Enabling Systemic Circularity in the Bioeconomy

January 2026

Summary and key Drax take-aways undertaken by:
Emma Persson, Sustainability Evidence Manager, Drax

Citation:
Thorneycroft, C.; Walker, N. (2026), Enabling Systemic Circularity in the Bioeconomy, Forum for the Future

Summary

The white paper by Forum for the Future, commissioned by Drax, finds that woody biomass is critical to meeting climate and nature goals. However, there is a risk, particularly in immature markets, that biomass could be directed to fragmented, often short lived or lower value pathways across different sectors, rather than coordinated into longer lived, higher value circular pathways. Such fragmentation limits carbon benefits and increases pressure on land and ecosystems. It concludes that a managed transition to a circular bioeconomy – guided by shared principles on regeneration, value hierarchy, longevity, policy coherence and data – is needed to unlock higher value, more resilient outcomes.

These insights were developed through desk research, a series of interviews throughout the value chain, and a facilitated multisector workshop. These brought together diverse stakeholder views ranging from packaging, waste management, recycling, bioenergy, timber building and logging to test assumptions, identify system barriers, and codesign practical interventions for coordinated action.

Key Drax take-aways

Forum's white paper makes an important contribution to the conversation on circularity in the bioeconomy. Several themes stand out strongly for Drax:

1. Biomass and bio-based materials are expected to be critical to the decarbonisation of multiple sectors. There is therefore likely to be multiple competing uses for the same biomass resource in the future.
    - There are multiple ways to assign value to each potential use, e.g., product longevity, environmental impacts of the material being substituted, and economic value.
    - Bioenergy with carbon capture and storage (BECCS) and bioenergy play a valuable role in a circular bioeconomy, supporting the deployment of renewable energy, and creating pathways for long-term negative emissions.
    - Embedding principles of circularity across the value chain helps to maximise the value of existing biomass to better enable scaling.
    - Sector and industry-wide collaboration is needed to achieve a circular and net zero bioeconomy.
2. Circular economy as a whole represents a valuable opportunity.
    - The foundation of the circular bioeconomy is efficiency, and improving efficiency presents significant opportunities for businesses. By enhancing efficiency, companies can work to reduce waste, increase profitability, and maximise resource utility.
    - Pursuing a circular bioeconomy may enable organisations to enhance their social and environmental impact and build a more robust corporate contribution, and should therefore be considered as an opportunity.

3. Transparency and collaboration are key underpinnings of a circular bioeconomy.
    - A core enabler of circularity is clear, verifiable data. Traceability throughout a resource's lifecycle is required to rigorously demonstrate sustainable sourcing and to facilitate cascading uses.
    - Collective action across industries, governments, NGOs, suppliers, and technology partners is vital. An effective circular bioeconomy relies on a shared vision, advocacy, leadership and coordination.

Extended Summary

Why a circular bioeconomy?

In early 2025, Drax published its Sustainability Framework, a comprehensive set of 26 timebound targets setting out how we're taking action to help decarbonise society, to protect and enhance nature, and to support the people who work with and alongside us. Among these commitments, target N1 set out our ambition to: publish a white paper exploring opportunities to adopt circular economy principles within Drax, with a particular focus on the circular bioeconomy, by the end of 2025.

Increasing circularity in all aspects of the economy reduces pressure on the creation of new materials and reduces the amount of waste material that needs to be managed. Incorporation of circular principles where possible can help to contribute to our overall goals of supporting positive outcomes for people, climate, and nature. Our operations offer several avenues to explore opportunities to integrate principles of circularity in our use of materials, and in the re-use of our waste products such as historic fly ash (a by-product of coal combustion). There may also be opportunities to increase circularity in our use of natural resources, in perhaps most notably, our use of biomass feedstocks. Biomass feedstocks, like those used at Drax Power Station, are primarily derived from forestry and agricultural residues, and form part of the bioeconomy – the economic system based on the utilisation of plant, animal and microbial life to provide materials, chemicals and energy. Outputs from the bioeconomy are already vital to modern life and are expected to become even more important in a net zero world.

Shifting to a systems approach

To deliver our target N1 on circular economy principles, we commissioned the help of Forum for the Future, recognising their independence, systems-change expertise, and our prior collaboration on the 'BECCS Done Well' report. We asked Forum to independently convene an open, exploratory process – one that brought together diverse perspectives and examined not only specific technologies or pathways, but the broader conditions needed for a thriving circular bioeconomy. Forum designed and led interviews, workshops, and cross-sector dialogue to identify both practical and strategic opportunities for circularity across the bioeconomy value chain.

While target N1 initially envisaged a Drax-specific assessment of circular economy opportunities, early scoping pointed instead to a need to gain a clearer understanding of Drax's role within the wider bioeconomy, and where it can aim to contribute most effectively. Achieving circularity requires not just novel technologies but also the concurrent development of appropriate infrastructure and policy instruments. In short, circularity in the bioeconomy depends on coherent systems, markets, innovations, and cross-sector collaboration – conditions that no single organisation can create alone.

