CIRCULAR BY NATURE

A POLICY AGENDA FOR BIO-BASED MATERIALS IN A CIRCULAR ECONOMY

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COALICIÓN DE ECONOMÍA CIRCULAR
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ABOUT THIS PAPER

This paper intends to shed new light on the application of the circular economy framework to bio-based materials, a subject that has, to date, received less attention than the analysis of circular models applied to finite materials. It finds that better aligning policy agendas on circular economy and bio-based materials presents a concrete opportunity for value creation with wide-ranging socioeconomic and environmental benefits. Many countries could see this as a key opportunity in the development of bio-based sectors within global value chains. It could also help to distribute value more fairly across all actors involved.

This report was prepared by the Ellen MacArthur Foundation as an independent contribution to the discussions of the Circular Economy Coalition for Latin America and the Caribbean. It should not be construed as representing the views, positions, or endorsement of the Coalition's member States. It forms part of the Coalition's workplan, and has received inputs and review from the steering committee and government members. It contributes to Latin America and the Caribbean's circular economy transition across policy, business innovation, knowledge building, and cooperation. It aims to raise awareness, generate interest, and stimulate debate, and marks a first step in a collaborative programme to enable circular value chains for bio-based materials. From there, it will help build a coherent advocacy effort to unlock economic opportunities and policy pathways, and to engage global forums and processes in advancing a shared vision for a circular economy that elevates bio-based materials. It is also the result of other important Coalition reports that have been contributing to the strengthening of the topic in the region, in particular the document *Circular Economy in Latin America and the Caribbean: A Shared Vision.*[1]

Furthermore, this paper is part of a broader initiative by the Ellen MacArthur Foundation to unlock a circular economy for natural systems through targeted research, a series of reports, and establishing cross-sector collaborations. This report follows on from several key publications: *The Big Food Redesign: Regenerating nature with the circular economy*;[2] *The Nature Imperative: How the circular economy tackles biodiversity loss;*[3] *Building Prosperity: Unlocking the potential of a nature-positive, circular economy for Europe;*[4] and *Scaling Action for Nature: How the circular economy can help deliver the Global Biodiversity Framework.*[5]

Scope and definition

For the purposes of this paper, bio-based materials are defined as materials derived entirely from renewable, biological resources such as plants, animals, algae, and microorganisms. This means their total mass contains no fossil-based inputs or other finite materials. While bio-based materials can come from a variety of sources, including aquatic ones such as seaweed and fish, this study prioritises land-based sources. The focus is therefore on materials such as wood, pulp and paper, cotton and other natural textile fibres, rubber, and leather, which are largely produced through land-based agriculture and forestry. This prioritisation reflects the centrality of these materials to large global industries, including fashion, packaging, furniture, construction, and mobility. However, the key insights and messages of the study are applicable beyond land-based sources.

The circular economy is based on three principles: eliminating waste and pollution, circulating products and materials at their highest value, and regenerating nature. By rethinking how products are designed and production systems are managed, materials can remain in use for as long as possible, avoiding waste and allowing natural systems to regenerate. It offers an approach to economic growth that is increasingly decoupled from resource extraction.

The circular economy system diagram[6] typically distinguishes between the biosphere, where value is recirculated through biological processes, and the technosphere, where value is maintained through technological cycles. In practice, however, circular strategies for bio-based materials aim to bridge these systems, allowing materials to transition between biological and technical pathways, and maximising value creation across both.

To quote this report, please use the following reference: Ellen MacArthur Foundation, *Circular by nature. A policy agenda for bio-based materials in a circular economy* (2026)

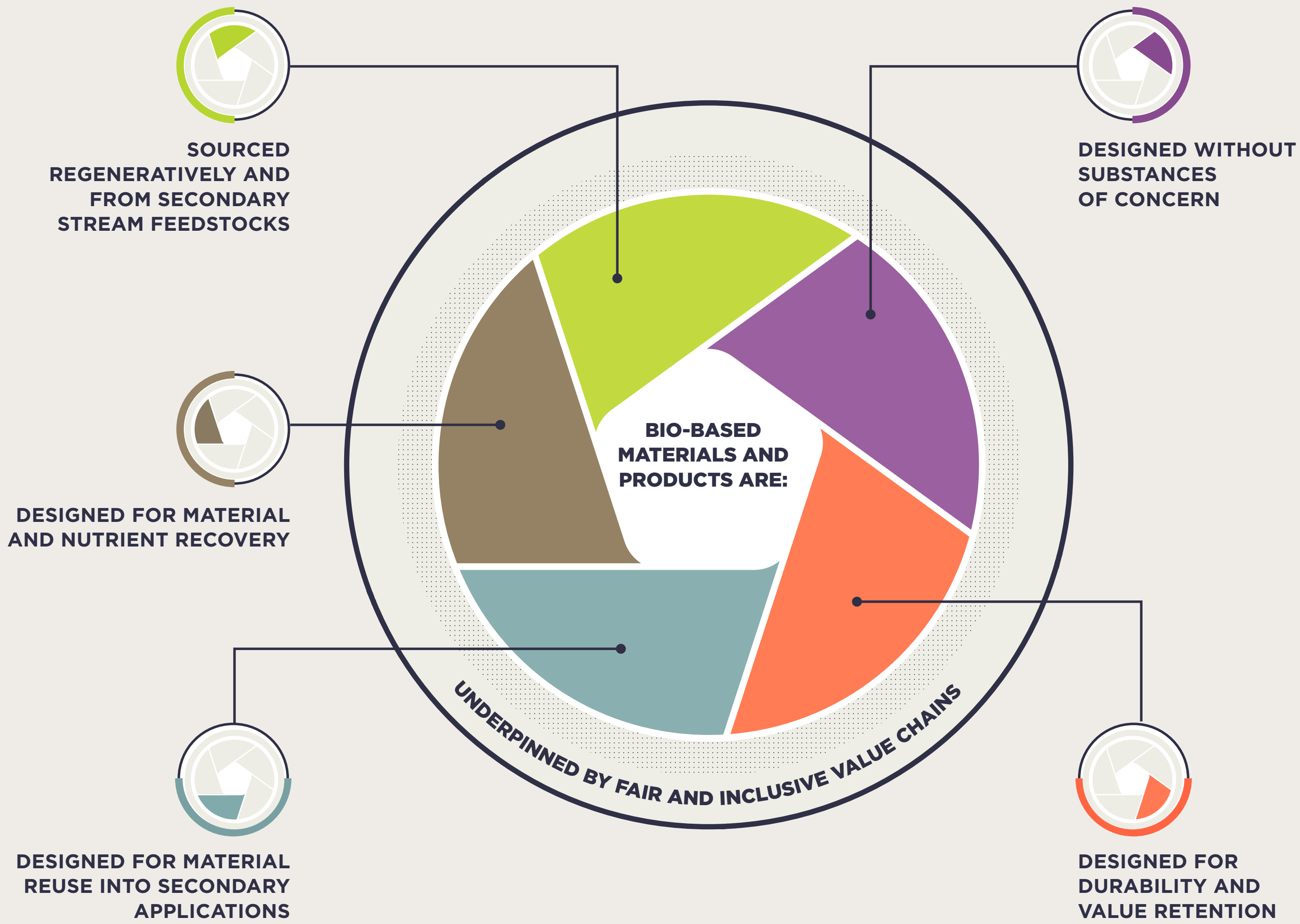
EXECUTIVE SUMMARY

The circular economy has made significant progress in developing strategies for finite materials, yet realising its full potential requires equal ambition for bio-based materials.

The circular economy is increasingly recognised as a pathway to long-term economic resilience and prosperity. However, its application to date has focused primarily on finite, technical materials, leaving bio-based materials – cotton, timber, natural fibres, rubber, and biochemicals that sustain major global industries – comparatively overlooked. This gap, often acknowledged but rarely addressed, limits the ability of the circular economy to deliver system-wide impact.

Greater policy alignment is needed to enable a consistent and effective transition. An analysis of 13 national circular economy strategies and 18 bio-based materials policy frameworks from countries worldwide confirms that these two policy agendas run in parallel but rarely intersect, each reinforcing its own logic at the expense of a coherent and effective transition. Most circular economy strategies treat bio-based materials as direct substitutes for non-renewable inputs, rather than focusing on how they are grown, used across successive applications and safely returned to biological systems. Most bio-based material policies have the inverse blind spot: they use them as renewable commodities to be extracted, converted into products, and converted into energy without taking advantage of the economic opportunities associated with repair, reuse, refurbishment and recycling. The result is a generation of policy development that has optimised linear bio-based systems rather than redesigned them. Regenerative production, successive material use, and nutrient return to natural systems are not systematically integrated in either circular economy nor bio-based materials policy instruments, limiting progress on climate, biodiversity and pollution while forgoing significant economic and social value.

A circular economy framework for bio-based materials defines the conditions under which a regenerative economy can flourish in the long term. Bio-based materials are renewable only insofar as the ecosystems producing them are given space and time to regenerate. Where extraction outpaces recovery — where soil health degrades, biodiversity declines, and land conversion continues — renewable resources become effectively finite. Thus substitution of non-renewable materials with bio-based alternatives holds real potential, but must be evaluated rigorously against land use, ecological context, and full life-cycle impacts. Embedding circular economy principles into bio-based material value chains is therefore not optional. In a well-functioning circular system, bio-based materials are sourced regeneratively and from secondary feedstocks; designed without substances of concern; products and components are kept at their highest value through reuse, repair, and secondary applications; and materials and components are recovered effectively at end of life through recycling, composting, or anaerobic digestion to generate biogas and nutrients that can be safely returned to natural systems. Critically, this framework is underpinned by fair and inclusive value chains, recognising that bio-based material production is often deeply connected to local communities and livelihoods. The transition should reflect the needs and realities of traditional communities, small-scale producers, and other local stakeholders, ensuring that support is not concentrated solely on a limited number of high-value supply chains but also extends to production models that contribute to a just and resilient circular economy.



A circular economy leveraging bio-based materials can unlock new revenue streams, drive innovation, and strengthen supply chain resilience. Bio-based materials are often produced and used within linear systems, and as a result, significant value is lost. By enabling regenerative sourcing, keeping materials in use at their highest value, valorising by-products and residues, and developing business models that decouple revenue from virgin resource consumption, a circular economy approach offers a clear pathway to improve resource productivity, create new value chains, and generate additional revenue streams. Company examples from Gucci, Klabin, Lojas Renner, Royal Ahrend, MYNUSCo, Crystal, and TraceSurfer illustrate how circular strategies for bio-based materials are already building resilience and generating new revenue streams in practice. For bio-based materials-producing countries, the opportunity is particularly significant: shifting from commodity export towards regenerative production, innovative bio-based materials, and local recirculation loops can generate more diversified economic returns, strengthen domestic industries, and create skilled employment opportunities.

The transition to a circular economy for bio-based materials delivers significant environmental and social returns alongside economic ones. Keeping bio-based materials in use for longer helps reduce pressure on land, cuts demand for virgin extraction, and eases key drivers of ecosystem degradation and emissions. Prioritising regenerative sourcing and diversified cropping systems actively restores soil health, water retention, and biodiversity, while composting and anaerobic digestion close biological cycles by returning nutrients safely to the ground. In addition, the transition creates employment across the full value chain (from regenerative agriculture to repair, recycling, and biorefining), but these gains are not evenly distributed by default. Realising them equitably requires that rural communities, smallholder farmers, and waste pickers are recognised as rightful participants in the transition, with access to finance, skills, and fair terms of trade built into policy design from the outset.

Five pillars of policy action chart the path forward. Aligning circular economy and bio-based material frameworks, improving incentives, and supporting the development of enabling infrastructure can help unlock the economic potential of circular solutions for bio-based materials. Five key policy areas are decisive for accelerating the transition:

1. Designing for circularity and elevating the principle of regeneration: adapting circular design standards for bio-based materials, building on proven existing frameworks, and embedding regeneration as a core standard, and mandating traceability.

2. Enable effective and safe material circulation: reviewing waste classifications that prematurely push bio-based materials into low-value treatment, and establishing clear secondary-use pathways.

3. Promote financial and economic incentives that shift the playing field: redirecting agricultural subsidies towards regenerative practices, deploying eco-modulated EPR schemes, reducing VAT on repair and secondary applications, and phasing out incentives that entrench linear production.

4. Invest in innovation, skills, and infrastructure: from regenerative growing techniques and fibre-to-fibre recycling to biorefineries and composting facilities, with skills development integrated across vocational, agricultural, and industrial training.

5. Collaborate across institutions, sectors, and borders: establishing cross-ministerial task forces, strengthening mutual recognition and interoperability of sustainability requirements across markets, and aligning trade policy with climate and biodiversity objectives.

