November 2024

Realising the potential of a circular economy for wood-based materials

The opportunities of regenerative forestry

This briefing paper has been written by Ramboll. It was commissioned by a steering group of four users of wood-based materials: Metsä Group, SCG Chemicals, Essity and Tetra Pak, and is endorsed by a larger group of companies who were consulted at different stages of the project including: H&M Group; Haleon; Marimekko; CHEP and Brambles. The group was convened as a Co-Project by the Ellen MacArthur Foundation.

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"With our commitment to the principles of regenerative forestry, we are excited to collaborate with the interdisciplinary scientific community and actors throughout the wood-based value chains to strengthen and develop the regenerative approach in circular economy. It is the power of collaboration that makes the required system level transition happen.

Maija Pohjakallio
VP Climate and Circular Economy, Metsä Group

"To explore how regenerative supply chains in our lifecycle can contribute to healthy ecosystems is important for us. The collaboration within this Ellen MacArthur Foundation co-project around regenerative supply chains is complementing our efforts to stop deforestation with the CGF Forest Positive Coalition and builds on existing certifications for responsible management of forests and fibres.

Susan Iliefski-Janols
VP Sustainability Products & Services, Essity AB

"This work highlights the huge potential sustainably sourced wood-based products have in helping a circular transition. The project investigates the existing regenerative frameworks and suggests actionable next steps to realise the full potential of wood-based materials in a circular economy, supporting our measurable targets for food systems transformation and nature.

Kristiina Veitola
Director Corporate Affairs Circular Economy and Packaging Policy, Tetra Pak

"Enhancing regenerative forestry practices is vital and can be achieved through cross-industry collaboration. Through this collaboration, we are excited to have contributed to clarifying and elevating the role of wood-based materials in a circular economy and the opportunities regenerative forestry present across the value chain.

Elina Myhre
Strategic Partnership Manager, Climate impact and circularity, SCG Chemicals

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The Soil Association welcomes this briefing paper, as it makes an important contribution for how the wise use of wood products can be viewed as a key component of a regenerative forestry concept. We look forward to the further development of how wood-based industries might help to support regenerative forestry management principles and practices in future.’