Our next steps

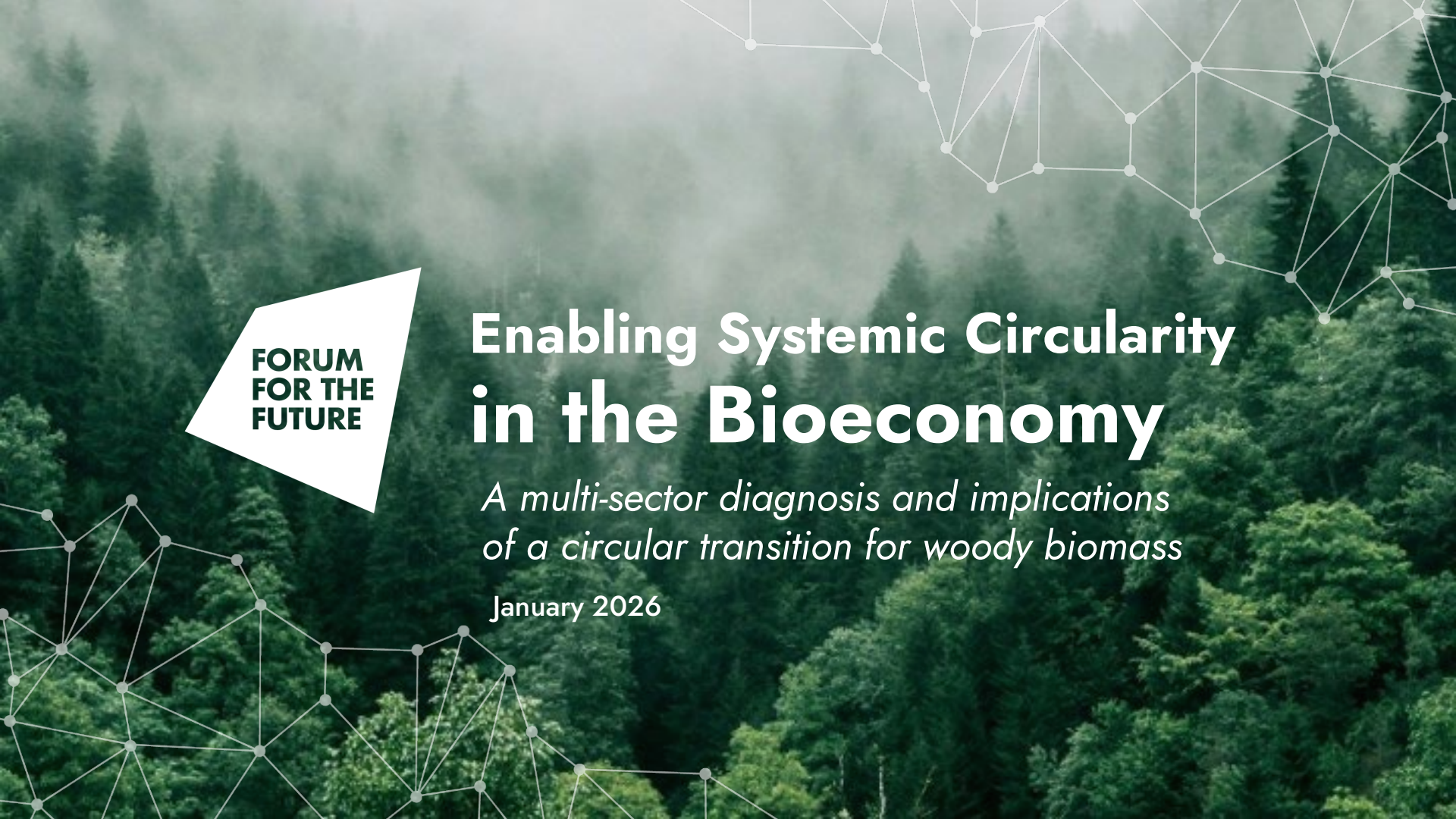
We welcome Forum's white paper and are pleased to share our reflections on its findings, its relevance to Drax's wider sustainability strategy, and how it will help to guide our next steps.

Forum's white paper represents an important milestone in working towards our Sustainability Framework commitments at Drax and deepening our understanding of circularity within the bioeconomy. We intend to use its insights to help guide the next phase of our work on circular principles, including:

- Further exploration of specific circularity opportunities within our value chain.
- Continued engagement with partners who share our ambition to enable circular systems to help accelerate progress where possible.
- Identifying any evidence-led actions we can consider in the near term to embed circular bioeconomy principles in our operations.

We are encouraged by the momentum this collaboration has generated. We welcome Forum for the Future's conclusion that by working together across industries and sectors, there is significant potential to unlock new forms of value – economic, environmental, and social – through a more circular bioeconomy. Drax remains committed to taking action to help decarbonise society, to protect and enhance nature, and to support the people who work with and alongside us.

Disclaimer
Drax commissioned Forum for the Future to assess circularity in the bioeconomy. Forum for the Future had full editorial control over the contents of this report, whilst acknowledging the support of Drax in commissioning the report.



FORUM FOR THE FUTURE

Enabling Systemic Circularity in the Bioeconomy

A multi-sector diagnosis and implications of a circular transition for woody biomass

January 2026

CONTENTS

EXECUTIVE SUMMARY

The global economy is entering a decisive decade. In 2024, global temperatures exceeded 1.5°C above pre-industrial levels for the first full calendar year, confirming that climate overshoot is no longer a future risk but a present condition. Limiting that overshoot and returning to safer conditions requires a systemic shift in our energy systems, how we conceive of and manage land, and to the structure of material flows.

In this report, we focus on woody biomass, a resource located at the nexus of energy, carbon, land and material transitions. Woody biomass is central to decarbonisation pathways for at least four reasons. 1) the commercial forests and managed woodlands it is sourced from act as carbon sinks when managed properly; 2) as a material it can store carbon for decades 3) act to substitute fossil-based materials in products, 4) it can be used as a feedstock for alternative forms of energy production. Woody biomass products flow through many diverse sectors: an input for chemicals, an alternative to cotton in textiles, timber in the built environment and paper and pulp in consumer goods.

Demand for woody biomass is rising alongside other sustainability imperatives. Its material properties create the potential for greater circularity, from production to end of life, yet the complex interconnections between sectors highlight the inherent challenges of managing the transition to a more circular future. At a fundamental level, woody biomass is also a resource with deep emotional and cultural currency. Globally, cultures connect with forests as part of national or regional identities. Their loss is symbolic of biodiversity decline and planetary health. Meanwhile, regenerating and managing forests gives rise to tensions with other land use needs, such as food, housing and energy production. Woody biomass is, therefore, critical to solving the big questions of this decisive decade.

Enabling circularity in woody biomass is a critical enabler to the transition to a circular bioeconomy, and ultimately more sustainable, resilient global and local economies. Yet, our research and that of others highlighted that existing efforts are fragmented and siloed within sectors and supply chains, risking inefficiencies, unintended consequences, and missed opportunities for accelerated, impactful change. This formed the basis of our approach, engaging and bringing together representatives from diverse sectors to align on the challenge of increased competition for material and land, and to ideate ways forward. The contribution of this report is to mobilise consensus on what is needed to enable a systemic shift to circularity is a cross-sector approach that centres regeneration, collective and harmonised action, and evidence-based, long-term strategy.

Why a systemic approach is essential

The bioeconomy spans multiple sectors, materials, geographies and time horizons. Decisions made in one part of the system about policy, technology, procurement or waste reverberate across others, shaping land-use outcomes, market dynamics and carbon impacts upstream and downstream. No single organisation, sector or government can resolve these challenges alone. Without coordination, well-intentioned interventions risk entrenching inefficiencies or destabilising critical parts of the system. For businesses, inaction compounds risk. Overshoot amplifies both physical and transition risks simultaneously: volatile feedstock availability, rising insurance costs, tightening regulation, and increasing scrutiny of land-use and biodiversity impacts. Firms that remain locked into linear 'take-make-waste' models face reduced resilience and shrinking strategic options. By contrast, a managed transition to circularity offers a pathway to regenerative ecosystems, innovation, skilled jobs and a resilient and sustainable biomass supply.

From principles to action

This report provides a multi-sector diagnosis and implications of a circular economy for woody biomass. It sets out practical interventions, identified by engaged stakeholders, that activate key levers of system change. These ranges from policy reform, standards development, new business models, shared data infrastructure, cross-sector collaborations and cultural shifts. Importantly, these interventions are designed to be mutually reinforcing: nurturing innovation, reshaping incentives, updating rules and norms, and building the social mandate for change.

Crucially, the report recognises that lower-value and short-term uses of biomass—including bioenergy and BECCS—continue to play a role in a healthy circular system. These are evolving sectors, whose legitimacy depends on transparent governance and alignment with long-term climate and nature goals.