This paper lays the analytical foundation for further work. It is part of a broader effort by the Ellen MacArthur Foundation and the Latin America and Caribbean Circular Economy Coalition to translate these insights into policy and market action at global, regional, and national levels. It establishes the analytical foundation for a multi-year programme of engagement at both global and national levels. The arguments presented here are intended to bridge policy, business strategy, and the emerging international debate the interconnections between the circular economy and nature.

Unlocking the full potential of bio-based materials requires moving beyond fragmented approaches towards a coherent system that maintains the value of resources, supports regenerative natural systems, and strengthens long-term economic resilience, especially in resource-rich economies where the transition to a circular economy could be most transformative.

01

ADDRESSING POLICY MISALIGNMENT BETWEEN CIRCULAR ECONOMY AND BIO-BASED MATERIALS FRAMEWORKS

With the linear economic model undermining both ecological resilience and long-term business stability, the circular economy is emerging in the policy sphere as a key pathway to long-term resilience and prosperity. In April 2026, over 100 countries adopted national circular economy roadmaps or action plans, representing a 34% increase since 2024. This demonstrates a growing consensus in favour of an economic model that gradually decouples growth from resource dependency, and strengthens long-term economic resilience.[7] Yet, while the circular economy concept envisions a shift to renewable energy and resources, policy frameworks have paid insufficient attention to bio-based materials – relative to fossil-based alternatives – and to ensuring that their sourcing, production and use deliver nature-positive outcomes.

Policy misalignment limits coherence and slows the adoption of circular solutions. An analysis of 13 national circular economy policy strategies found that, where bio-based materials such as paper, natural fibres, biochemicals, and timber appear at all, they are framed primarily as substitutes for finite materials (for the methodology applied and the list of policies by country studied, please refer to the Appendix 1). How they are grown, manufactured, circulated, and returned to the ground receives little consideration. Circular economy policies remain largely silent on upstream land-use pressures, biodiversity impacts and nutrient cycles. Similarly, certification schemes verify that a material can be industrially composted, not that it restores soil health, or that the infrastructure to process it at scale exists.

Policy frameworks consistently fail to apply a full life-cycle lens, resulting in misalignment between supply chains, use phase, and end-of-life pathways with the principles of the circular economy. As a result, regenerative production, value retention through reuse and secondary applications, and safe reintegration into natural systems are not systematically embedded. These strategies also tend to prioritise downstream uses of biomass waste, scraps and residues, such as repurposing agri-waste and waste to energy. While such approaches create additional value, energy security and divert waste from landfill, when implemented in isolation, they merely optimise the existing linear system rather than rethinking it.

Policies that more specifically govern bio-based materials — bioeconomy strategies, agricultural and forestry frameworks, industrial growth policies — show the same blind spot in reverse. Further analysis of 18 policy strategies regulating bio-based materials worldwide confirms that significant circular opportunities across the full life cycle of products are not being captured (see Appendix 1). Many policy commitments related to bio-based materials promote practices that deliver nature-positive outcomes during primary production, such as agroforestry and crop-livestock-forestry. Yet, by incentivising bio-based inputs, these policies create demand signals that can drive intensification, or land conversion, directly undermining the regenerative logic that makes biological cycles viable in the first place. Bioeconomy policy frameworks often reward substitution, replacing fossil-derived inputs with bio-based alternatives, without requiring that those materials actually cycle. First-use substitution is rewarded; secondary bio-based applications are not. Under this logic, a bio-based single-use product can satisfy bioeconomy targets while being actively at odds with circular economy principles. Thus, for durable and semi-durable goods, circular strategies such as reuse, life extension, refurbishment, and recycling, are often overlooked. Similarly, existing regulatory frameworks offer no meaningful incentive to extract maximum value from biological materials, such as timber and textiles, across successive applications before returning them to biological systems. This divergence extends to end-of-life treatment: many policies continue to incentivise conversion of bio-based materials and products to energy. While this can, in some cases, contribute to energy security, it also represents a missed opportunity to retain value and keep materials in productive use for longer.

Aligning circular economy and bio-based materials policies can unlock significant value. Better integration would allow policymakers to address the triple planetary crisis of biodiversity loss, climate change, and pollution more effectively, while generating social benefits and reinforcing business resilience.

02

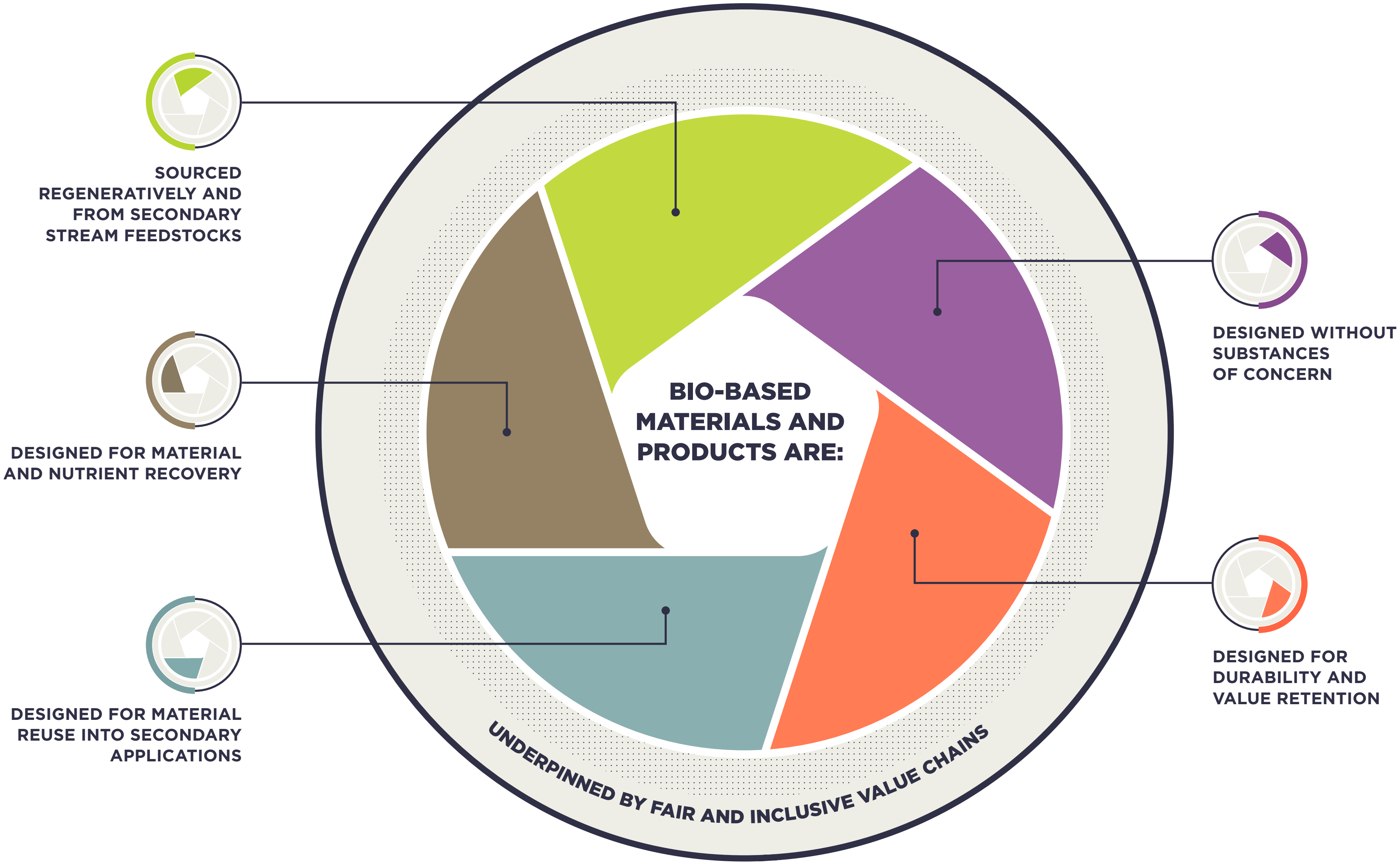
ADVANCING A CIRCULAR ECONOMY FOR BIO-BASED MATERIALS

A CIRCULAR ECONOMY SYSTEMS APPROACH TO BIO-BASED MATERIALS

Bio-based materials hold significant potential for resource efficiency, emissions reductions and economic opportunities. Yet, realising these benefits over the long term, requires clear guidelines and guidance to ensure rising biomass demand does not intensify land conversion or degrade ecosystems. A circular economy framework for bio-based materials is essential to ensure that renewable resources are used at rates ecosystems can sustain, deliver maximum value over multiple life cycles, and are safely returned to nature. Moving beyond simple substitution, this approach reduces pressure on land and ecosystems, minimises waste and pollution by design, and strengthens supply chain resilience. At the same time, it unlocks new economic opportunities through material efficiency, circular loops of value creation, and innovation — aligning climate, biodiversity, and competitiveness objectives.

Embedding bio-based materials in a regenerative circular economy requires a coherent, integrated framework of mutually reinforcing strategies applicable across sectors. Five mutually reinforcing circular economy strategies provide a framework offering clear guidance and direction to businesses, innovators, investors and policymakers to help them reap the benefits of the responsible integration of bio-based materials into the economy. This coherent framework, where each strategy complements and enhances one another, must be implemented in a consistent and integrated manner, to ultimately enable a comprehensive circular economy approach. In addition, an overarching social dimension must be included to ensure that people and communities are fully involved in the transition, and that it is also socially just and inclusive for all value chains. These drivers can be applied across sectors and products, from clothing and packaging, to buildings and furniture.

Figure 1: A circular economy framework for bio-based materials, components, and products



In a circular economy, bio-based materials, components, and products are:

1. SOURCED REGENERATIVELY AND FROM SECONDARY STREAM FEEDSTOCKS: Bio-based materials should be sourced from renewable biomass produced in a way that restores ecosystems rather than depletes them.

Regeneratively sourced bio-based materials are materials derived from renewable biological resources and produced through agricultural and forestry practices (such as agroforestry, permaculture, and silvopastoral systems) that restore and enhance natural systems, including soil health, biodiversity, ecosystem functions, and carbon sequestration, while sustaining long-term resource productivity. The choice of practices is dependent on the local context, since the approaches adopted must be aligned with local ecological processes, which vary according to the ecosystem, including reflecting the socio-economic context. A more diverse cropping system can support agrobiodiversity, soil health, reduce pest infestation, and increase resilience to climate change, while expanding farmers' revenue streams. In addition, using biomass residues, waste and by-products from agricultural and forestry production as feedstocks for bio-based materials and products reduces the need for dedicated biomass production or additional land conversion. Overall, regenerative sourcing requires avoiding deforestation, limiting land-use change, protecting and restoring biodiversity, and ensuring that biomass extraction remains within ecological limits.

2. DESIGNED WITHOUT SUBSTANCES OF CONCERN: Bio-based materials should be designed to be safe for people and the environment across their whole life cycle and should return to nature without leaving harmful residues.

Products and materials are made without toxic inputs or substances of concern that hinder their safe return to the soil. For example, this could include designing packaging that meets robust, recognised standard specifications for home composting and biodegradability in soil, freshwater, and marine environments to avoid persistent plastic pollution.[8]

3. DESIGNED FOR DURABILITY AND VALUE RETENTION: Products and components made from bio-based materials should be designed with durability and repairability in mind to keep them at their highest value in the economy.

Products should be designed for durability, modularity, and ease of maintenance and repair. Thus, the embedded energy and biochemical properties of bio-based materials contained in those products are retained at their highest utility across multiple use cycles. For example, in the built environment, timber-based prefabricated and modular construction design – which can be assembled, disassembled, and relocated – can be widely adopted, thereby reducing overall resource extraction, material processing, and emissions compared to conventional construction.[9]

Circular business models such as resale, rental, and Product-as-a-Service, keep products in circulation longer, and incentivise take-back for repair, remanufacturing, and recycling, decoupling revenue from virgin material consumption and reducing emissions, pollution, and biodiversity loss.

In fashion, clothing rental platforms and resale marketplaces facilitate the movement of products from user to user, so garments are kept in use for longer, displacing the need for new virgin bio-based resources extraction.[10]

4. DESIGNED FOR MATERIAL REUSE INTO SECONDARY APPLICATIONS: Bio-based materials should be kept in productive use for as long as possible across multiple sequential applications, recognising that the highest value uses are context-dependent, and should be determined by local economic, social and ecological priorities.

After multiple use cycles, the bio-based materials in products and components can be kept in circulation in the economy through applications in other value chains before being eventually recovered through recycling and composting. For example, wood can first be used in construction, then repurposed into furniture and engineered wood products, and finally utilised for energy recovery once material quality declines and uses have been exhausted. These strategies unlock economic value generation from the same unit of biomass.