Clive Thomas
Senior Adviser, Regenerative Forestry, Soil Association

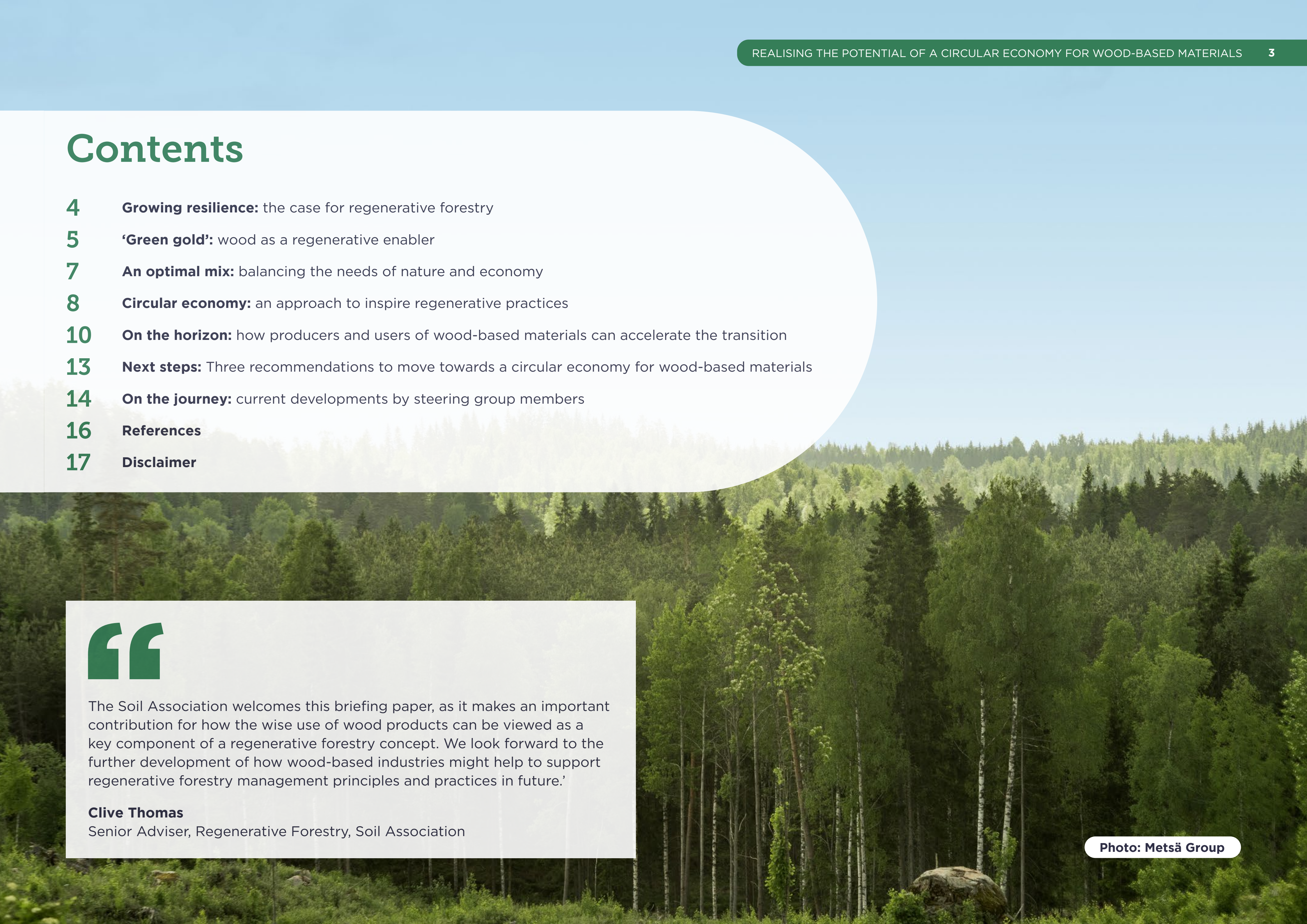


Photo: Metsä Group

Growing resilience: the case for regenerative forestry

Producers of wood-based materials and products stand at a crossroads. As makers or processors of what is arguably one of the most abundant renewable resources available, they hold one of the keys to a more resilient and sustainable future. But the picture is complex and requires system-level change in the way the wood value chain operates. This paper has been created to accelerate this transition.

Climate change, biodiversity loss, and pollution are all ongoing crises that threaten the foundational ecosystem services that nature provides. It follows that mitigating these threats by reducing our dependence on non-renewable and fossil-based materials is a key step towards a more sustainable future.

In this transition, sustainably produced wood-based materials play a particularly important role, offering unique possibilities to support a shift towards a sustainable and climate-neutral circular economy – a system where materials never become waste and nature is regenerated.

Wood is renewable because trees have the ability, through photosynthesis, to capture carbon dioxide from the atmosphere and turn into useful material by using energy from the sun. If managed responsibly, it is possible to sustain a net growth of wood-based resources while still allowing its use.

This characteristic makes wood especially significant for the circular transition. Since many materials cannot be reused or recycled indefinitely, new virgin materials will still be necessary. Renewable virgin resources like wood can support a circular economy without depleting material stocks.

However, this strategy relies on ensuring that wood consumption does not exceed the planet´s capacity to regenerate it. To maintain a long-lasting supply of wood-based materials and other forest ecosystem services, production processes must avoid depleting natural resources or compromising ecosystem integrity. The long-term goal is for wood-based materials and their by-products to generate net-positive outcomes for nature, the economy, and society, thus supporting the sustainable use of forest resources and ecosystem services. A system meeting these criteria could be described as regenerative.

Photo: Metsä Group

‘Green gold’: Wood as a regenerative enabler

Wood and wood-based products are vital commodities in modern society due to their versatile characteristics and broad applicability. Wood is a renewable, recyclable, and naturally biodegradable material that in many cases can serve as a viable alternative to CO_2-intensive materials and products, such as plastics, steel, and cement. When used in place of CO_2-intensive feedstock in this way, forest biomass can give rise to positive substitution effects and a reduced climate impact under many circumstances, although a holistic analysis is necessary before claiming such benefits (Leskinen et al., 2018).