Five principles to guide the transition

Drawing on stakeholder insights and existing best practice, we propose five principles to act as a common language and decision-making framework for a circular bioeconomy:

1. **Regenerative for planet and people:** Circularity must restore ecological and social systems, and be grounded in lived realities, not abstract optimisation.
2. **Value hierarchy-led decision-making:** Shared hierarchies should guide land and biomass use toward the highest environmental and social value, avoiding low-value lock-in.
3. **Creating the conditions for longevity:** Materials should be designed, used and circulated to maximise their useful life through reuse, repair and remanufacture.
4. **Promoting long-term, coherent policy:** Stable, aligned policy signals are essential to enable investment and innovation across multi-decade horizons.
5. **No blind spots in data:** Trusted, interoperable data on materials and land use underpins transparency, accountability and effective circular flows.

Together, these principles provide a foundation for collaboration, helping actors navigate trade-offs, align incentives and build confidence in a shared direction.

A call to action

The transition to a circular bioeconomy will reshape value chains and redistribute value over time. Managing this transition fairly and effectively requires early, inclusive engagement across sectors. The risks of delay are shared, and so are the benefits of action.

This report invites you—businesses, policymakers, civil society and researchers—to:

- **Join the next phase of cross-sector collaboration**, helping turn shared insight into coordinated action;
- **Apply the principles and systemic levers** within your own strategies, investments and operations; and
- **Engage your value chains** to align incentives, share data and pilot new circular approaches.

In an era of climate overshoot, choosing business-as-usual is not a neutral option. It shifts greater cost, instability and risk into the future. A resilient, regenerative future requires a collaborative transition to a circular bioeconomy.

5

Section 1

INTRODUCTION

6

1. INTRODUCTION

This report sets out why and how a systemic, cross-sector approach is essential to shaping a circular bioeconomy.[1]

It outlines our motivation behind this project, the challenges we seek to address, and the methodology we used to develop it. We also share the results of our collective inquiry: the principles that emerged from our workshop, the systemic barriers and enablers identified by participants, and proposed interventions to address them. Together, these insights build the foundation for the collaboration necessary to drive action.

Our process combined desk research, in-depth interviews across the value chain, and iterative refinement of our problem statement. We then brought stakeholders together in a facilitated workshop to test these insights, surface lived experience and co-develop practical interventions. This blend of evidence, perspective, and collective sense-making was designed to illuminate not only what must change, but how we might change it together.

A clear message emerged from this process: we cannot move fast enough by working in isolation. We have a window of opportunity for a managed transition that embeds the policies, models and practices that are sustainable in the long-term. Conversely, the risks of inaction are rising, as is the risk of entrenching unsustainable, yet currently mainstream, supply chain models, technologies, policies and practices. The only viable path is one we build collaboratively, drawing on the strengths and responsibilities of different sectors. We invite you to join the next stage of this collaboration and help turn shared insight into shared action.

1 For the purposes of this paper, a circular bioeconomy is defined according to the Sustainable Manufacturing and Environmental Pollution Programme and UN Trade and Development as:

"A circular bioeconomy aims to shift existing bioeconomy practices, that are typically linear and extractive, towards practices that emphasises resource efficiency, waste reduction and re-use of wastes and other biological resources to displace fossil-fuels and non-renewable resources. It is a dynamic, interconnected economic system that reduces pressures on resources by creating cascading loops which recover value, avoid landfilling and reduce fossil input needs.

It aims to maximize the value of biological resources by keeping them in use for as long as possible and minimizing waste generation, increasing sustainable production and use, and valorisation of biological resources such as forest residues to produce materials and goods, and integrates end of life solution and early value chain solutions."

Section 2

ABOUT THIS WORK

8

2. ABOUT THIS WORK

2.1 Our Just and Regenerative Mission

At Forum for the Future ("Forum"), we have set our vision as a just and regenerative future and our mission is to accelerate the transition towards it. There are many interpretations and uses of the word "regenerative". In this report, we are using Forum's current understanding of this term. To us, a Just and Regenerative approach means strengthening the capacity of all living systems—human and non-human—to adapt, replenish and regenerate; respecting everyone's human rights and potential to thrive; and rewiring our economies and societies to serve both people and planet. See our Business Transformation Compass for a deeper discussion of our definition of "Regenerative".

For 30 years, Forum has worked with business, governments, and civil society to help accelerate the shift toward a sustainable future. We recognise the world today is facing complex challenges, and we look to leverage our role as a trusted "critical friend" and deploy our strengths (e.g. systems thinking and futures methodologies) to navigate complex sustainable development challenges.

2.2 Our relationship with Drax

In 2022, Drax Group plc commissioned Forum to convene an independent High-Level Panel to identify the conditions under which Biomass Energy with Carbon Capture and Storage (BECCS) can genuinely benefit nature, climate, and people.

The BECCS Done Well Report outlined the conditions we argue are necessary to ensure biomass material is sourced sustainably. While this report may touch upon these issues, it is primarily focused on how this material exists and recirculates in the bioeconomy. Please refer to the BECCS Done Well Report for more detail on our positions on sustainable forestry and biomass sourcing practices.

In early 2025, Drax published its Sustainability Framework, setting out a series of time-bound targets to accelerate decarbonisation, protect and restore nature, and support communities. Among these 26 targets is a commitment to publish a white paper exploring opportunities to embed circular economy principles within Drax, with a particular focus on the circular bioeconomy.

To help achieve this ambition, Drax invited Forum to lead this work. Building on our expertise in systems change and our previous collaboration on the BECCS Done Well report, we led this piece of work to identify practical and strategic opportunities for circularity across the bioeconomy. Our contribution is to provide independent insight, convene diverse perspectives, and ensure that the approach reflects best practice and drives meaningful impact for a sustainable future.

Forum maintains full editorial independence over the analysis and conclusions presented here, as it did in the BECCS Done Well Report, while recognising Drax Group plc's role in commissioning and supporting the design and facilitation of this process.

2.3 Our approach to collaboration

From the outset, we designed this collaboration to be as inclusive and balanced as possible. All participants, including Drax, were given equal access to project materials, opportunities to shape the inquiry, and space to review and comment on emerging findings. Our intention was to create a process that values every perspective and supports open, constructive dialogue across sectors and roles.

2.4 Our methodology

The insights we present here draw on a combination of desk research, expert interviews, and stakeholder workshops. We began by conducting an initial phase of desk research to articulate a draft problem statement, which we then tested through seven exploratory interviews with stakeholders from across the bioeconomy. These conversations helped us assess the level of interest in a cross-sector initiative and refine our early understanding of the system. Confident there was sufficient mandate to proceed, we carried out a further nine in-depth interviews to deepen our analysis of the opportunities, tensions, and dynamics shaping biomass allocation today.

We then convened a multi-stakeholder workshop with participants representing resource management, forest management, fast-moving consumer goods, bioenergy, academia, environmental professionals, the built environment, and product design to explore divergent perceptions of the system, discuss the implications of emerging and future trends for the bioeconomy, and identifying systemic barriers and enablers that could accelerate or impede the transition towards a more circular, regenerative future.