5. DESIGNED FOR MATERIAL AND NUTRIENT RECOVERY: Products should be designed so materials can be recovered through recycling, composting and biodigestion to safely return to natural systems.

Products and components made of bio-based materials should be designed to be effectively recovered and recirculated at the end of their use phase. This requires moving away from design choices that hinder disassembly (such as permanent adhesives and complex multi-material blends) in favour of approaches that enable clean separation at end of use, including mechanical fasteners and monomaterial design.

Depending on their composition and application, materials could be recovered through mechanical recycling, such as the recovery of fibres from paper or textiles; processing through biorefineries, where organic materials are broken down into reusable molecular components; or biological cycling, including composting or anaerobic digestion. Crucially, these recovery pathways must be clearly defined at the design stage and aligned with collection and treatment infrastructure, ensuring that materials can be practically and locally recovered and reintegrated into economic or natural cycles.

After the bio-based material has delivered as much economic and functional value as possible through prior reuse, repair, or recycling[11] it should return safely to natural systems. This requires materials to be truly biodegradable under realistic environmental conditions and free from persistent or harmful substances that could contaminate soils and ecosystems more widely. Through processes such as composting or anaerobic digestion, these materials can contribute to nutrient cycling and soil health, helping to regenerate natural systems.

6. UNDERPINNED BY FAIR AND INCLUSIVE VALUE CHAINS: A bio-based circular economy should support equitable social outcomes across the entire value chain.

As biomass and bio-based material production occur in places where rural and indigenous communities have deep connections to the land, a circular economy transition must recognise them as rightful participants, respecting their rights and culture, and valuing their knowledge to improve both environmental and socioeconomic outcomes. The transition should also reflect the needs and realities of small-scale producers, and other local stakeholders, ensuring that support is not concentrated solely on a limited number of high-value supply chains. From the earliest stages of bio-based material value chains, open information exchange is crucial to ensure the inclusion and equitable distribution of value among all stakeholders.

Further along the value chain, safe working conditions and skills development are equally important, enabling workers to access new jobs and economic opportunities as the circular economy grows.

The social dimension is inherent to each of these drivers, not additional to them. Embedding equity and justice considerations into design, sourcing, production and material flow is what allows circular systems to be truly regenerative — restoring ecosystems and securing the prosperity of the communities that depend on them.

Such an approach can help integrate bio-based materials into a regenerative circular economy, maximising the value of biomass whilst respecting natural system limits. Bio-based materials are part of a system in which resources are used efficiently, ecosystem integrity is maintained, and nature's regeneration is recognised as a prerequisite for long-term economic prosperity. Regeneration sits at the core of this framework, anchoring its overall direction and ensuring that bio-based materials contribute positively to nature — not only by reducing harm, but by actively restoring ecosystems. Then the framework considers how materials and products are designed, and the business models through which they flow. These are, fundamentally, strategic choices: when products are designed to be safe for circularity, they can circulate through multiple loops — such as reuse, repair and remanufacturing — or through secondary uses that avoid disposal. Finally, the framework recognises components that depend on broader systemic change — including industrial composting, biodigesters and recycling infrastructure — which rely on enabling conditions often shaped by public policy and require higher levels of coordination across value chains. Each loop generates additional economic value per unit of biomass, while helping reduce new virgin resource extraction, pollution, and emissions.

Substituting non-renewable materials with bio-based alternatives holds great potential but is limited by ecological factors and requires rigorous environmental impact assessment and attention to geographic context. While bio-based materials are renewable and can offer lower GHG emissions than fossil-based counterparts, they carry environmental trade-offs, including land-use change, eutrophication and acidification. Given that bio-based materials are inherently ecosystem- and context-dependent, no single solution applies universally across all materials or settings. Therefore, any substitution opportunity needs to be tailored to specific contexts, material properties, and application requirements — weighing potential environmental trade-offs and, where necessary, identifying appropriate mitigation actions in each case.

As demand for biomass is expected to grow, a circular economy must also create space for biodiversity to thrive by conserving at least 30% of lands, inland waters, and oceans worldwide as stated by the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (GBF).[12]

A circular economy framework for bio-based materials is fully in line with international frameworks for building inclusive and resilient global economies. By sourcing bio-based materials regeneratively and from secondary feedstocks, designing products and components without substances of concern for durability and value retention, and nutrient recovery, the circular economy framework for bio-based materials, underpinned by fair and inclusive value chains, contributes to the UN Sustainable Development Goals (SDGs). By offering a systemic approach to achieving economic prosperity, environmental sustainability, and social well-being, the circular economy supports in particular SDG 12 (Responsible Consumption and Production)[13] but has also been recognised for the contribution it can make to the remaining 16 goals.[14] While the Global Biodiversity Framework does not explicitly recognise the circular economy as a tool to achieve its objectives, it aligns closely with its principles, particularly in addressing unsustainable production and consumption.[15] Although still not widely reflected in national biodiversity strategies and action plans, circular approaches and business models are essential to transforming economic systems to better value, protect, and regenerate nature.

To unlock such a system-level change, a set of enabling conditions must be put in place. These include investment in capabilities and know-how, advances in material innovation and performance, processing capacity and infrastructure for effective material circulation, and supportive regulatory and trade frameworks (see chapter 4 for policy recommendations).

Redesigning product and material leveraging circular economy strategies:
From regenerative sourcing to composting

This example illustrates how a conventional sneaker can be redesigned to fit within a circular economy and how value can be captured through leveraging circular economy strategies, from regenerative sourcing to composting. It also shows how circular business models, such as resale and rental, contribute to extending product lifetimes while creating new revenue streams.

In a linear economy, a typical shoe is composed of three main materials – rubber, leather and fabric – and commercialised through a one-way selling, perpetuating an extractive and wasteful Take-Make-Waste model.

In the example presented, the three main materials can be substituted with several different bio-based materials options, depending on available resources, durability criteria, environmental benefits (pollution, emissions, end-of-life treatment) and economic opportunities along the value chain (resale, recycling, biogas).

Conventional cow leather, whose production is associated with GHG emissions, could be replaced with a regeneratively sourced option, such as cow leather produced in agrosilvopastoral systems that bring nature-positive outcomes to the land. Alternatively, bio-based leather made from secondary stream feedstocks, such as pineapple leaves or innovative materials made from cactus or mushroom, could represent interesting substitutes, provided that they are grown regeneratively and designed without substances of concern.

Fossil-based rubber could be substituted by natural latex, harvested from Hevea, grown using agroforestry to promote biodiversity and avoid deforestation, and sustainably harvested from native trees. Responsible tapping techniques rely on traditional knowledge and expertise, supporting local communities and ensuring the longevity of the tree.

Finally, conventional cotton or other textile fibres could be substituted by cotton produced using practices that bring nature-positive outcomes, or with post-consumer recycled cotton supporting material recovery and resource efficiency, thereby reducing further biomass extraction, GHG emissions and biodiversity loss.

To fit within a circular economy, the selected materials are designed without substances of concern; using natural, non-toxic dyes that do not jeopardise their safe return to the environment or nutrient recovery at the end of life. Additionally, the shoe is designed to be easily repairable, and its parts can be disassembled to be replaced when needed. Business models such as resale, rental and take-back schemes retain product and material value for longer and encourage circular design choices.

At the end of a shoe’s lifespan, when it can no longer be worn, materials are separated, and recycled into another shoe or reused in secondary applications such as furniture stuffing or building insulation. Ultimately, when no other option is available, materials can be composted or converted into biogas, and the digestate and its nutrients returned safely to the natural system.

Finally, traceability tools such as digital product passports can be incorporated to ensure information exchange about the product among all stakeholders involved in the value chain. It can contain information about possible secondary applications or recycling options, and certifications of regenerative sourced, inclusive and fair trade practices.

03

UNLOCKING THE BENEFITS OF A CIRCULAR ECONOMY FOR BIO-BASED MATERIALS

ECONOMIC, ENVIRONMENTAL, AND SOCIAL VALUE OF CIRCULAR SYSTEMS

A circular economy for bio-based materials represents a systemic shift in how value is created, moving beyond linear extraction and use towards regenerative, multi-cycle value creation from biological resources. Embedding a circular economy framework for bio-based materials can unlock new sources of revenue, drive innovation, and enable more resilient and diversified economic models across sectors. Beyond economic gains, it also delivers wider benefits, including reduced environmental pressures, enhanced biodiversity, stronger rural livelihoods, and improved long-term resource security.

A circular economy leveraging bio-based materials opens up new economic opportunities and innovation pathways by fundamentally transforming the way value is created. By harnessing value throughout the multiple life cycles of biomass, a circular economy paves the way for businesses to tap into new sources of revenue and new market segments. For products made of bio-based materials, circular strategies such as reuse, repair, refurbishment, and resale extend product lifespans by preserving embedded economic value and maintaining assets at their highest productive utility for longer. This improves asset utilisation and cost efficiency, reduces the need for continuous new material inputs, and enables business models such as Product-as-a-Service and secondary markets that generate more stable and recurring revenue streams over time.

In addition, the valorisation of bio-based by-products and waste streams, including agricultural residues, forestry by-products, and food waste, can be converted into valuable inputs for new products and industrial processes, thereby creating new value chains and revenue streams. Incentivising the transition to regenerative forms of production and to the use of biodiversity in higher value-added products can also benefit farmers. Studies have shown that, after a transition period, regenerative production systems can lead to greater yields and compelling increases in farmer profitability.[16]

Opportunities for innovation in materials are also significant and often lead to differentiated products with higher added value. Companies are already developing new bio-based alternatives to fossil and mineral-based materials, including advanced fibres, biochemicals and bio-based composites. Often this innovation drive is being led by start-ups, which are more agile and better placed to make an impact in advancing circular economy solutions.[17] For example, MynusCo (see case study on chapter 3.2), is an Indian bio-based materials innovator that transforms agricultural waste into bio-composite pellets that replace plastics. Seringô,[18] a Brazilian Amazon based company, creates shoes made of bio-based materials such as natural latex harvested from rubber trees by local communities, organic cotton, jute, açai pits, and natural dyeing. Each product contains a digital product passport tracing the full journey of the product, from the extraction to final fabrication.

Overall, the potential of the bioeconomy is far greater than is commonly thought, and the opportunities span a wide range of sectors, yet remain largely untapped. For example, according to several studies, a nature-positive transition (i.e. aligned with the GBF targets) could represent USD 10 trillion in annual opportunities globally by 2030.[19] China, by harnessing the potential of key bio-based industries such as biomedicine, bioagriculture, environmental biotechnology and bioinformatics, could generate an additional USD 1.9 trillion in revenue per year and create 88 million jobs by 2030.[20]

For bio-based materials-producing countries, the opportunity is significant. By shifting from commodity export towards circular activities — regenerative production, conversion of biomass into innovative materials, and local recirculation loops through repair, reuse, and recycling — countries can generate more diversified economic returns, strengthen domestic industries, and create skilled employment opportunities, reducing dependence on raw material exports.[21] By design, a bio-based circular economy continuously regenerates its natural resource base, enabling economic prosperity to be progressively decoupled from environmental degradation.

By design, circular economy strategies can reduce dependency on virgin inputs, and enhance supply chain resilience. Designing products to keep bio-based materials in use longer and recover them effectively at end of life reduces dependence on virgin raw material extraction, eases pressure on ecosystems, and helps address resource scarcity. Producing bio-based materials using regenerative practices improves water retention, soil health, and local biodiversity, thereby increasing supply chain resilience to environmental shocks. Such practices promote more stable yields and help to secure material supply over the long term. In addition, encouraging the production of a more diverse cropping system reduces reliance on a single commodity, which lowers the risk of widespread shortages and price surges.[22]

Transitioning to a bio-based circular economy can generate job creation opportunities across value chains. These jobs span a wide range of activities, from regenerative agriculture to repairing, refurbishing and recycling of products, materials and components. Scaling a bio-based economy will also require research and innovation in material design and manufacturing, as well as in the development of processing technologies and post-use infrastructure (e.g. biorefineries, composting facilities). Evidence shows that bio-based manufacturing underpins extensive value chains spanning biomass production, processing and distribution, with each direct job in the sector supporting around 1.79 additional jobs across agriculture, logistics, and services.[23] For example, regions where biorefineries have been established have higher employment growth than those that have not.[24] A nature-positive, circular economy offers a promising opportunity for job creation across all stages of the value chain, but emphasis needs to be placed on the quality of these new jobs, working conditions, upskilling, and inclusivity.