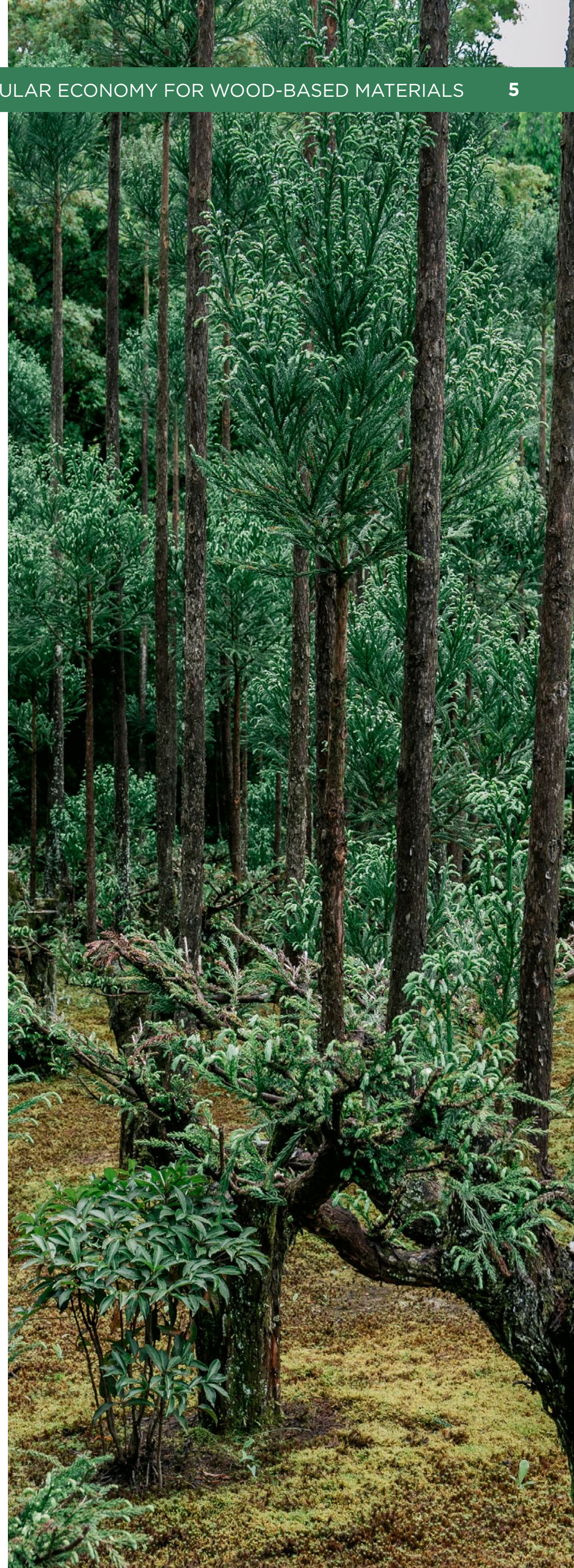
Forests and forest-based value chains are essential to the global carbon cycle by contributing to carbon sequestration and storage, thereby reducing atmospheric CO_2 levels. In this role, forests act as biological carbon sinks. Over the past 30 years, the global forest sink is equivalent to nearly half of all fossil fuel emissions (Pan et al., 2024).

Due to these positive effects, the potential of renewable materials, particularly wood, is increasingly recognised, positioning it at the forefront of numerous sustainability strategies. Policy documents, industrial sector programs and company forecasts are all highlighting the need for increased use of sustainably produced biomass, directly causing a rising demand for timber and wood-based products. As an example, estimates show that the production of wood products is expected to rise by more than 50% globally from 2010-2050 (Peng et al., 2023).

Coupled with an anticipated rise in wood-based materials use in other applications such as textiles, chemicals, plastics and packaging, attention must be paid to ensure that use does not exceed sustainable supply capacities and that forest management activities support healthy and long-term growth of forests. This needs to be included in forest certifications to ensure responsible management.

As global wood production is already at record levels – at about 4 billion m^3 per year according to the Food and Agriculture Organization of the United Nations (FAO) – the escalating demand for wood has placed considerable stress on forest ecosystems. Climate change is also making forests more vulnerable to stressors such as wildfire and pests.

Increasing the efficiency of use of wooden products has huge potential, for example through cascading – which includes the use of side streams from industrial processes (see info box on the next page for further explanation of this concept). But the development of these solutions struggles to keep up with the ever-increasing demand. Simply put, further development of forestry-based value chains is necessary to maintain a healthy wood supply in the long term.

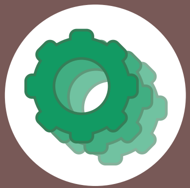


What is cascading?