2.5 Project Scope and System Boundaries

Material: Woody biomass
Sectors: Forestry, Manufacturing, Construction, Furniture, Energy, Transport, Waste Management
Geography: N.A.

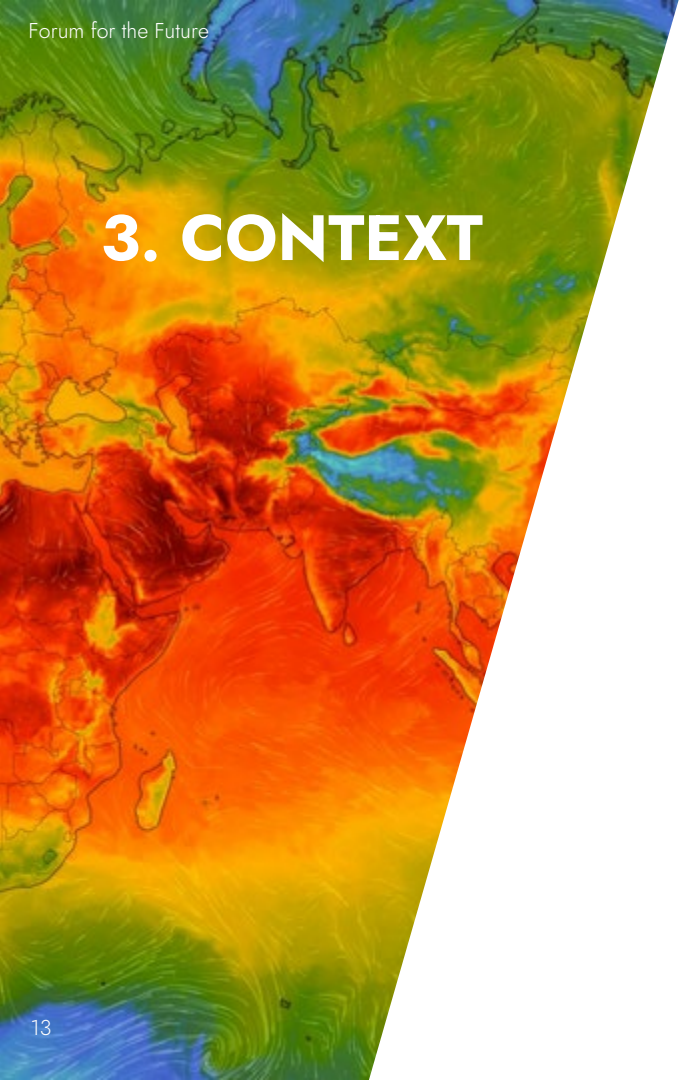
A note on scope

Geographic scope: The issue of geographic scope has been a persistent challenge throughout this process, due to both the regional specificities of the supply and demand dynamics in each sector, and the transnational nature of the supply chains between these sectors. To avoid inconsistencies or mischaracterisations, we have therefore decided to avoid defining a specific geographic scope for this project. Our intention is that the insights and interventions identified in this report are agnostic to specific geographies or jurisdictions, and that future efforts to implement these interventions will require greater regional specificity.

Sector scope: The sectors covered in this report are those represented through our stakeholder engagement. We acknowledge the critical importance of sectors such as textiles and chemicals to increasing demand of woody biomass. While not covered extensively in this report, our objective is to include these sectors over time. Equally, the main insights and recommendations are directed toward civil society, government and business; however, insurance and finance actors are equally important to any systemic shift. The expansion of sectors in scope and stakeholders from finance and insurance are promising next steps for this work as it develops.

Section 3
CONTEXT

12



3. CONTEXT

3.1 Overshoot or collapse

In early 2025, the European Copernicus Climate Service confirmed that 2024 was the first full calendar year in which global temperatures exceeded 1.5°C above pre-industrial levels. Crossing this threshold is now all but guaranteed in the 2030s, signalling that the world is entering a period of heightened climatic instability and deep uncertainty across social, economic and political spheres.

In response, scientists and policymakers are exploring an "overshoot" scenario, in which society temporarily exceeds the Paris Agreement temperature limit before returning to safer conditions. This would require not only significant carbon emissions reductions, but the removal of billions of tonnes of carbon dioxide from the atmosphere and storing it securely for the long term. It will not be possible to reverse the impact caused by exceeding our natural and climate boundaries as biodiversity collapse and carbon emissions are interlinked and reinforcing. To meet the challenge of both entails carbon removals that build or support natural ecosystems to sequester carbon, as well as exploring technological advancements. Carbon removals are no longer optional; they are an essential part of building a future that is just and regenerative for all.

3.2 Linear systems on a finite planet

Every living system on Earth has evolved to cycle materials and remain in balance with the broader system in which it sits. From the way individual cells continuously metabolise energy and nutrients, to the way forests circulate nutrients through soil, water, and biomass, life is organised around cycles of renewal. Humanity is the outlier. We extract, manufacture, use, and discard at a pace and scale unmatched anywhere in nature. Our dominant "take–make–dispose" model assumes limitless resources and an infinite capacity of natural systems to absorb waste. Shifting to a sustainable circular economy is not simply a good idea; it is a fundamental realignment with how life works. Only by redesigning how materials are sourced, produced, used and managed at end of life can we move back into harmony with the wider living systems we depend on.

3.3 The potential role of woody biomass in the circular bioeconomy

The bioeconomy sits at the intersection of these two challenges of an overshoot scenario and the dominance of linear systems. Biomaterials have evolved over 3.8 billion years to possess extraordinary properties, with applications that can substitute for other materials throughout the economy.

Woody biomass comprises the residues of the wood processing industry, post-consumer waste materials, and materials arising from forest management. Prior to its value as a material in human industry, woody biomass derives from natural systems that have their own intrinsic value. Forests and woodlands, when managed regeneratively, provide ecosystem services for biodiversity and air and water quality while, under the trees, forest soils sequester significant volumes of carbon.

As a resource, woody biomass stands out from other forms of biomass, such as fast-growing or low-density materials like agricultural residues or seaweed, due to its potential for ***both*** carbon storage ***and*** substitution effects. Its relatively high density and durability makes it better at both drawing carbon from the atmosphere and storing it for decades or even centuries, while also substituting for other more carbon-intensive materials such as concrete, steel and plastics. Other materials, such as hemp or bamboo, can also act as a substitute, but lack woody biomass' established supply chains. Materials derived from woody biomass can be strong, flexible, energy-rich, and chemically complex, offering valuable applications in construction, textiles, chemicals, fuels, packaging, and more. However, lifecycle assessments of products using woody biomass are extremely sensitive to production conditions, what the material is used for, the product it is substituting for and the treatment of the material at the end of its current life.