A bio-based circular economy offers significant environmental benefits, including GHG emissions and pollution reduction, while supporting biodiversity. Bio-based materials can be viable alternatives to non-renewable and carbon-intensive materials in many sectors. In construction — one of the most material- and carbon-intensive sectors — bio-based materials offer compelling alternatives to high-emitting inputs such as cement and steel.[25] The numbers are striking: bio-based products could eliminate up to 2.5 billion tonnes of CO_2 eq. annually in Europe by 2030,[26] while a global shift towards a bioeconomy could deliver up to one-third of the emissions reductions required to limit warming to 1.5°C.[27] In a bio-based circular economy, waste is designed out and organic residue and by-products are transformed into valuable products, thereby preventing pollution and reducing emissions from landfill, open burning and unmanaged decomposition. At the product's end of life, when nutrients can return to the soil through anaerobic digestion and composting, it further decreases pollution.

At the same time, by keeping products in use for longer, demand for virgin inputs is reduced, easing pressure on land. Through prioritising regeneratively sourced biomass and diversified cropping systems, a bio-based circular economy can help create more varied habitats and restore soil health. This creates the conditions to allow below- and above-ground biodiversity to thrive, simultaneously increasing water retention and carbon sequestration.

Integrating bio-based circular economy approaches to products and sectors into the Nationally Determined Contributions (NDCs) and National Biodiversity Strategies and Action Plans (NBSAPs) would support the scaling of the above mentioned benefits.

RESPONSIBLE SUBSTITUTION
THE CASE OF FLEXIBLE PACKAGING [28]

To understand how bio-based substitution could be part of a broader circular economy strategy, the Ellen MacArthur Foundation analysed the case of flexible plastic packaging – one of the most challenging material categories in the context of plastic pollution. The study concluded that, to be efficient in fighting pollution, flexible paper-based packaging must meet four critical conditions: it must be recycled locally, be sourced and produced responsibly, be technically and economically viable, and avoid hazardous chemicals and persistent plastic pollution. The study also highlights that substitution with paper-based packaging must not contribute to an increase in demand for wood that surpasses ecological limits. To comply with that, it is important to limit the consumption of virgin fibres, increase non-wood material alternatives, and ensure good supply practices throughout the industry.

The report offers guiding principles to support case-by-case decision-making, recognising that the environmental impact of different material options depends heavily on packaging design, local waste management systems, and social and economic context. Assessing the best option requires considerable research and local stakeholder engagement.

TO LEARN MORE ABOUT THE TOPIC, PLEASE VISIT:

Paper-Based Flexible Packaging: The role it could play in tackling small-format flexible plastic pollution in markets with high leakage rates.

BUSINESS IN ACTION: EXPANDING REVENUE STREAM AND STRENGTHENING RESILIENCE

Companies around the world are starting to embed circular strategies for bio-based materials into their operating models as a way to ensure supply chain resilience and create new revenue streams. The following examples demonstrate some of the paths being implemented today to expand nature regeneration, circulation of products and materials, circular design, and traceability, while delivering environmental and socio-economic benefits.

Gucci: building resilience through regenerative sourcing and circular design

Driven partly by risk management for key materials (wool, cotton, leather), Gucci reinvents its luxury catalogue and value chain with a sustainability approach that involves strategic decisions from the farm level to a management system for raw material sourcing, design, and post-use materials.

For example, Gucci is investing directly into regenerative production through a key partnership with NATIVA™, a natural fiber brand created by Chargeurs Luxury Fibers. The project covers 115,000 hectares of pastureland, and has been focusing on improving soil health, biodiversity, and carbon sequestration, while also improving supply resilience and ensuring high-quality, fully traceable materials for incorporation into Gucci's collections.

At the product level, Gucci repair centres ensure longevity and continued use of garments that are designed for durability. Moreover, through the Gucci Circular Hub, the platform for innovation, design and manufacturing of circular products launched in 2023, the company develops circular solutions and smarter manufacturing practices that reduce environmental impacts.

As another example, through their Regenerative Denim Project, created in line with circularity principles, the company combines 76% certified and traceable cotton from regenerative agriculture practices in Europe with 24% recycled fibers from Italy.

Klabin: From regenerative approaches to recycling solutions for packaging

The Brazilian pulp and paper company Klabin has a high degree of vertical integration, which gives it control of its whole value chain from raw material production to finished packaging. The company leverages this characteristic to enable a more productive and circular approach to packaging production. To secure long-term productivity Klabin employs a large-scale 'mosaic model' of forestry – a system implemented on degraded land that intersperses native species with commercial forests of pine and eucalyptus. The model achieves 54% higher annual productivity than the national average for eucalyptus and 26% for pine, while also supporting local biodiversity. Moreover, the company accounts for 10% of Brazil's installed cardboard recycling and leverages this position to reduce its reliance on virgin fibre, while exploring upcycling opportunities for paper production by-products, such as polymer lignin. Finally, Klabin is exploring innovative solutions to replace fossil-based materials with paper-based flexible packaging, such as products like the 'Ekolayer®' bag, a recyclable solution for multi-layer packaging that includes natural resin instead of conventional flexible fossil fuel-based plastic.

Lojas Renner: creating a path to circular and regenerative textiles

Brazilian fashion retailer Lojas Renner has partnered with startup FarFarm[29] to bring agroforestry cotton cultivation in the Cerrado, as part of its commitment to reach 100% circular and regenerative textiles by 2030. The Cotton Forests project develops knowledge and trains family farmers in regenerative production and has delivered early results. 1.5 tonnes of cotton across 4.5 hectares of agroforestry land has been produced in its first year, with 63% of farmers reporting a doubling of their annual cotton income.

Lojas Renner seeks to apply this same circular logic to its supply chain. To ensure that products circulate through multiple use cycles, the company created a Circular Design Guide for product development, including the possibility of using natural dyes, components designed for easy disassembly, and mono-material compositions that facilitate recycling or reuse at end of life. Through the Moda Responsável programme, the company also works on pre-consumer waste management alongside its supply chain, as well as post-consumer collection systems in stores. The company also owns Repassa, a resale platform for clothing of any brand. In 2024, according to the company, the platform diverted 406,000 items from landfill disposal, saving around 900 million litres of water and avoiding the emission of 4,000 tonnes of CO_2.

Royal Ahrend: modular design for circular wood systems

The Dutch office furniture manufacturer, Royal Ahrend, operates on a business model of continuous use of bio-based materials, notably wood, at an industrial scale. Firstly, Ahrend's design strategy focuses on eliminating waste before it is created, through modular product design and design for disassembly, as well as durable material choices. This strategy allows individual components to be repaired, replaced, or remanufactured without discarding the full product. Returned furniture is refurbished and reintroduced to the market through "Second Life" sales. Complementing these efforts, the company offers a Furniture-as-a-Service model, leasing furniture to office clients while retaining responsibility for maintenance, repairs, and upgrades.

Moreover, at the manufacturing stage, all wood cutting waste from its Czech production facility is returned to chipboard suppliers for reprocessing — an initiative that has reduced the factory's wood waste output by 30%. Through partnerships with private waste processors, discarded furniture wood is separated by grade and reintegrated into new chipboard containing approximately 80% recycled content, enabling post-consumer material to re-enter production cycles at scale.

MYNUSCo: Creating economic and social value from waste

Indian bio-based materials innovator MYNUSCo shows how circular strategies can both upgrade materials in the economy and deliver greater value to people along the chain. The company transforms agricultural waste – which would otherwise be burned – into bio-composite pellets that replace plastics and other carbon-intensive products, feeding them into high-value loops such as consumer goods, packaging and automotives. The company has two types of products, BioPur, for disposables, which are compostable, and BioDur, for durable materials like furniture, which are recyclable. By sourcing directly from farmers and paying them 15 rupees per kilo — two to three times more than what they would receive from the biofuel industry — MYNUSCo not only raises the worth of underused materials but also doubles rural incomes. Moreover, the company provides its bio-composite pellets to a network of 25 plastics manufacturing Small and Medium Enterprises (SMEs), which incentivises the use of recycled source materials.

Crystal: Reviving Colombia's cotton sector through regenerative practices

Colombian fashion manufacturer Crystal S.A.S shows how circular models can strengthen both corporate resilience and help support the country's cotton sector. By investing in regeneratively produced cotton — grown in rotation with rice, corn, and soy to restore soil health — the company aims to reduce its dependence on imported cotton, which still accounts for half of its supply. Once known as "white gold," the country's cotton industry thrived in the 20th century before collapsing under pressure from cheaper imports. Crystal's initiative aims to help revive the sector — this time through a modern approach that is beneficial not only for business but also for nature.

Beyond growing methods for cotton, Crystal S.A.S collaborates with universities, such as Universidad Pontificia Bolivariana (UPB) to test new fibres like pineapple, fique, and banana, opening pathways to diversify local bio-based industries.

TraceSurfer: enabling circularity through information exchange and regulation

Uruguayan company TraceSurfer shows how digital and traceability innovation helps SMEs capture new value and integrate into global markets under circular economy policy drivers. The company offers a platform for full product life-cycle traceability, enabling companies to collect and share data on product performance, raw material origin, durability, and defects with value chain partners. Its digital traceability tools help companies like certified B-corp Warmi, as well as pilot initiatives carried out with leading Latin American companies such as Crystal and Vicunha comply with international regulations to facilitate exports — most notably the upcoming Ecodesign for Sustainable Products Regulation and mandatory Digital Product Passport for textiles in 2027 — as well as regional EPR schemes such as in Chile. Beyond responding to policy drivers, TraceSurfer actively shapes them, contributing to UNEP's regional data framework and global ISO standards.

04

ACHIEVING ALIGNMENT BETWEEN POLICIES FOR CIRCULAR ECONOMY AND FOR BIO-BASED MATERIALS: RECOMMENDATIONS FOR POLICYMAKERS

To help provide a practical starting point for a better alignment of circular economy and bio-based materials policy agendas, five pillars of policy recommendations, applicable worldwide, can pave the way for a circular economy for bio-based materials. The recommendations have been informed by the Universal Circular Economy Policy Goals (UPGs),[30] created by the Ellen MacArthur Foundation to ensure a clear direction of travel towards a circular economy, and avoid creating fragmented solutions. **The following recommendations offer greater impacts if pursued in an interconnected way:**

Design for circularity, elevating regeneration

Enable effective and safe circulation of bio-based materials

Promote suitable financial and fiscal incentives

Invest in innovation, skills and infrastructure

Collaborate across institutions, sectors and borders

DESIGN FOR CIRCULARITY, ELEVATING REGENERATION

- **Begin developing or adapting design standards for circularity for bio-based materials, drawing on proven international frameworks**
- **Identify opportunities to embed the principle of regeneration into standards across the bio-based materials life cycle.**
- **Build towards greater transparency and traceability, starting from existing certification schemes.**
- **Apply the circular economy framework for bio-based materials, complemented by proven existing tools**

Design is the driving force behind the shift to a system that keeps resources in use for longer, reduces extraction, minimises land conversion, and allows nature to thrive. Decisions made at the design stage dictate how products, services, and value chains perform — shaping markets and business models in ways that are difficult and costly to reverse. By embedding circular economy principles from the outset, resources can be optimised before waste is ever created, reducing environmental pressures and preserving long-term economic value. Policy development for the circular economy has largely recognised this role, stimulating circular design so that materials and products can be used, reused, and repurposed across multiple lifecycles. Yet, more can be done to reflect and integrate the specificities of bio-based materials.

Unlike[31] finite resources, regeneratively grown renewable resources can deliver nature-positive outcomes — such as carbon capture or soil regeneration — and, after several cycles of use, many can safely return to biological systems. This requires carefully designed conditions: materials must be non-toxic, free from problematic mixtures, and compatible with safe return pathways such as industrial composting or other controlled processes such as anaerobic digestion, enzymatic recycling or bio-refining, tailored to specific material properties.

Without policy intervention, design decisions default to cost and speed-to-market. Bio-based materials will continue to be designed for single use, without traceability, and without safe end-of-life pathways — not because circular design is technically impossible, but because no regulatory or economic signal requires otherwise.

Begin developing or adapting design standards for circularity for bio-based materials, drawing on proven international frameworks

Design standards for circularity and, specifically, for bio-based materials, need to be created. Also, embedding clear definitions of terms relating to bio-based materials into product and industrial policies is central to this effort. Such definitions should be agreed across government departments, and used to guide the production, design, and management of bio-based materials. Businesses and civil society should also be consulted, while the academic community should provide the scientific expertise and methodology needed to underpin the definitions and standards. Those definitions can align concepts that remain inconsistent, such as regenerative production, durability, safe compostability, biodegradability, bio-based content, and substitution. These definitions can be integrated into circular economy policies, product standards, agriculture and forestry regulations, and industrial strategies. Without shared definitions, data, and metrics, barriers persist that hinder investments in innovation, infrastructure, skills and scaling in the industrial system. Conversely, alignment of standards and methodologies foster transparency, strengthen investor confidence, and facilitate international comparability – accelerating the growth of regenerative and circular value chains.