The cascading principle is key in circular economy, especially for biomaterials like wood. It involves using materials multiple times for various purposes throughout their lifecycle. This approach extends material life, reduces waste, creates more value from fewer resources and supports natural regeneration.

Cascading in time refers to increasing the life span of biomass in use. It promotes options which delay end-of-life of the wood-based product as far as possible. An example of this could be recycling of paper.

Cascading in value refers to finding preferable alternatives for biomass use which maximise the value over the whole life cycle on a system level. This often happens in a cascading time framework. An example of this could be refining of crude biomethanol, one of the side streams in a pulping process, into a grade suitable for raw material use in the chemical industry.



Cascading in function aims to maximise the total functional use of the different streams stemming from a biomass stream. Biorefineries are an example of functional cascading.

The urgency of this transition becomes even more pressing when looking at forests as not only manufacturing plants for wood, but as ecosystems providing a wide range of benefits necessary for all life on earth.

Ecosystem services – the array of values derived from natural capital – span several categories including provisioning, supporting, regulating, and cultural functions. Forests provide multifaceted ecosystem services not limited to the provisioning of wood, fibre, and fuel, but also erosion prevention, nutrient cycling, water purification, climate regulation, and serve as a basis for recreation and tourism.

Forests also deliver substantial benefits for the planet from the richness of their biodiversity. Primary or old growth forests with diverse landscapes generally provide a greater variety of ecosystem services, partly due to the abundance of biodiversity present in these ecosystems. But any type of forest, including those produced primarily for commercial benefit, are of great value to the planet and its human inhabitants.

An optimal mix: balancing the needs of nature and economy

Given the increasing societal demand for wood and wood-based products, trade-offs will continue to have to take place between production (economic) and the ecological and social dimensions of sustainability. But this balance is currently, in many cases, skewed towards production, leading to forests that are less resilient and less diverse, therefore not able to provide the full spectrum of potential ecosystem services.

From the 1990's, efforts to introduce sustainable forest management in the wood-based material value chain have been advanced through standardisation and certification schemes like PEFC and FSC. These standards have made significant strides in balancing environmental, social, and economic concerns.

Large parts of global forests are now certified, increasingly contributing to conservation efforts, other biodiversity actions and reduced deforestation rates. Additionally, evolving forest management practices now showcase methods such as planting a variety of species together and adopting climate-adaptive tactics to increase the resilience of forests.

While these initiatives have undoubtedly contributed to more responsible forest management, and have potential for further implementation and development, global forest biodiversity is still declining. The global rate of species extinction, which is already at least tens to hundreds of times higher than it has averaged over the past 10 million years, is clearly linked to the unsustainable use of natural resources such as forests (FAO, 2024; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2022).

This shows that further measures are necessary. To enable thriving and resilient forests that supply us with a wide range of ecosystem services today and in the future, a paradigm shift from intensive forest management practices towards a model prioritising long-term healthy ecosystems is needed. This shift should emphasise the enhancement of the multitude of services a forest can provide, as opposed to a narrow prioritisation focusing solely on maximising wood production.

Such a shift can alter in implementation in the two main categories of forestry i) land-sparing forests, such as plantations and ii) land-sharing forests, for example semi-natural boreal forests (Forest Europe, 2020). In land-sparing forests leaving set-asides elsewhere is the main means to foster biodiversity whereas in land-sharing biodiversity improvements are mainly integrated to wood production on the same piece of land, focusing on the delivery of ecosystem services (Löfroth et al., 2023).

Circular economy: an approach to inspire regenerative practices

To promote ecosystem health, it is essential to minimise environmental impacts across the entire value chain. While wood-based products provide a strong foundation, further efforts are required to address climate change and biodiversity challenges, especially at the global scale. A key aspect of this transformation is to further promote a societal shift from a linear to a circular economic model, facilitating the decoupling of economic growth from the consumption of finite resources.

At its essence, a circular economy is about the creation of an entire economic system that balances the needs of the humans that live on earth with the natural world that supplies the economy with resources. Achieving a circular economy means redesigning business models, products, and services so that waste and pollution are avoided, materials are kept in use as long as possible and then circulated, and that nature is regenerated. It's a fundamental shift that has implications for every corner of the business world and the financial system that enables it.