It is these attributes that give rise to the pressures the bioeconomy will face through the net-zero transition. As a substitute for fossil-fuel based materials and fuels, demand for woody biomass from liquid and solid biofuels, the built environment, textiles and further is expected to soar. Yet, we cannot assume infinite resources in a future of increased competition for them. It is this imperative that provides impetus for a transition to a circular bioeconomy, aligned with policy that ensures regeneratively managed forests.

Section 4

THE CURRENT STATE OF THE BIOECONOMY

15

4. THE CURRENT STATE OF THE BIOECONOMY

4.1 The versatility of woody biomass

Woody biomass underpins a remarkably diverse set of value chains. Our sketch of the system identified 18 different types of actors interacting with woody biomass, collectively producing at least 31 distinct products, by-products and waste streams. Even a seemingly simple by-product such as sawdust or wood chips can flow to as many as eight different applications, from pulp and paper mills to furniture manufacturers, biorefineries, unabated bioenergy power stations, bioenergy production, or BECCS facilities. Each application carries a different carbon and nature profile, with varied storage durations and substitution benefits depending on the product's lifespan and the carbon intensity of the materials it replaces.

This versatility is a source of resilience and innovation potential. Yet it also means that choices made by one part of the system can reverberate widely, influencing carbon outcomes, market dynamics, and long-term land-use decisions.

4.2 Cultural narratives

Underlying economic forces, regulation, and policy discourse and decisions are the types of mindsets and narratives that forests evoke. Woodlands are evocative of national or regional identities in many countries, such as Finland, Canada and the United States, that produce and export significant quantities of timber or related products. They are tied into discourse on public commons, and a cultural connection that goes beyond the economic value a forest can or does provide. While this is true, stakeholders engaged throughout the project also underlined an increasing cultural severance in other regions between increasingly urbanised societies and the realities of forests, working or otherwise, and related industries. It is difficult to measure the influence and implications of such narratives, yet critical to acknowledge the role they can and do play.

4.3 Economic forces driving biomass pathways

The way biomass flows through our socioeconomic system is shaped by a complex interplay of economic, logistical, and technical factors. Technologies vary in their market readiness, capital cost, and processing efficiency. The logistics required to transport materials from where they are produced to where they are needed often represents a substantial financial, environmental and social cost, which is also influenced by how concentrated or dispersed resource sources are. Regional markets differ in the availability of complementary industries, labour, and infrastructure. Political realities shape fiscal incentives, which can change suddenly without warning. As a result, the "highest-value" or "best-use" pathway for biomass is not fixed; it shifts across geographies and over time as incentives, technologies, and policy frameworks evolve.

This complexity often leads to misalignment between the uses that might deliver greater value for achieving climate goals, nature-restoration and long-term economic prosperity and those that are currently most economically viable. The result is a pattern in which promising circular or longer-lived applications struggle to compete with simpler, more established, or more heavily subsidised pathways.

4.4 Upstream land-use dynamics

Markets for timber and biomass, including lower-grade materials and residues, play an important role in the economics of working forests. When demand is steady and predictable, it can help maintain incentives for landowners to keep land in forest cover, invest in stewardship, and manage forests regeneratively for long-term health. However, this dynamic varies by region and depends on the balance of markets across the complex web of value chains.

In a scenario where major biomass uses collapse, as happened to the pulp and paper sector in parts of the Southern US, the economic rationale for maintaining some forests can weaken, creating risks for both livelihoods and landscapes. In such cases, forest managers under financial pressure may decide to harvest their remaining stock and pivot to alternative land uses that offer viable immediate returns. Depending on what follows, whether agricultural expansion, development, or abandonment, the land may never recover its previous carbon stocks, take decades to regenerate into "natural" forest, or is irreplaceable.

In a scenario where demand for timber and biomass exceeds the supply of sustainable biomass from well-managed forests, as is forecast to happen in Europe, pressure can build upstream in ways that test both ecosystems and governance systems. In regions where oversight is robust, this may simply drive-up prices and intensify competition between sectors. However, where regulations, transparency and enforcement are weak, this rising pressure can create powerful short-term incentives to expand harvesting into previously unlogged or ecologically sensitive areas.

4.5 Inefficiencies and market failures

The full potential of the bioeconomy is far from being realised. Evidence we heard from interviewees shows persistent inefficiencies, fragmentation, and missed opportunities. Biomass feedstocks are frequently allocated to lower-value or short-lived uses, even when higher-value, longer-lasting, or more carbon removal efficient pathways are technologically possible. Many promising circular innovations remain small in scale or disconnected from larger sources of material. Incentives and infrastructure often reward linear practices, while barriers such as contamination, mismatched standards, and a lack of shared data make it difficult to circulate materials effectively.

For example, overly conservative waste legislation, high transport costs, and contamination risk undermining efforts to redirect waste streams into high-value applications such as engineered wood products or biochemicals. Meanwhile, some policy incentives disproportionately favour energy end-uses, particularly SAF and unabated bioenergy, often at the expense of longer-term carbon storage or material substitution potential.

4.6 The systemic cost of inaction

These shortcomings represent enormous opportunity costs; either we fail to achieve the levels of carbon removal required, or we increase pressure on our natural ecosystems by needing to harvest more virgin biomass than is otherwise necessary to meet our carbon removal targets. Meanwhile, our economy continues to operate on a largely linear model, resulting in resource depletion and waste accumulation, while we fail to realise the potential for innovative, high-value, circular applications and skilled jobs in a circular bioeconomy.

Section 5

ENABLING THE TRANSITION TO A CIRCULAR BIOECONOMY

19

5. ENABLING THE TRANSITION TO A CIRCULAR BIOECONOMY

Real transformation requires a portfolio of interventions. Yet individual organisations or single sectors rarely have the remit or resources to act across the full set, meaning change efforts often remain fragmented.

A systemic approach calls for cross-sector collaboration to identify the right interventions, coordinate timing, and decide which actors are best placed to drive which levers. No single organisation needs to do everything all at once, but together we can activate a balanced portfolio that works across the system.

5.1 A vision for a future bioeconomy

A common vision for a circular, regenerative bioeconomy is a critical step in building collaborative action. Throughout our research and stakeholder engagement, experts and industry stakeholders were asked to provide signals of change and suggestions of their conceptualisation of the future.

A future circular bioeconomy may mean material flows aligned with a broader conception of value, delivering on nature, climate and societal goals while driving economic prosperity. It may reconnect communities to land and forests, adopt regenerative forestry and agriculture, deepen greener cities. It may lead to transformed patterns of consumption, prioritising durability, repairability and quality over seasonality and convenience. It may also be a deeply digital future, integrating technological innovation with the fundamental data needs to ensure robust governance and management. It may grow new skills in our economies, uncover lost ones, and transition others to other parts of the economy.

To catalyse this consensus, we suggest a set of five principles drawn from participant engagement and building on the work from Ellen MacArthur Foundation, the World Business Council for Sustainable Development, academia, as well as sector-specific initiatives, to act as a guiding framework and common language for the transition to a circular bioeconomy.