Given that policies for circular economy already recognise bio-based materials as potential substitutes for non-renewable or hazardous materials, one opportunity is coordinating product policies with innovation, industrial and consumer-safety policies to identify applications where the substitution by bio-based materials can be encouraged. For instance, where products are prone to leakage into the environment or even where there is an opportunity to diversify bio-based material inputs with proven economic, social and environmental advantages such as innovation on biochemicals and alternative fibers for textiles.

Identify opportunities to embed the principle of regeneration into standards across the bio-based materials life cycle.

The principle of regeneration should be agreed upon and embedded in standards across every stage of the bio-based materials life cycle. Standards governing bio-based materials currently focus predominantly on technical performance such as compostability thresholds, biodegradability rates, and material composition, but without requiring that materials actively contribute to regenerating the natural systems from which they are derived. Embedding regeneration as a principle across the bio-based materials life cycle would mean reorienting standards at each stage: when materials are grown, by linking certification to land management practices that restore soil health and protect biodiversity; when they are processed, by requiring that formulation and manufacturing preserve biological value rather than simply achieving technical compliance; and when they are recovered, by conditioning end-of-life claims — compostability, biodegradability, return to soil — on the existence of infrastructure capable of delivering those outcomes at scale, and on evidence that returned materials genuinely rebuild soil organic matter and support biological cycles. In this way, the social and environmental benefits associated with nature regeneration can be fully realised.

Brazil's National Circular Economy Strategy[31] shows what embedding regeneration as a core principle can achieve: the objective surfaces in adjacent instruments, including Nova Indústria Brasil,[32] which promotes biofertilisers, bioinputs, and agroindustrial traceability which are foundational to regenerative production. When regeneration is treated as a shared principle across circular economy and industrial policy, it creates cross-sector coherence and embeds circular practices at the core of economic development.

Build towards greater transparency and traceability, starting from existing certification schemes

To enable a bio-based circular economy, policies can mandate greater transparency and traceability. Tools such as digital product passports and labelling schemes can disclose material content, regenerative origin, circular design features, chemical composition, repair instructions, and end-of-life options. This enables verification of effective material circulation (reuse, recycling, and return to the soil), regenerative sourcing, and fair labour practices. Digital product passports offer a technical pathway to build trusted information flows across borders and supply chains — provided that criteria, data models, and metrics are harmonised to enable comparability, finance, and scale. At the same time, policies should go beyond premiums and certification schemes to make regenerative production viable for all producers, not just early adopters able to absorb compliance costs. Existing traceability and digital product passports providers could benefit from harmonisation of data standards and definitions across markets. It could ensure information is consistent and globally interoperable for companies and consumers alike.

Apply the circular economy framework for bio-based materials, complemented by proven existing tools

The circular economy framework for bio-based materials set out in this report provides policymakers with a coherent basis for designing bio-based materials, components and products. This can be complemented and operationalised by existing tools and frameworks already being applied in practice.

Some examples that can be used are the ISO standard for digital passports, developed with the UNTP,[33] and the UNECE traceability protocol[34] for garments and footwear, which sets durability, reparability, recyclability, and Digital Product Passport requirements. Another inspiration is Chile's Extended Producer Responsibility Framework,[35] which combines EPR with eco-design and collection targets to guide material choices and system compatibility. Policymakers can also consult business initiatives to provide clear and tested criteria for durability and material health.

One example is the Jeans Redesign,[36] a set of guidelines to design jeans so they could be used more, made to be made again, and made from safe and recycled or renewable inputs. After being developed with input from 80 experts across industry, academia, and NGOs, more than a hundred businesses applied them to redesign their products. Finally, to accelerate uptake, sector-specific guidelines should be piloted with stakeholders before being embedded into national product policies and procurement rules to scale adoption.

In practice

As illustrated by Gucci's experience, classifying clean, pre-consumer scraps as resources rather than waste can remove bureaucratic barriers that hinder efficient recycling and industrial symbiosis — unlocking productivity gains and reducing reliance on virgin materials. When such approaches are embedded into national product and industrial policies, the benefits extend far beyond individual firms: they enable countries to stimulate innovation, strengthen domestic value chains, and increase competitiveness through better resource efficiency. Similarly, harmonised and cost- effective methods to measure and verify regenerative production outcomes — as highlighted in Gucci's case — can enhance transparency and stakeholder confidence, creating the conditions for regenerative production to scale across entire economies.

ENABLE EFFECTIVE AND SAFE CIRCULATION OF BIO-BASED MATERIALS

- **Review existing waste classifications to begin distinguishing between waste and secondary biomass streams**
- **Explore sector-specific standards that encourage bio-based materials reuse into secondary applications**
- **Identify and clarify feasible pathways for secondary use of bio-based materials, starting with the most abundant and economically significant streams**

To shift from waste management to resource management, policies should enable systems that preserve resource value and extend their use. While policies for circular economy promote circulation generally – such as incentives for collection, separation, and sorting systems that enable reuse, repair, remanufacturing, high-quality recycling, and end-of-life treatment – few policies explicitly address the specifics of bio-based materials, leaving untapped opportunities to keep them in circulation. Additionally, waste regulations often classify biomass and biogenic residues as waste, missing on value creation opportunities from circular economy strategies.

Review existing waste classifications to begin distinguishing between waste and secondary biomass streams

To move away from discarding bio-based materials that could be used to create new products, it is fundamental that circular economy and waste management policies differentiate what can be recovered, repurposed, and transformed into new products. Harmless, non-toxic residues can be inputs for new products and safely return to the ecosystem, they should therefore be set apart from contaminated residues that need to be disposed of under controlled conditions.

In line with this, updating waste classification and material flows regulations would enable biochemical extraction, bio-polymers creation, and other secondary applications, reducing landfilling and associated GHG emissions. These policies should also align with soil-health and organic production regulations, typically framed within agricultural policies, to capture opportunities for reusing by-products and surplus crops.

Explore sector-specific standards that encourage bio-based materials reuse into secondary applications

Sector-specific standards for the circulation of bio-based materials can encourage the use of bio-based materials for durable applications, such as furniture, before moving to alternative applications, such as paper packaging, taking into account the realities of regional value chains and local development priorities. For instance, the Forest Stewardship Council (FSC) is exploring how forest biomass can be used sequentially across multiple applications to maximise its value and extend the lifespan of the fibre. In this case construction materials or durable goods are prioritised before the material is recycled into paper products.[37]

One consequence of creating these criteria is to stimulate the circulation of bio-based materials in practice, reducing the amount of materials needed to make new products, and reducing landfilling. These pathways can be aligned with policies regulating the production and use of bio-based materials to provide certainty. Public procurement can also reinforce these standards by rewarding products that demonstrate extended lifecycles. However such an approach should also recognise that value is context-dependent and should encompass not only economic returns, but also local industrial development, livelihood creation, ecosystem regeneration, and resource security. These policies should therefore be designed to maximise value retention while supporting locally relevant development pathways and regenerative outcomes

Identify and clarify feasible pathways for secondary stream feedstock, starting with the most abundant and economically significant streams

Some countries have already begun monitoring their flows of bio-based materials and biomass to make the most of their resources. These tools help pinpoint inefficiencies — such as uncollected residues, low-value uses, or outdated processing. They also identify scarcity risks linked to over-extraction, competing uses, or supply vulnerabilities. Linking such resource intelligence to circular economy policy ensures better coordination with national agriculture and industrial development agendas.

Some examples of policies driving this are Finland's Biomass Atlas,[38] Canada's national Material Flow Accounts,[39] and the Netherlands' Grondstoffenscanner,[40] which have developed system-wide intelligence on bio-based stocks and flows. Finland's Biomass Atlas, for instance, is an open mapping tool that aggregates spatial data on forestry, agriculture, livestock, and waste streams into a single platform. By allowing any actor to calculate biomass availability within a defined territory, it supports investment planning, logistics optimisation, and industrial symbiosis decisions. Beyond planning, tools like this reduce information barriers between biomass producers and potential users, lowering the cost of accessing secondary and certified non-virgin inputs at scale.

These pathways take different forms depending on the material and context. Facilitating industrial symbiosis, for instance, can connect traditionally siloed sectors, such as furniture, fashion, packaging and construction, to ensure high-value materials keep circulating between companies. Finland's Industrial Symbiosis System (FISS)[41] is an example of this. The programme is structured to enable companies to identify opportunities of transforming excess flows of inputs, by-products, waste, and energy from one company to another. FISS is actively coordinated by Finland's government, who acts on mobilising regions, offering technical support, standardising methodologies, and integrating the programme with the national circular economy strategy.

This could also mean linking urban composting facilities with agricultural lands on city fringes to replenish soils with nutrients and help farmers transition to regenerative practices. One practical example of this is Brazil's resolution on organic waste,[42] which has evolved from forbidding any compost from going to agricultural lands to creating a system that categorises the types of compost and their potential uses.

One benefit of this action is the amplification of income opportunities for waste pickers and collectors, who play a crucial role in recovering valuable materials and keeping them in circulation. Waste pickers and recyclers could work on sorting bio-based materials and redirecting them to the more suitable pathways – be it remanufacturing, recycling, biorefining, composting or others.

In practice

Royal Ahrend's ability to reintroduce post-consumer wood into new products at industrial scale depends entirely on an enabling condition that most economies have not yet put in place: recycling infrastructure that separates bulky wood waste by quality. In the Netherlands, this classification system exists, allowing Ahrend to source chipboards containing approximately 80% recycled content. Without it, that same material would flow to landfill or waste-to-energy facilities, regardless of how well the product was designed for disassembly.

This illustrates why establishing clear pathways for secondary use of bio-based materials — and the infrastructure and classification systems that make them operational — should be considered from the outset as a circular economy strategy, and not as a downstream consideration.

PROMOTE SUITABLE FINANCIAL AND ECONOMIC INCENTIVES

- **Review existing economic policy instruments to identify opportunities to integrate circular bio-based materials**
- **Assess where economic incentives can be progressively redirected to prioritise regenerative practices, beginning with existing agricultural and forestry subsidies**
- **Identify near-term measures to improve the competitiveness of circular solutions for bio-based materials against linear alternatives**
- **Ensure support mechanisms for SMEs, cooperatives and communities are embedded from the outset of policy design**

Incentivising circular solutions at scale can be achieved by integrating bio-based materials into economic policy measures such as subsidies, taxes, and public procurement. Such measures can be cross-sectoral in the form, for instance, of public procurement and payments for ecosystem services, or specific to industrial sectors or agriculture and forestry in the form of changes to particular subsidies or tax rates to help stimulate regenerative and circular approaches to bio-based materials. Measures that actively undercut linear alternatives are equally important: phasing out subsidies that currently favour resource intensive bio-based production, and introducing taxes on certain models of virgin material extraction and landfilling, would tilt the economic playing field towards circular solutions rather than merely supplementing them.

Review existing economic policy instruments to identify opportunities to integrate circular bio-based materials

To stimulate the uptake of a circular economy for bio-based materials, reviewing existing economic policy instruments - such as public procurement - to identify opportunities to integrate circular bio-based materials can be highly supportive.

Governments are among the largest buyers of goods and services in any economy, and public procurement is therefore one of the most direct levers available to generate stable demand for circular bio-based products and shape markets at scale. By specifying requirements for regenerative sourcing, circular design, and end-of-life recovery in public tenders, governments can send reliable market signals that justify private investment across circular value chains for bio-based materials.

The Netherlands' Procurement with Impact programme[43] illustrates this potential by specifying that schools and public buildings must purchase furniture or timber from certified regenerative sources. Public procurement can also reinforce circulation standards by rewarding products that demonstrate extended lifecycles, repairability, and take-back schemes — shifting market norms beyond individual purchases

Assess where economic incentives can be progressively redirected to prioritise regenerative practices, beginning with existing agricultural and forestry subsidies

To make regenerative practices more attractive than conventional production, policies in the agricultural and forestry areas can redirect subsidies towards practices that restore degraded land and deliver nature-positive outcomes. This means prioritising approaches such as agroforestry, intercropping, and low-impact forest management.

Some countries are already moving in this direction. India, for example, operates a Priority Sector Lending framework[44] that requires banks to allocate a share of credit to sustainable agriculture. South Africa's Land Bank[45] is experimenting with green credit lines for climate-smart farming. In Brazil, subsidised credit is offered to no-tillage farming,[46] agroforestry and pasture recovery.[47]

The same prioritisation logic should apply across broader environmental and sustainability policy frameworks, including payments for ecosystem services schemes and voluntary carbon and biodiversity credits. Those instruments can be redirected to reward land managers for practices that underpin circular bio-based materials value chains, including restoring degraded land and delivering ecological benefits such as carbon sequestration, watershed protection, or biodiversity conservation – particularly in regions where large-scale production is not feasible.