The Ellen MacArthur Foundation has created three central principles of the circular economy:

Eliminate waste and pollution

Circulate products and materials (at their highest value)

Regenerate nature

Wood fits well into this vision, facilitating the first principle because it is a renewable material that can replace finite resources. It is important to keep in mind however that the circulation of materials at their highest value must be prioritised. This means that reusing a product (or material) is in most cases preferable to recycling.

In the circular economy, forest-based value chains interact with both biological and technical cycles. In the biological cycle, forest resources like wood and biomass can be returned to the soil, either by composting or other processes, thus helping to sequester carbon and recycle nutrients. This aligns with the idea of regenerating natural systems, one of the core principles of the circular economy.

In the technical cycle, forest-based products (e.g. timber, paper, textiles, or composites) should follow a circular economy's "R-principles" (such as reduce, reuse, and recycle) to keep materials in use for as long as possible. This means minimising the extraction of wood-based raw materials by reusing and recycling forest-based products, thereby reducing the environmental impact associated with production. One example of how this is done is through cascading (see box on page six).

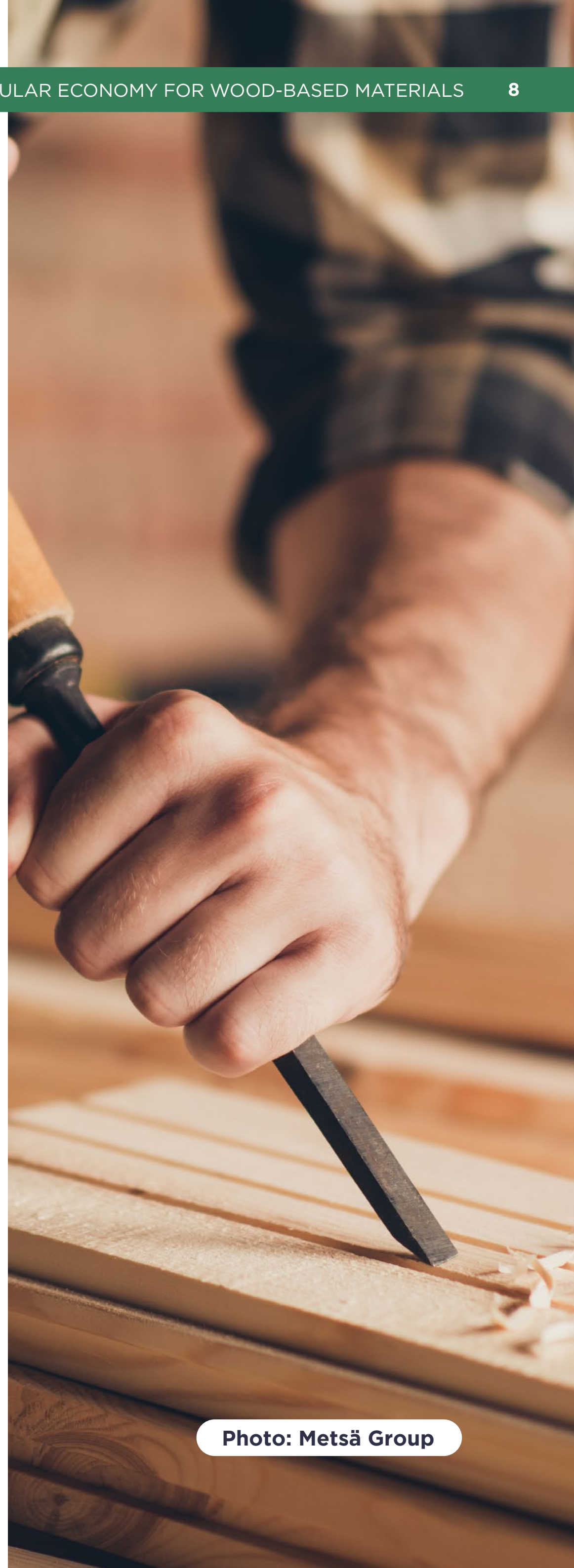


Photo: Metsä Group

Due to the challenges presented by climate change and biodiversity loss, there is a societal need to increasingly focus on the third principle of a circular economy - regenerative thinking. For makers of wood-based products, this is very relevant as forests hold such a significant role in mitigation strategies for both these global challenges. How can the forest-based materials sector adapt to support this planetary need, while thriving commercially?

A good place to start is with some insight into what regenerative thinking constitutes, and in what ways it diverges from the contemporary discourse on sustainability.