1. Regenerative by default: Ensuring people-led circularity
2. Value hierarchy-led decision-making
3. Designing and prioritising longevity
4. Promoting long-term, coherent policy
5. No blind-spots in data

Explore our proposed principles for a circular bioeconomy here, including how you can sign up and get involved in creating a collective vision for the circular bioeconomy transition.

5.2 Framing cross-sector action for the bioeconomy: levers of change

To achieve the vision presented by the principles requires a transition from today's system. In our work designing strategies for system transitions, we emphasise eight "levers of change" (defined as places to intervene in the system where one shift can produce big changes across the system) that operate across different phases of a transition's S-curve: start-up, acceleration, and stabilisation. In the figure, the systemic levers appear in dark green boxes, positioned to reflect whether they operate at the landscape level (top), within the day to day "regime" (middle), or in niche innovations (bottom).[1]

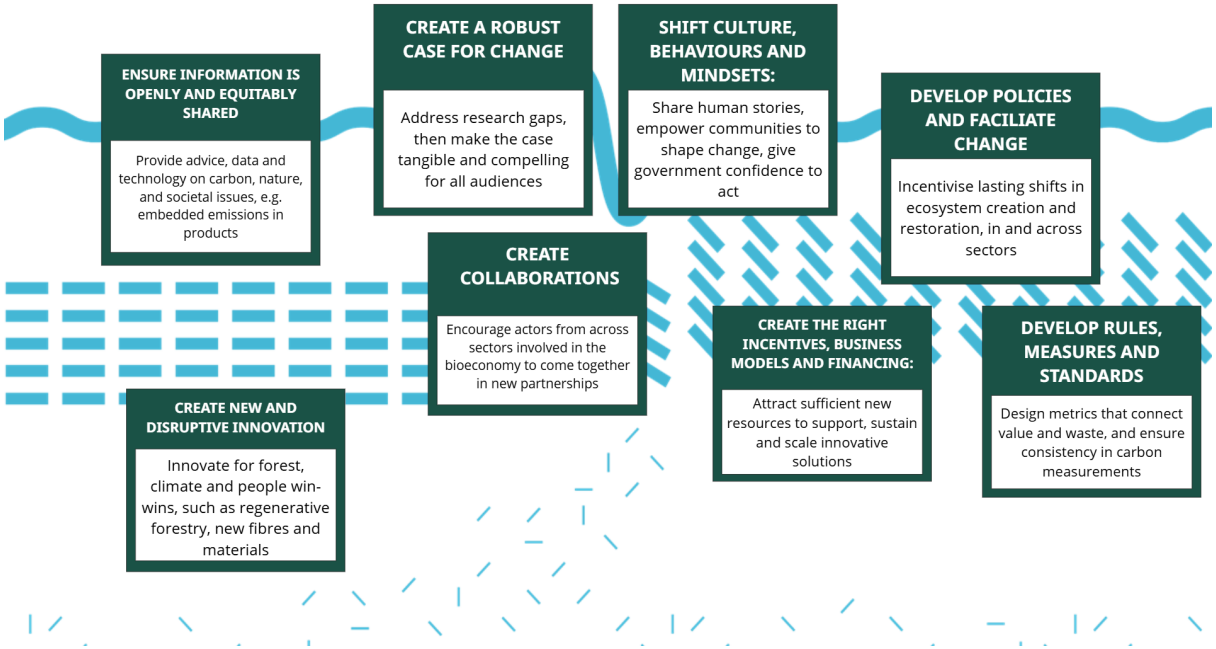


Figure 1: Levers for system change in the bioeconomy

[1] For more information on this framework, click here.

5.3 Shifting a system

Policy reforms, new standards and redesigned incentives all play a crucial role in reshaping how the sectors currently operate. Examples of interventions that could help align market incentives with the waste hierarchy include embedding circularity criteria into procurement and building regulations, updating definitions of "waste", establishing consistent embodied carbon limits, recognising embodied ecological impacts in supply chains, and improving transparency through digital product passports. Creating governance innovations, such as an independent Circularity and Land Use Responsibility Body, could support this by coordinating oversight and enabling fair, predictable decision-making across sectors.

At the same time, "innovations", practices and technologies that are not yet mainstream, are also necessary to provide the experimentation and learning vital to any transition.

Regenerative forestry practices, modular and off-site construction, and emerging biochemical and material pathways all demonstrate alternatives that reduce waste, extend material life, and unlock new forms of value from biomass.

Cross-sector collaborations, shared proof-point repositories and skills-exchange initiatives can help these innovations mature and spread. Efforts to shift consumer mindsets, co-led with trusted civil society groups, further expand the cultural space in which circular solutions can take hold.

Systemic transitions are most likely when portfolios of interventions are designed to reinforce one another: when innovations are nurtured, the transition is invested in, institutions adapt to reward new solutions, behaviours and cultural norms shift and when external pressures accelerate the need for transformation. The interventions identified through this process collectively describe how such alignment can be created.

5.4 Proposed interventions by workshop participants

Workshop participants representing stakeholders from across our target sectors identified interventions that together have the potential to support a transition to a resilient circular bioeconomy. The following table highlights where these are already emerging in practice and shows which systemic lever each intervention activates.

Lever	Intervention	Example
Create collaborations | Shift culture, behaviours and mindsets	Identify partnerships with businesses in different sectors to develop e.g. apprenticeship programmes.	Suez and Unilever partnered to bring together employees in an apprenticeship exchange programme to provide employees from both organisations experience of different sectors, build their skills and apply their own.
	Developing a collective vision for driving alignment and action.	The Cotton 2040 initiative kicked off with the Fashion Futures campaign, bringing together stakeholders from across the supply chain on possible futures and aligning on desired trajectories and shared challenges.
	Leveraging existing bodies (e.g. WBCSD) to create cross-sector platform for action.	WBCSD's Forest Solutions Group already convenes actors close to forestry, providing a strong foundation to broaden cross-sector engagement
Create new and disruptive technology	Private sector collaboration to invest in infrastructure and innovation.	Ingka Investments, the investment arm of IKEA, aims to invest €1 billion into businesses building recycling infrastructure such as RetourMatras and Morssinkhof Rymnoplast.
Create the right incentives, business models, and financing	Advocating for tax system shifts, including reduction of VAT on circular products, refurbishing buildings, while ensuring disincentives for, e.g. landfill or new building.	While several countries globally such as the UK have landfill taxes, it remains an underdeveloped disincentive by many nations. France has introduced a VAT reduction on the repair of several items, including textiles.
	Procurement standards that incentivise sustainable materials.	The city of Barcelona piloted a scheme that focused on sustainability metrics such as embodied carbon, safety and quality of life, leading to two award winning social housing projects.