A leading example of this is Costa Rica's Payment for Environmental Services Program (PPES),[48] while the Tropical Forest Forever Facility (TFFF)[49] represents a promising new development in this space.

Moving further, consolidated definitions and metrics for regenerative production across ministries and institutions are essential. Several emerging frameworks, standards, and taxonomies recognising and defining regenerative practices could be leveraged to ensure consistency in reporting financial flows, support recognition of regenerative practices across the value chain, and improve the ability to attract funding.

Identify near-term measures to improve the competitiveness of circular solutions for bio-based materials against linear alternatives

Circular solutions often face market barriers as linear alternatives remain more economically competitive under current market conditions. In this scenario, industrial policies can act as allies of circular solutions by offering tax incentives for regeneratively produced inputs, recovered by-products, and the creation of bio-based materials designed for durability and secondary uses. Fiscal measures can further encourage activities that extend product lifespans, such as reducing Value Added Tax (VAT) from textiles, furniture, and construction materials, as well as from repair services, remanufacturing, recycling and other secondary applications.

Additionally, tax incentives within waste management regulations can be introduced to reward secondary applications of biomass where possible, and disincentivise disposal.

The development, market access and viability of bio-based material alternatives can also be supported through complementary instruments such as eco-modulated EPR schemes — which adjust fees based on the circularity and environmental performance of materials — and regulatory phase-outs of linear and potentially polluting materials

Ensure support mechanisms for SMEs, cooperatives and communities are embedded from the outset of policy design

A consistent transition to a circular economy cannot be achieved without all stakeholders — yet small and medium enterprises, cooperatives, and communities often face structural barriers that prevent their full participation without targeted support. These groups should be able to enter the bio-based circular economy market supported by economic policy measures. For instance, policies can deploy micro-credit for smallholder farmers and early-stage innovators, ensuring that the benefits of a circular economy for bio-based materials reach stakeholders of all sizes and in all stages of the value chain – from production to end-of-life treatment. Also, dedicated finance schemes can be created to strengthen waste pickers' work and related infrastructure, enabling new pathways to valorise bio-based materials and expand earning opportunities for these workers.

The National Program for Strengthening Family Farming (PRONAF), established in Brazil in 1995, is one of the most prominent examples of targeted public financing for small-scale producers.[50] Designed to expand access to subsidised rural credit, the programme provides tailored financial instruments to family farmers, supporting both agricultural and non-agricultural activities and enabling investments in productivity, diversification, and sustainable practices. Over time, PRONAF has become the main credit policy instrument for this segment, accounting for around 70–75% of all rural credit contracts in Brazil, although representing a smaller share of total credit volume due to its focus on smaller-scale operations.[51]

In practice

Klabin's experience in Brazil reveals how fiscal frameworks can work against circular production even when a company is voluntarily investing in it. Operating within a tax system that applies charges at multiple stages of the recycling chain, Klabin faces structural cost disadvantages that limit its ability to scale circular production, not because the business case is weak, but because the incentive environment favours linear processes. At the same time, its mosaic forestry model, which achieves significantly higher productivity than conventional approaches, demonstrates what becomes possible when regenerative practices are supported.

This illustrates why reviewing and redirecting existing economic incentives, rather than simply adding new ones, can be such an impactful lever to make circular solutions for bio-based materials economically competitive.

INVEST IN THE INNOVATION, SKILLS, AND INFRASTRUCTURE NEEDED TO ENABLE CIRCULAR SYSTEMS FOR BIO-BASED MATERIALS

- **Direct available research and innovation funding towards bio-based materials fit for a circular economy, aligning with existing national innovation priorities**
- **Begin aligning investment efforts in resource management infrastructure across relevant policies, prioritising the most critical gaps in collection, processing and recovery**
- **Identify opportunities to develop people's skills for a circular economy for bio-based materials within existing agricultural and industrial training frameworks**

To ensure bio-based materials support nature and circulate effectively, investment is needed in innovation, skills, technology, and infrastructure across product life cycles. This requires public funding alongside incentives for private-sector investment. Circular economy policies already encourage training and infrastructure for materials circulation, but they rarely address the specific needs of bio-based materials.

Direct available research and innovation funding towards bio-based materials fit for a circular economy, aligning with existing national innovation priorities

Opportunities and the need for innovation funding span the full lifecycle of bio-based materials — from how they are grown and produced, to how they are used across multiple cycles, and how new materials are developed to deliver new applications. In how materials are grown and produced, progress depends on developing growing methods that are regenerative according to the landscape, with cultivation techniques adapted to the specific conditions of each territory. This also requires the development and diffusion of high-quality bio-inputs, alongside training on how to apply them. Building a solid technological base, local manufacturing capacity, and advisory networks is essential to ensure that bio-inputs reach farmers and that producers understand how to apply them effectively. Public institutions focused on research, innovation, and training, such as Embrapa (Brazilian Agricultural Research Corporation) in Brazil can play a pivotal role by providing research, technical assistance, and capacity building. Farmers, in turn, need reliable access to biofertilisers and soil-enhancing inputs, coupled with practical guidance for their effective use. The challenge is compounded by the fact that, while extractive conventional agriculture relying on synthetic inputs is the most widely available method of production, regenerative bio-inputs still face limited distribution, variable quality, and persistent knowledge gaps at the farm level.

In how materials are used across multiple cycles, innovation is needed to develop bio-based materials that can circulate effectively and remain in use for longer. This includes advancing durable bio-composites and long-lasting bio-based materials, as well as innovative circular strategies. For instance, fibre-to-fibre recycling, modular timber systems, secondary-use applications, and advanced recycling solutions all contribute to the creation of material cycles that preserve value and reduce waste.

In developing new materials to deliver new applications, innovation is needed to create bio-based alternatives that match or outperform fossil-based materials while eliminating toxicity across their lifecycle. As examples, in Kenya,[52] textile fibres are being made from agricultural residues like pineapple leaves; in India, Zero Circle's algae-based coating replaces plastic film in packaging; and MynusCo's biocomposites substitute various types of conventional plastics. Scaling alternative bio-based materials is relevant particularly in the cases where virgin wood is considered the main bio-based substitute. A complementary study by the Ellen MacArthur Foundation points out that it is essential that sustainably sourced non-wood material alternatives are expanded to avoid that wood demand surpasses the ecological limits.[53]

To sustain innovation and accelerate the transition, funding mechanisms should prioritise circular solutions at the material, business model, and system levels. Key methods include dedicated innovation funds, R&D tax credits and grants, as well as the strategic use of public and blended finance.

One example is the Circular Bio-based Europe Joint Undertaking, a Public-Private Partnership (PPP) between the European Commission, and the Bio-based Industries Consortium (BIC).[54] Its funding scheme enhances innovation across the value chain towards end market readiness, and enables businesses to make further investments beyond the partnership. In addition, policies can incentivise private sector innovation while promoting knowledge sharing, collaboration, and the diffusion of best practices across value chains, to ensure that innovations contribute to broader systemic change.

Aligning funding priorities across innovation, circular-economy, and green industrial policies is essential, and these incentives must also extend to SMEs so that stakeholders of all sizes can participate in new market opportunities.

Begin aligning investment efforts in resource management infrastructure across relevant policies, prioritising the most critical gaps in collection, processing and recovery

To accelerate the infrastructure implementation, policies for circular economy, industrial development and waste management can align their investment efforts. Infrastructure in areas such as reverse logistics, bio-based materials collection, composting systems and biorefineries are fundamental to add value to biomass and support circulation.

The development of biorefineries should prioritise the transformation of residues into biochemicals, polymers, biofertilisers, while limiting energy recovery to streams that cannot be productively recirculated. If well designed, they can serve as platforms for innovation and diversification in countries with abundant biomass – and opportunity for industrialisation and trade of high value-added bio-based materials.

Investment in these areas can have a ripple effect, and stimulate innovation and job creation. Opportunities will arise at all stages of the cycle, such as collection, separation, recycling, remanufacturing, and industrial composting and nutrient return to soils, but training and skills development is also needed.

Identify opportunities to develop people's skills and education for a circular economy for bio-based materials within existing agricultural and industrial training frameworks

Policies for circular economy, rural development and labour can be coordinated to support the development of people's skills and formal education systems for a bio-based circular economy. This includes promoting training programmes on regenerative farming and forestry, designing bio-based materials and products that are fit for a circular economy, developing secondary applications for used bio-based materials, working on product repair, repurposing, remanufacturing, and material collection, sorting and recycling.

Expanding knowledge and working skills will support the consolidation of all the stages of a bio-based materials circular system. For instance, training can allow rural workers and traditional communities to adopt regenerative growing practices that bring nature-positive outcomes, to add value to products, to identify opportunities to valorise biomass, and to access credit linked to environmental results. There is also scope for building industry capacity to develop new bio-based materials that replace finite ones, design products using bio-based materials, create circular business models, and work at the post-use recirculation operations, such as repairing functions, remanufacturing, recycling, working at biorefineries and composting facilities.

Building the right skills is essential. Circular economy competencies should be integrated into vocational training, design curricula, and agricultural outreach services. International collaboration can also expand local solutions through platforms such as SWITCH to Circular Economy Value Chains.[55]

It is essential that skills development opportunities are available for people from different backgrounds and companies of all sizes – such as smallholder farmers and SMEs – to ensure they can participate in this economic change and capture the benefits of transition.

In practice

Amcor has developed paper-based packaging formats that are recyclable at scale and compostable under controlled conditions. The technology works, but in markets without established composting infrastructure, these products cannot deliver their environmental benefit. In practice, at end-of-life they are treated as conventional packaging. Lojas Renner faces a similar constraint in textiles: circular design choices embedded in its products can only be realised if collection, sorting and recycling infrastructure exists to recover them.

These experiences illustrate why investment in innovation, infrastructure and skills is essential.

COLLABORATE ACROSS INSTITUTIONS, SECTORS AND BORDERS

- **Establish or designate cross-ministerial coordination mechanisms to begin integrating circular economy principles into policies relating to bio-based materials**
- **Engage with key trade partners to explore progressive harmonisation of definitions, standards, and certifications for bio-based materials fit for a circular economy**
- **Take steps to align trade and socio-environmental agendas, recognising trade in circular bio-based materials as a potential contributor to climate and biodiversity goals**

At the national level, establishing cross-ministerial task forces to embed circular economy principles into policies relating to bio-based materials ensures coherence, accountability, and clear target setting. To achieve the worldwide benefits of circular bio-based materials, trade-related policies and measures are pivotal. Strengthening mutual recognition and interoperability of sustainability requirements across markets, while pursuing longer-term harmonisation where feasible, helps reduce friction and uncertainty.

Establish or designate cross-ministerial coordination mechanisms to begin integrating circular economy principles into policies relating to bio-based materials

Given that there are significant aspects of the transition to a circular economy and the support for bio-based materials production spanning across policies and ministries, establishing national cross-ministerial task forces is fundamental to integrate a consistent circular economy approach into policies regulating the production and use of bio-based materials and ensuring coherence across agendas.

As an example, the EU's Circular Economy Action Plan (CEAP)[56] provides useful lessons in policy integration through inter-ministerial cooperation. Under the coordination of the European Commission, it engaged policymakers across different policy areas and levels of governance, as well as various stakeholders, to promote a collaborative approach. The Action Plan mapped out 54 actions that, four years later, were all adopted or implemented. The highlights of the successful orchestration was setting clear priorities and cross-portfolio mandates to embed circularity into diverse regulations – from eco-design to chemicals and trade. Lessons learned from this process could now be brought to action when implementing the updated EU Bioeconomy Strategy adopted at the end of 2025.[57]

In Brazil, to implement the National Circular Economy Strategy, a presidential decree created a Forum to bring together ministries and organisations from the private sector and civil society to design and monitor national policies for circular economy.[58] All policies suggested and implemented by the government go through the lens and opinions of the National Forum members. The National Circular Economy Plan, the detailing of the Strategy, was also developed through this political dialogue space. It is a governance mechanism from which both sides benefit. On one hand, the government has the opportunity to share what it is doing and receive feedback from companies and organizations. On the other hand, stakeholders involved in the topic can hold the government accountable and push for increasingly ambitious measures.

Another pathway for cross-ministerial collaboration is demonstrated by the Netherlands' Transition Agendas.[59] In a collaborative effort by government, industry, research institutes, and civil society, the country developed five transition agendas with sector-level goals, design principles, and interventions across the full lifecycle of materials in biomass & food, construction, plastics, manufacturing, and consumer goods. The structure helped align agriculture, industry, environment, innovation, and finance portfolios, and informed major funding instruments, such as the National Growth Fund.[60] Although the focus of the agendas is not specific to bio-based materials, efforts in this area could prioritise bio-based materials sectors, such as textiles, timber, and packaging, with measurable goals for circulation.

