and social goals.

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