5.4 Proposed interventions by workshop participants

Lever	Intervention	Example
Create collaborations | Shift culture, behaviours and mindsets	Develop a clear, integrated material and land use hierarchy.	The UK Department for Environment, Food, and Rural Affairs (DEFRA) released a consultation in January 2025 as part of a long-awaited Land Use Framework.
	Develop/advocate for regional economic strategies.	Amsterdam has set itself the target of being the first circular city by 2050, establishing targets and strategies across major sectors from the built environment to consumer goods.
	Form a joint standards or advocacy body to cover entire system from forestry.	Timber Development UK's Timber in Construction Roadmap aims to bring together stakeholders to drive and advocate with a common voice low-carbon economy developments, while the UK Green Building Council is working with its 700 members on embodied ecological impacts in the built environment.
	Advocate for/establish independent policy authority (like OBR) that sets long-term vision and direction of travel beyond party politics.	The UK Circularity Taskforce, fully launched in 2024, comprises a diverse group of experts and leaders from various sectors to support the development of a circular economy strategy.
Develop rules, measures and standards	Support and advocate for the development national standards for reuse of products and materials.	The ISO: IPO 59020, used to measure and assess circularity performance. A new standard for reuse for structural timber, e.g., could take inspiration from steel.

5.4 Proposed interventions by workshop participants

Lever	Intervention	Example
Share information equitably	Collaborate to develop interoperable, accessible, non-proprietary data sharing platforms.	The OpenData Charter advocates for interoperable data flows between governments and accessible and usable by the public. The Open Up Guide on Climate Change, between Chile and Uruguay, is one example of such a platform.
	Develop repository of best/good practices and positive impacts.	The Built by Nature awards recognises excellence in timber building projects which demonstrate alignment with the Principles for Responsible Timber Construction in completed and in-use projects—including new builds, renovations, and significant extensions.
	Mandatory embodied carbon measurement and limits, and embodied ecological impacts for products.	France's RE2020 law mandates an LCA and an EPD for every new building material used in construction. In the UK, Part Z calls on the government to introduce embodied carbon regulation.
Shift culture, behaviours and mindsets	Develop interactive tool demonstrating consequences/implications of certain decisions tool demonstrating consequences/implications of certain decisions.	The EN-ROADS tool by Climate Interactive allows users to model scenarios and demonstrate the potential impact of certain policies or scenarios through a variety of metrics.
	Engage citizens to play a role in guiding policies.	Citizen assemblies for issues such as climate change are becoming an increasingly potent tool for education and agency. Brazil has also seen several citizen assemblies specifically on waste management in cities and regions.

Section 6

Conclusion

26

6. CONCLUSION

6.1 The commercial cost of inaction

Failing to return to 1.5°C is more than a missed climate target. It reshapes the conditions under which governments, investors, businesses, and communities operate. As warming exceeds this threshold, climate impacts accumulate non-linearly and meet tipping points, triggering further rapid warming through carbon release and other reinforcing feedback loops. Extreme heat, crop failures, water scarcity, and climate-fuelled disasters become more frequent, more severe and concurrent.

The economic costs rise sharply as critical infrastructure is damaged, supply chains are disrupted, and essential natural systems lose their ability to buffer shocks. For governments, this means mounting fiscal pressure from disaster response, health burdens, and adaptation costs, alongside rising volatility in food and energy markets. The social impacts are profound too, deepening inequality, driving displacement, and eroding public trust.

For businesses, overshooting 1.5°C magnifies transition and physical risks simultaneously. Businesses face growing operational disruptions, volatile commodity prices, stranded assets, and tightening regulation as policymakers scramble to respond to escalating impacts.

Markets become harder to predict, insurance becomes more costly or withdrawn altogether, and investor expectations shift rapidly. Firms that are unprepared for these shifts risk losing biomass sources, competitiveness, seeing their business models destabilised, or becoming locked into high-cost, high-risk adaptation pathways. Entire value chains become more fragile if the ecosystems they rely on—forests, soils, freshwater—are degraded beyond their capacity to regenerate.

6.2 The need for a managed transition to a circular bioeconomy

Today's allocation of biomass is far from optimal even seen through a narrow lens of economic value, let alone carbon sequestration, ecosystem services, or carbon removal efficiency. Large volumes of material continue to flow into short-lived or low-value pathways while higher-value, longer-lived, or more circular applications struggle to scale.

Markets are never in a perfect state of natural equilibrium but shaped by a patchwork of regulations, subsidies, political and fiscal incentives. As seen above, well-designed interventions can help correct these inefficiencies and encourage the cascading of materials through multiple life cycles. Yet, intervening without a clear view of system dynamics risks destabilising the very industries needed to enable the transition. Abrupt policy shifts could undermine these pathways before they are able to contribute meaningfully to climate and circularity goals. Emerging circular solutions, like forests themselves, require time, investment, and stability to reach maturity.

6.3 Our call to action: The need for engagement from all stakeholders

Transitions of this scale reshape value chains, shifting who benefits and when. As biomass moves toward higher-value, longer-lived uses, lower-value sectors that rely on steady feedstock flows will experience disruption. In a cascading system, materials may reach them later and in more diffuse or lower-quality forms. Recognising this early is essential for a fair and managed transition that supports long-term system health.

All affected actors need to be part of this conversation. Cross-sector collaboration helps organisations anticipate risks, shape solutions, and protect livelihoods while advancing circularity, climate and nature goals. Leaning into transition is more secure than resisting it, given the uncertainty that arises when systems shift without coordination.

Crucially, lower-value and short-term uses of biomass, including bioenergy and BECCS, have a useful role to play in both the near future and the long term. In the short-term, they provide practical ways to realise an economic value from waste and residues until higher-value circular applications become commercially viable. Over the long term, they offer a credible destination for carbon once materials have cascaded through multiple life cycles, supporting stable revenue streams and contributing to responsible forest management and rural economies.

These uses are therefore not "sunset sectors" but viable components of a healthy, circular bioeconomy whose roles will evolve rather than disappear. At the same time, regulators and civil society must maintain independence and remain alert to the risk of delay tactics or overly positive narratives that obscure harmful practices; the innovation and scaling of more efficient, higher-value uses can be inhibited or undermined by too much focus on lower value, short-term uses. Transparent governance ensures policy frameworks keep pace with climate, biodiversity, and social goals.

For incumbents, welcoming this scrutiny strengthens trust and credibility. By committing to cross-sector collaboration in good faith, they can demonstrate meaningful leadership and secure their place in a more circular, regenerative, and resilient bioeconomy.

6.4 Get involved

In this era of overshoot, we cannot rely on any single actor to make the first move. The risks are shared, interconnected, and accelerating, and so are the responsibilities. Choosing to prioritise business-as-usual, in the hope that someone else will fix the problem, simply transfers greater costs and instability into the future.

Three actions you can take now

1 Join the next phase of the collaboration
Become an active partner in shaping a systemic, resilient circular bioeconomy. Our goal is to explore pathways for collaborative action emerging from this work alongside the nascent cross-sector coalition. Contribute your organisation's capabilities, insights, and influence to support this project by joining as a collaboration lead or partner.