To strengthen the accountability and legitimacy of policies, these agendas should embed monitoring and social participation methods. Decision-making processes should guarantee equitable participation of stakeholders of all sizes and origins, including SMEs, smallholders, waste pickers and traditional communities.

Engage with key trade partners to explore progressive harmonisation of definitions, standards, and certifications for bio-based materials fit for a circular economy

The alignment of definitions, standards, and certifications for bio-based materials and products that are fit for a circular economy is essential to support international trade in bio-based materials and ensure benefits are achieved worldwide. The reason is that shared criteria help ensure that goods are comparable across markets, fostering trust and supporting transparency and traceability across borders. It also facilitates access to the international market.

Differences in definitions, certifications, and reporting requirements across markets are pointed out as barriers to scaling, due to increased compliance costs. To overcome this challenge, governments can engage proactively with key trade partners to explore mutual recognition of standards and traceability requirements. This can reduce duplicative costs, unlock interoperability across borders, and help overcome inconsistencies between international standards and local regulations.

Platforms for regional collaboration are spaces where efforts towards harmonisations have more potential to thrive, as they often unite nations with similar challenges and policy alignment. The EU Circular Economy Resource Centre,[61] the Latin American and Caribbean Circular Economy Coalition,[62] and the African Circular Economy Alliance[63] are examples of actors that could initiate works that enable harmonisation.

Take steps to align trade and socioenvironmental agendas, recognising trade in circular bio-based materials as a potential contributor to climate and biodiversity goals

The global demand within a linear system underpins the degradation of ecosystems, land-use-based carbon emissions and biodiversity loss in countries that produce bio-based materials. For example, 26% of deforestation to make room for agri-forest practices can be attributed to international demand,[64] while 25% of the total projected species extinctions is estimated to be linked to land use for export production.[65] Negative impacts commonly take place outside national boundaries, with high income countries – due to their consumption levels – being particularly responsible for trade-related spillovers;[66,67] more than 50% of the biodiversity loss associated with consumption in developed economies is estimated to occur outside their own territory.[68]

Trade in bio-based materials designed for a circular economy can help deliver the implementation of climate and biodiversity targets. By positioning trade as a driver of environmental action, countries can unlock new pathways to reduce emissions, preserve and regenerate ecosystems, while sustaining economic growth. Facilitating bio-based materials trade that builds on circular economy principles aligns market activity directly with environmental objectives. To achieve this, trade-related instruments and mechanisms need to go beyond volumes and prices to embed binding environmental safeguards, traceability and due-diligence across global value chains, ensuring shared responsibility between producing and consuming countries.

For example, national biodiversity policies implemented under the National Biodiversity Strategies and Action Plans (NBSAPs) can benefit substantially from integrating trade in general – and in circular bio-based materials in particular – as means to deliver their objectives.[69] Better integration and establishment of synergies can mobilise resources towards biodiversity action, create economic counterparts to environmental commitments, and accelerate progress for national and global goals.[70]

Multilateral collaborations that align environment, trade and supply chain economics are already underway. In 2024, members of the G20 adopted ten voluntary and non-binding High-Level Principles on Bioeconomy,[71] including calling for “advancing sustainable consumption and production patterns and the efficient and circular use of biological resources, whilst promoting the restoration and regeneration of degraded areas and ecosystems”. The following year, during COP30, a Bioeconomy Challenge was launched as an international and multi-stakeholder platform created to implement the global principles of bioeconomy in a concrete and scalable way by 2028.[72]

The expanding global framework of trade agreements can provide a way for countries to tackle challenges that cannot be solved by one nation alone. There is ample room to advance issues such as trade in Environmental Goods and Services (EGS),[73] preferential tariffs, and circular trade facilitation measures to increasingly include bio-based materials and products.

For example, the Agreement on Climate Change, Trade and Sustainability (ACCTS),[74] signed in 2024, removes tariffs on green technologies and can evolve to include circular bio-based goods, showing how trade frameworks can adapt to sustainability goals. In parallel, the World Trade Organization's Trade and Environmental Sustainability Structured Discussions (TESSD), launched in 2020, strives to advance good practice on standards alignment, transparency, and trade facilitation through discussions within its Circular Economy and Environmental Goods and Services working groups.[75]

Moving forward, it will be crucial to ensure that certifications and standards are available for businesses of all sizes. Firstly because SMEs are accountable for a large amount of bio-based materials production and innovation. Secondly, to ensure fair access to markets. Furthermore, all trade-related mechanisms should explicitly address the inclusion and equitable participation of stakeholders in trade partner countries along the supply chain. For instance, without technical and financial support, SMEs risk exclusion from circular trade opportunities. International standards are thus favoured to reduce fragmentation and ensure access to markets, but they must recognise different national contexts (e.g. environmental and ecological and level of institution development) in standard-setting processes, so that trade acts as an enabler of inclusive, regenerative bio-based value chains rather than as a barrier.

In practice

TraceSurfer, a Latin American SME, is helping companies comply with the EU's forthcoming Digital Product Passport requirements and regional EPR schemes, and in doing so is actively contributing to shaping the international standards those regulations are built on. Its ability to operate across borders depends on a degree of definitional consistency between markets. Where standards diverge, compliance costs multiply and smaller actors are effectively excluded from circular trade opportunities entirely.

This experience illustrates two things simultaneously: why harmonising definitions and standards across markets is a condition for inclusive participation in circular value chains for bio-based materials, and why multi-stakeholder collaboration is so critical.

Agroecology A holistic and integrated approach that blends ecological and social principles in the development and re-design of sustainable agrifood systems. It seeks to optimise the interaction between plants, animals, humans, and the environment while promoting socially inclusive food systems (adapted from FAO)

Agroforestry Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the different components. (CGIAR)

Agrosilvopastoral systems Agrosilvopastoral systems are those in which perennial crops are grown simultaneously with a herbaceous crop, and livestock production is integrated in combinations. (FAO)

Anaerobic digestion Microbial breakdown of organic matter in the absence of oxygen. In a circular economy, anaerobic digestion can be used to convert food waste, agricultural residues, sewage sludge, and other biodegradable materials into digestates (or ‘biosolids’) that can be used as soil enhancers and biogas.

Bio-based material Materials derived from biological sources, including plants, animals, marine organisms, and forestry, that serve as inputs for commercial or industrial products. Bio-based materials span a wide spectrum: from traditional materials such as wood, cotton, linen, leather, and fish skin, to novel intermediates such as bio-based polymers and building blocks used to produce bio-based plastics, lubricants, and solvents.

Bio-based products Bio-based products are commercial or industrial goods (other than food or feed) composed in whole or in significant part of biological products, forestry materials, or renewable domestic agricultural materials, including plant, animal, or marine materials. The term Bio-based product encompasses bio-based chemicals, bio-based plastics, enzymes, bio-based materials. (adapted from OECD)

Biochemicals Can refer to any chemical compound which is part of the makeup of living cells. Bio-based chemicals offer a sustainable alternative to chemicals based on fossil feedstocks. Developed from biomass, these chemicals can be structurally identical to existing chemicals (‘drop-in’ chemicals) or have new structures that offer new opportunities. (European Biomass Industry Association)

Biodegradability The capability of the compostable material to be converted into CO_2 under the action of micro-organisms. In order to show complete biodegradability, a biodegradation level of at least 90% must be reached in less than 6 months. (EU Commission)

Biological cycle The set of processes — such as composting and anaerobic digestion — that help to regenerate natural capital. The only materials suitable for these processes are those that can be safely returned to the biosphere.

Biomass Encompasses, but is not limited to, agricultural crops and trees, including dedicated energy crops, food, feed and fibre crop residues; aquatic plants and animals, algae, fish bones and other fish residues; forestry and wood residues; agricultural waste, including animal manure; processing by-products and any other non-fossil organic material. (FAO)

Biorefinery An overall concept of a processing plant where biomass feedstocks are converted and extracted into a spectrum of valuable products (food, feed, materials, chemicals) and energy (fuels, power, heat). (EU Commission)

Carbon sequestration Taking carbon dioxide out of the atmosphere and storing in terrestrial, oceanic, or freshwater aquatic ecosystems. (FAO)

Circular business model A business model that creates, delivers, and captures value while keeping products, components, and materials in use and regenerating natural systems. Some examples include rental, product-as-a-service, sharing platforms, and resale.

Composting Microbial breakdown of organic matter in the presence of oxygen. In a circular economy, composting can be used to convert food waste and other biodegradable materials into compost that can be used as a soil enhancer.

Crop-livestock forestry Integrated crop-livestock-forestry (ICLF) is a sustainable production strategy that integrates farming, cattle, and forestry activities in common areas, by intercropping, succession, or rotation. It seeks to intensify and share the benefits generated by the synergy of the integration from the different activities combined in four production system modalities: integrated crop-livestock (ICL), or agropastoral; integrated livestock-forestry (ILF) or silviagriculture; integrated crop-forestry (ICF), or silvopastoral; and integrated crop-livestock-forestry (ICLF), or agrosilvopastoral systems. (The Brazilian Agricultural Research Corporation – Embrapa)

Circular economy A systems solution framework that tackles global challenges such as climate change, biodiversity loss, waste, and pollution. It is based on three principles driven by design: eliminate waste and pollution, circulate products and materials at their highest value, and regenerate nature. It is underpinned by a transition to renewable energy and materials and aims to decouple economic activity from finite resource consumption.

Digital Product Passport A structured collection of product related data with pre-defined scope and agreed data management and access rights conveyed through a unique identifier and that is accessible via electronic means through a data carrier. The intended scope of the DPP is information related to sustainability, circularity, value retention for reuse, remanufacturing, and recycling. (CIRPASS)

Downstream uses The activities and processes related to a product or material following its initial use. This can include reuse,collection, sorting, recycling and repurposing.

Durability The ability of a product, component or material to remain functional and relevant when used as intended. Durability often applies to the physical attributes of a product (its ability to resist damage and wear), though with some products durability can be technological, for example the ability of software to be upgraded many times.

Finite materials Materials that are non-renewable on timescales relevant to the economy, i.e. not geological timescales. Examples include: metals and minerals; fossil forms of carbon such as oil, coal, and natural gas; and sand, rocks, and stones.

Fossil-based Derived wholly or partly from fossil resources such as oil, coal, or natural gas

Intercropping Growing two or more crops as a mixture in the same field at the same time. Intercropping can be one way of adding diversity to a crop system.

Linear economy An economy in which finite resources are extracted to make products that are used - generally not to their full potential - and then thrown away tipically after a short lifespan ('take-make-waste')

Recyclability The practical and scalable ability of a material to be collected, sorted, and recycled into new materials.

Recycle The process of converting products or components into basic materials for reprocessing into new materials. Recycling generally results in the loss of embedded energy and value, so, in a circular economy, it is considered a last resort.

Refurbish The process of restoring a product to good working condition through repair, replacement of components, updating of specifications or improving appearance.

Regenerative production Regenerative production provides food and materials in ways that support positive outcomes for nature, which include but are not limited to: healthy and stable soils, improved local biodiversity, improved air and water quality. In agriculture, regenerative production schools of thought include agroecology, agroforestry, and conservation agriculture.

Renewable materials Materials that are continually replenished at a rate equal to or greater than their rate of depletion.

Renewable natural resources Natural resources that, after exploitation, can return to their previous stock levels by natural processes of growth or replenishment. (OECD)

Resale Products are sold for reuse through the original brand, third-party marketplaces, or peer-to-peer platforms

Repair Operation by which a faulty or broken product or component is returned back to a usable state to fulfil its intended use.

Repairability The ease with which a product or component can be repaired.

Reuse The repeated use of a product or component for its intended purpose without significant modification. Small adjustments and cleaning of the component or product may be necessary to prepare for the next use.

Reverse logistics Supply chains dedicated to the reverse flow of products and materials for the purpose of maintenance, repair, reuse, refurbishment, remanufacture, recycling, or regenerating natural systems.

Silvopastoral system The integration of trees and shrubs in pastures with animals for economic, ecological and social sustainability. Well-managed silvopastoral systems can improve overall productivity, while sequestering carbon, and providing potential additional economic benefit for livestock farmers (adapted from FAO).

Technical cycle The processes that products and materials flow through in order to maintain their highest possible value at all times. Materials suitable for these processes are those that are not consumed during use - such as metals, plastics and wood. In the technical cycle the opportunities to maintain and generate value come through retaining the greatest proportion of the energy and labour embedded in the product. This is achieved, in order of value, by: maintaining, prolonging, sharing; reusing and redistributing;

Traceability The ability to identify and trace the history, distribution, location and application of products, parts and materials, to ensure the reliability of sustainability claims, in the areas of human rights, labour (including health and safety), the environment and anti-corruption. (UN Global Compact)

Transparency Transparency relates directly to relevant information being made available for all elements of the value chain in a harmonized way, which allows for common understanding, accessibility, clarity and comparison. (UNECE)

Upstream uses The activities and processes related to a product or material before it reaches the market. This can include resource extraction, sourcing, product design, business model, manufacturing model, and intended use.