2 Apply the principles and systemic levers within your own organisation
Work with us to use the report's insights to review current strategies, identify where your organisation can activate, or play in a role in activating, the interventions provided in this report, and begin piloting interventions that align with circular and regenerative outcomes.

3 Engage your value chain
Cross-sector action can begin in your supply chain. Suppliers or customers may sit at the nexus of different sectors. Take action on the findings of this report by convening peers, suppliers, and customers to share its insights, and find ways to share data, align incentives, and explore joint opportunities.

Get in touch

To discuss the findings of this report, and how you and your organisation can get involved, contact us at info@forumforthefuture.org

Acknowledgements

This report was produced by Forum for the Future and funded by the Drax Group. The authors are Neil Walker and Charlie Thorneycroft, with review by Jordan McKay, Hannah Pathak, Martin Hunt and Fern Yu. The authors would like to extend a special thank you to Samantha Deacon, Jos Harrison, Shane Hughes, Emma Persson, Eilidh Forster and Alicia Newton for their role in reviewing and providing feedback on the report. The authors would also like to thank the more than 20 individuals we spoke to as part of the research of this report, and the 14 attendees of the in-person workshop.

To cite this report

Thorneycroft, C.; Walker, N. (2026), ***Enabling Systemic Circularity in the Bioeconomy,*** Forum for the Future

Glossary

Bioenergy, Carbon Capture and Storage (BECCS): This refers to capturing and permanently storing CO2 from processes where biomass is converted into fuels or directly burned to generate energy.

Bioeconomy: According to the EU, this encompasses all sectors and associated services and investments that produce, use, process, distribute or consume biological resources, including ecosystem services

Carbon accounting: While fossil sectors have had a GHG Protocol Guidance for over 20 years, for bio-based sectors the GHG Protocol Guidance is still in draft. As a generic term, carbon accounting refers to the assessment of GHG emissions, based on lifecycle assessment principles, and covers the whole supply chain, including final use.

Circular economy: Multiple definitions for circularity and the circular economy exist. The Ellen MacArthur Foundation defines it as a system where products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling and composting. Within this, the circular bioeconomy refers to integrating circular principles with the bioeconomy for the sustainable management of biological resources, shifting typically linear practices that deplete resources and do not contribute to maintaining ecosystem services.

Primary forests: Various definitions for primary forests exist. A typical framing is a forest that has never been logged, and which has little to no indication of human activity, with undisturbed ecological processes. They comprise approximately 26% of the world's natural forests, and represent incredible carbon and biodiversity richness, and can sequester carbon for centuries. Returning to full primary forest can take several decades to hundreds of years.

Regenerative forestry: Regenerative Forestry UK provides the following definition: 'Moving away from large scale felling operations which destroy ecosystems and release high levels of carbon from the soil; regenerative forestry is the practise of managing woodlands sensitively to create more diverse and resilient environments that can provide habitats and ecotones, while still providing timber products and lock away carbon.' Our concept of regenerative forestry builds on this definition by recognising the importance of context as to what species can be grown sustainably and where under future conditions, local community needs, catchment-scale "woody" nature-based solutions, habitat integrity/wildlife corridors.

Sink/Storage/Substitution: Functions to trade how carbon flows through the forest system, as presented by Climate-KIC. **Sink:** Carbon absorbed and stored in forests through sustainable growth and harvest. **Storage:** carbon retained in long-lived wood products like buildings and furniture. **Substitution:** Emissions avoided by using wood instead of more carbon-intensive materials or fossil fuels.

Sustainable bioeconomy: A low-carbon and circular economy through the supply of renewable products from sustainable working forests to substitute fossil-based materials.

Sustainable Aviation Fuel (SAF): Sustainable, non-conventional, alternative to fossil-based jet fuel. This includes aviation biofuels produced from biological resources such as plant and animal material. To qualify for the term sustainable, they must meet sustainability criteria such as lifecycle carbon emissions reduction, limited freshwater requirements, no competition with needed food production, and no deforestation.

System: A system is 'a set of things—people, cells, molecules or whatever—interconnected in such a way that they produce their own pattern of behaviour over time' (Meadows, 2010). A system can be ecosystems, such as forests, that also include our social systems such as food systems, they can be socially created systems such as education or describe a place. In this paper, we refer to systems to describe both the network of interconnected sectors to woody biomass, as well as to the ecosystems it is sourced from. This is an intentional double meaning as all systems are inherently connected.

Waste hierarchy: Referring to the priority order in waste prevention and management legislation and policy, intended to minimise adverse impacts of the generation and management of waste, and to improve resource efficiency. In descending order of priority, the options in the hierarchy are Prevention; Reuse; Recycling/Recovery; Disposal.

Woody biomass: Residues of the wood processing industry, post-consumer woody waste materials and agricultural residues in addition to material arising from forest management or fuels reduction activities.

Working woods/forests: "Working forests" are defined as forests that are actively managed to generate revenue from multiple sources, including sustainably produced timber and other ecosystem services, such as carbon sequestration and biodiversity gains, and thus are not converted to other land uses such as residential development.

References

The insights presented here are primarily derived from interviews and workshops. Light-touch desk research was conducted to ground the project team in the context of the bioeconomy. Below is a list of sources referenced in the Report:

Copernicus Climate Change Service (2025) ***2024: First Year on Record to Exceed 1.5°C Above Pre-Industrial Levels***. Available at: https://climate.copernicus.eu/copernicus-2024-first-year-exceed-15degc-above-pre-industrial-level

EIT Climate-KIC (2025) ***Reconnecting Forest-to-Wood Value Chains: A Framework for Action***. Available at: https://www.climate-kic.org/news/reconnecting-forest-to-wood-value-chains-a-framework-for-action/

Energy Transitions Commission (2021) ***Bioresources within a Net-Zero Economy***. Available at: https://www.energy-transitions.org/publications/bioresources-within-a-net-zero-economy/

Forum for the Future (2022) ***Framing the future as 'just and regenerative': why and how.*** Available at: https://www.forumforthefuture.org/framing-the-future-as-just-and-regenerative-why-and-how

Forum for the Future (2021) ***A Compass for Just and Regenerative Business***. Available at: https://www.forumforthefuture.org/just-and-regenerative-business
Metabolic (2023) ***Impact Scan for Timber Construction in Europe***. Available at: https://www.metabolic.nl/publications/impact-scan-for-timber-construction-in-europe/

USDA Forest Service (2016) ***Decline in the pulp and paper industry: Effects on backward-linked forest industries and local economies.*** Available at: https://research.fs.usda.gov/treesearch/54915

Velenturf, A. P., & Purnell, P. (2021). Principles for a sustainable circular economy. ***Sustainable production and consumption, 27. Available at: https://doi.org/10.1016/j.spc.2021.02.018***

forumforthefuture
Forum for the Future
Forum for the Future
forumforthefuture
Forum4theFuture

READ MORE ABOUT OUR WORK AT

FORUMFORTHEFUTURE.ORG

Get in touch:

info@forumforthefuture.org

Sign up for Forum's newsletter