Virgin materials Materials that have not yet been used in the economy. These include both finite materials (e.g. iron ore mined from the ground) and renewable resources (e.g. newly produced cotton).

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About the Ellen MacArthur Foundation

The Ellen MacArthur Foundation is an international charity that develops and promotes the circular economy in order to tackle some of the biggest challenges of our time, such as climate change, biodiversity loss, waste, and pollution. We work with our network of private- and public-sector decision makers, as well as academia, to build capacity, explore collaborative opportunities, and design and develop circular economy initiatives and solutions. Increasingly based on renewable energy, a circular economy is driven by design to eliminate waste, circulate products and materials, and regenerate nature, to create resilience and prosperity for business, the environment, and society.

Further information: ellenmacarthurfoundation.org

About the Latin America and the Caribbean Circular Economy Coalition

The Circular Economy Coalition for Latin America and the Caribbean was launched in 2021, in the framework of the XXII Meeting of the Forum of Ministers and High-Level Authorities of Environment of the region, to serve as a regional platform to enhance inter-ministerial, multi-sectoral and multi-stakeholder cooperation, increase knowledge and understanding on circular economy, and provide capacity-building and technical assistance for the development of public policies for circular economy and sustainable consumption and production. It currently comprises 18 governments, coordinated by the United Nations Environment Programme (UNEP) and led by a steering committee composed of five high-level government representatives on a rotating basis. Its current steering committee members include Brazil, Argentina, Chile, Ecuador and Paraguay, together with six strategic partners: the Climate Technology Centre & Network (CTCN), the Ellen MacArthur Foundation, the Inter-American Development Bank (IDB), the World Economic Forum (WEF), the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), and UNEP.

Further information: coalicioneconomiacircular.org

DISCLAIMER

ENDNOTES

1 Circular Economy Coalition for Latin America and the Caribbean, Circular Economy in Latin America and the Caribbean: A Shared Vision (2022)

2 Ellen MacArthur Foundation, The big food redesign: Regenerating nature with the circular economy, (2021)

3 Ellen MacArthur Foundation, The Nature Imperative: How the circular economy tackles biodiversity loss, (2021)

4 Ellen MacArthur Foundation, Building Prosperity: unlocking the potential of a nature-positive, circular economy for Europe, (2024)

5 Ellen MacArthur Foundation, Scaling action for nature: How the circular economy can help deliver the Global Biodiversity Framework, (2025)

6 The circular economy system diagram, known as the butterfly diagram, illustrates the continuous flow of materials in a circular economy. Further details are available at: https://www.ellenmacarthurfoundation.org/circular-economy-diagram

7 United Nations Industrial Development Organization, Global Stocktake of National Circular Economy Roadmaps and Strategies: 2025 Update, (2025)

8 Ellen MacArthur Foundation, Paper-based flexible packaging: The role it could play in tackling small-format flexible plastic pollution in markets with high leakage rates, (2026)

9 Ellen MacArthur Foundation, Building Prosperity: unlocking the potential of a nature-positive, circular economy for Europe, (2024)

10 Ellen MacArthur Foundation, Circular business models: redefining growth for a thriving fashion industry, (2021)

11 Crucially, only certain bio-based materials can be returned to nature either directly or after processing via, for example, industrial composting, anaerobic digestion or biorefining; certain bio-based plastics that are not amenable to such processing cannot enter the biological cycle. This is also true of product components that cannot be separated from the rest of the product without contamination.

12 Convention on Biological Diversity's (CBD), Kunming-Montreal Global Biodiversity Framework, UNEP

13 Ellen MacArthur Foundation, Circular Economy and Extended Producer Responsibility (EPR): How G20 countries are embedding circular economy in policy frameworks and implementing EPR, (2025)

14 Schröder, Patrick and Barrie, Jack. How the circular economy can revive the Sustainable Development Goals: Priorities for immediate global action, and a policy blueprint for the transition to 2050, (2024).

15 Ellen MacArthur Foundation, Scaling action for nature: How the circular economy can help deliver the Global Biodiversity Framework, (2025)

16 Ellen MacArthur Foundation, The big food redesign: Regenerating nature with the circular economy, (2021)

17 Ellen MacArthur Foundation, Circular Start-up Index, (n.d).

18 Seringô is a Brazilian footwear and design brand that draws on Amazonian biodiversity and craftsmanship. Its products — including shoes and sandals — are made with natural rubber from the Amazon and incorporate bio-based materials such as micronised açaí seeds in the soles. The company operates on a made-to-order model to avoid waste, and distributes 20% of each sale directly to the riverine communities involved in material production, supporting a standing-forest economy. See: www.seringo.com.br

19 World Economic Forum and Oliver Wyman, 50 Investible Opportunities for a New Nature Economy, (2026)

20 World Economic Forum, Seizing Business Opportunities in China's Transition Towards a Nature-positive Economy. (2022)

21 Anangwe IJ, et al., Growing a Sustainable Bioeconomy Through Trade and International Cooperation, (2025)

22 Ellen MacArthur Foundation, The big food redesign: Regenerating nature with the circular economy, (2021)

23 Daystar, J., et al., An Economic Impact Analysis of the US Biobased Products Industry. Industrial Biotechnology.(2026)

24 Ubando, A., et al., A Comprehensive Review of the Development of Biorefineries in a Circular Bioeconomy. (2020)

25 Metabolic. Impact scan for timber construction in Europe, (2023)

26 Biological resources mentioned in this example include urban bio-waste, organic residues or wastes from primary production and industrial processes, and dedicated industrial crops. Bio-based products and processes, European Commission

27 Nature Finance, Growing a sustainable bioeconomy through trade and international cooperation. Input paper for the G20 Initiative on Bioeconomy, (2025)

28 Ellen MacArthur Foundation, Paper-based flexible packaging: The role it could play in tackling small-format flexible plastic pollution in markets with high leakage rates, (2026)

29 FarFarm is a Brazilian startup that researches, designs, and implements strategy, communication, and sustainability solutions for brands seeking to grow through impact and regeneration. See: https://farfarm.co/

30 Ellen MacArthur Foundation, Universal Circular Economy Policy Goals, (2021).

31 Government of Brazil. National Strategy for Circular Economy. (2025)

32 Government of Brazil. New Industry Brazil, (2025)

33 United Nations Economic Commission for Europe, UNECE and ISO launch joint initiative on Digital Product Passport to advance sustainability and circular economy,, (2025).

34 UNECE, Traceability, Transparency and Data, (2025).

35 Ellen MacArthur Foundation, EPR for textiles in Chile, (2024).

36 Ellen MacArthur Foundation, The Jeans Redesign Guidelines, (2021).

37 The Forest Stewardship Council (FSC) Circularity Hub is an innovation initiative exploring how forest-based materials can be more responsibly used, reused, and recirculated within a circular economy. See: fsc.org/en/circularity

38 Statistics Finland, Economy-wide material flow accounts: documentation of statistics, (2025).

39 Statistics Canada, Canadian System of Environmental and Resource Accounts - Material and Energy Flow Accounts (MEFA), (2012)

40 Grondstoffen Scanner, Are your raw materials still future-proof?, (2022)

41 Interreg Europe, FISS - Finnish Industrial Symbiosis System. Interreg Europe, (n.d)

42 Government of Brazil: Resolution No. 481 - Conselho Nacional do Meio Ambiente (CONAMA): Control and environmental quality of the organic waste compostingprocess, (2017).

43 Government of the Netherlands, Government of the Netherlands, Procurement with Impact: Strategy for sustainable, social and innovative commissioning by central government, (2021).

44 Reserve Bank of India, Master Directions – Priority Sector Lending (Targets and Classification), (2025)

45 UNEP World Conservation Monitoring Centre (UNEP-WCMC), The Land Bank: Our financial sustainability relies on nature, (2021)

46 European Court of Auditors, Greening: a more complex income support scheme, not yet environmentally effective, (2017)

47 Government of Brazil: Ministry of agriculture and livestock. Low Carbon Agriculture: The ABC Plan in Brazil, (2023).

48 United Nation Climate Change, Payments for Environmental Services Program | Costa Rica, (2023).

49 Government of Brazil. Tropical Forest Forever Facility (TFFF),

50 Brazilian Agricultural Research Corporation (Embrapa), Public policies for family farming, (n.d.)

51 Climate Policy Initiative, Family farming in Brazil: Inequalities in credit access, (n.d.)

52 Formenti L, et al., Beyond the Technical Loop. Driving the circular bioeconomy through global policy coherence, (2025)

53 Ellen MacArthur Foundation, Paper-based flexible packaging: The role it could play in tackling small-format flexible plastic pollution in markets with high leakage rates, (2026)

54 The Bio-based Industries Consortium (BIC) is a European non-profit association representing the private sector across the full bio-based value chain, from primary production to market. Founded in 2013 as the private partner in a public-private partnership with the European Commission, the consortium's vision is to make Europe's bio-based industry the leader of a circular bio-based society by 2050. For more information: Bio-based Industries Consortium

55 SWITCH to Circular Economy Value Chains (SWITCH2CE) is an EU-funded initiative led by UNIDO, designed to support small and medium-sized suppliers in developing countries to adopt circular economy practices within global value chains. For more information: switchtocircular.eu

56 European Commission, A new Circular Economy Action Plan: For a cleaner and more competitive Europe, (2020).

57 European Commission, EU Bioeconomy Strategy, (2025).

58 Government of Brazil, Decree No. 12.082: National Circular Economy Strategy (ENEC), (2024). (ENEC), (2024).

59 Holland Circular Hotspot, Transition Agendas, Circular economy, (2018)

60 National Growth Fund, Dutch government, The National Growth Fund. Nationaal Groeifonds, (n.d.)

61 The EU Circular Economy Resource Centre (EU CERC) is a five-year initiative launched in 2025, funded by the European Commission and the Finnish Ministry of Foreign Affairs and implemented by Sitra and the Belgian Development Agency Enabel. For more information: sitra.fi/en/eu-cerc

62 The Latin America and the Caribbean Circular Economy Coalition, launched in 2021 and coordinated by UNEP, is a regional platform bringing together governments, businesses and civil society. For more information: coalicioneconomiacircular.org

63 The African Circular Economy Alliance (ACEA), formally launched at COP23 in 2017, is a government-led coalition of African nations and coordinated by the African Development Bank. For more information: aceaafrica.org

64 Pendrill F, et al., Environmental Research Letters, Deforestation displaced: trade in forest-risk commodities and the prospects for a global forest transition, (2019).

65 Chaudhary A, Brooks TM, National Consumption and Global Trade Impacts on Biodiversity, (2019).

66 SDG Transformation Center, Tracking Spillover Effects, (n.d)

67 Berger A, et al.,. News Forms of International Partnerships to Reduce Negative International Spillover Effects in Support of Global Sustainability, (2024).

68 ACS Publications, Wilting HC, et al., Quantifying Biodiversity Losses Due to Human Consumption: A Global-Scale Footprint Analysis, (2017).

69 UN Environment Programme (UNEP) and Forum on Trade, Environment & the SDGs (TESS), Nature-positive trade for sustainable development: Opportunities to promote synergies between the Kunming-Montreal Global Biodiversity Framework and work on sustainable trade at the WTO, (2023).

70 Ellen MacArthur Foundation, Scaling action for nature: How the circular economy can help deliver the Global Biodiversity Framework, (2025).

71 Agreed under Brazil's G20 Presidency in September 2024, the ten High-Level Principles on Bioeconomy were developed through the G20 Initiative on Bioeconomy (GIB). They cover sustainable development, inclusion, climate action, biodiversity conservation, and the circular use of biological resources, and while voluntary and non-binding, all participating members committed to their implementation. For more information: gov.br/g20/en

72 Bioeconomy Challenge, Bioeconomy Challenge: Transforming principles into action, (2025).

73 The WTO Environmental Goods and Services (EGS) discussions relate to efforts to liberalise trade in products and services that have environmental benefits. The idea is that reducing trade barriers can accelerate the global deployment of technologies and solutions that help address environmental challenges such as climate change, pollution, and resource efficiency.

74 The Agreement on Climate Change, Trade and Sustainability (ACCTS), signed in November 2024 by Costa Rica, Iceland, New Zealand, and Switzerland, is the first legally binding trade agreement primarily designed to achieve environmental objectives, covering fossil fuel subsidies, trade in environmental goods and services, and eco-labelling. For more information: mfat.govt.nz/accts

75 World Trade Organization, Participants launch MC14 environmental sustainability package, chart new phase of action, (2026).

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