To address this, we have conducted an extensive literature review on the concept of regenerative thinking, thoroughly examining its definitions and applications across four key sectors: agriculture, textiles, forestry, and the built environment.

The examined frameworks are still in development and differ substantially in the application of the term 'regenerative'. On a general level, they function independently of one another, demonstrating the need for increased harmonisation between frameworks and sectors. Due to this segmentation, it remains unclear what differentiates 'regenerative' from similar terms, such as 'nature positive', 'restorative," and 'closer to nature'. Without a broad and common understanding of what regenerative is and how it is defined, there is a risk that the concept is misused, decreasing its credibility.

However, the analysed frameworks do share some common aspects. For example, they generally support an outcomes-focused strategy, judging the value of regenerative practices by their results rather than the processes used. Such an approach calls for relevant, context-aware metrics capable of reflecting the complexities of regenerative systems and the progress towards these results, although certain quantifiable indicators grounded in science remain crucial.

It's also vital to establish a clear baseline for 'regenerative', which could be either a pristine ecological state unaffected by humans or an ecosystem already modified by human involvement. This baseline choice critically shapes our definition of regenerative systems. Current frameworks, such as the ISO-standards for circular economy (ISO59004), suggest comparing against today's altered environmental state, aspiring to continually move the goalposts towards further regeneration.

Regenerative principles – A summary of analysed frameworks

- Aim to reverse ecological harm and build resilience for the long haul by repairing, revitalising, and positively contributing to environmental integrity and social fairness, creating an enduring state where ecosystems can self-renew and thrive.
- Accomplished by proactively rejuvenating and replenishing natural resources and ecosystems.
- Aim to create system-wide net-positive transformation.

Photo: Metsä Group

On the horizon:
how producers and users of wood-based materials can accelerate the transition

Within the forestry and wood-based materials sector, the application of regenerative thinking holds massive potential. Getting the industry closer in line with working methods that reverse ecological harm and build long-term resilience holds the potential to slow, and ultimately reverse, biodiversity loss. Regeneratively-produced renewable/biobased materials could also be brought into the wider circular economy, maintaining their value as far as possible and further enhancing sustainability.

Figure 1 illustrates this integration, showing a regenerative forest as the foundation of the forest-based materials value chain, alongside the roles played by the companies in this paper's steering group. Regenerative forestry complements the existing value chains, where solid wood products such as timber and engineered wood form the core for minimally processed products such as timber for construction and furniture. As depicted in the figure, wood can move or cascade through the value chain, being converted into products like paper, textiles, and chemicals, and can also be continuously reused and recycled to improve resource efficiency. At the end-of-life, wood can return nutrients and carbon in the soil, for instance through composting.

Photo: Metsä Group

Regenerative forestry and supply chains

Can regenerative forestry ensure healthy ecosystems?

Existing ways of working in forestry aim to:

- Compliance with forest certification criteria
- Compliance with FSC™ or PEFC ™ certifications
- No deforestation and no degradation
- Net growth of the forest

Regenerative principles for forestry aim to:

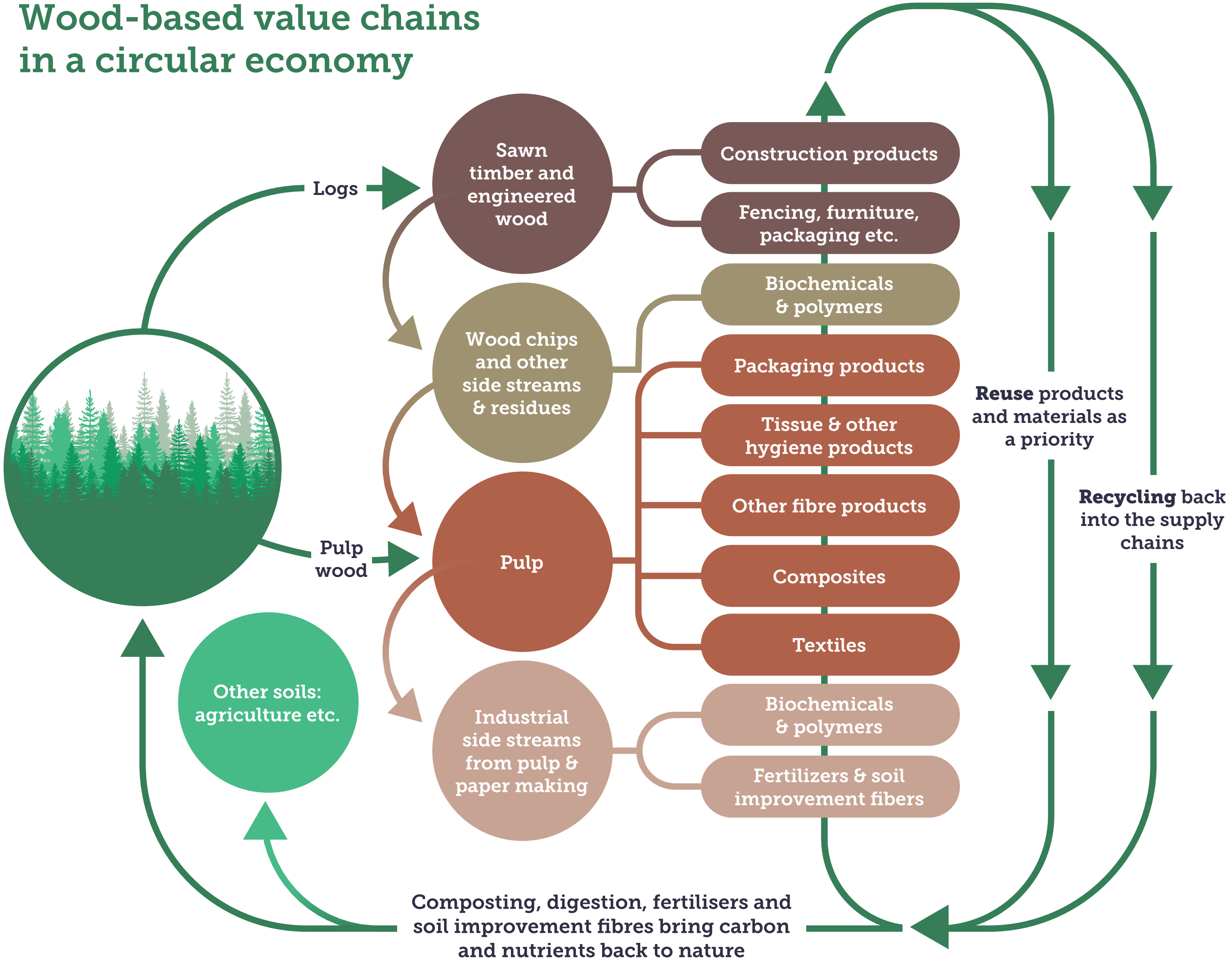
- Reverse ecological harm and build resilience for the long haul creating an enduring state where ecosystems can self-renew and thrive
- Proactively rejuvenate and replenish natural resources and ecosystems
- Create system-wide net-positive transformation

Regenerative forestry contributes to healthy ecosystems and provision of ecosystem services such as:

- clean water and fresh air
- climate regulation
- responsibly managed wood and other raw materials
- carbon sequestration and storage
- food
- pollination
- recreational experience

FIGURE 1

Wood-based value chains in a circular economy



Forest services and wood-based products

Metsä Group is a forest industry company focusing on wood supply and forest services, wood products, pulp, paperboards, and tissue and greaseproof papers. They are committed to the principles of regenerative forestry to measurably strengthen the state of nature in their owner-members forests in Finland.

Packaging products

Tetra Pak is a global food processing and packaging solutions company. Their packaging, predominantly made of wood fibre, helps to provide safe nutrition for millions of people in more than 160 countries every day. They innovate for increased circularity of the packaging and food inside.

Tissue & other hygiene products

Essity is a Hygiene & Health company. Fresh and recycled wood based pulp is an important material in many of Essity's products and packaging. In the EU project Calimero they are exploring improved ways of measuring soil health and biodiversity in a life cycle perspective.

Biochemicals & polymers

SCG Chemicals is ASEAN's leading innovation company in chemicals and polymers. It has integrated the circular economy into their core strategies to deliver low-carbon solutions to our customers. SCGC Green Polymers™ portfolio is built on four pillars—Reduce, Recyclable, Recycle, and Renewable biobased polymers— and enables circular solutions throughout the plastics value chain.

Photo: Metsä Group

These processes are already partly in place, as well as the corporate measures that can facilitate them. For example Metsä Group's regenerative forestry principles related to northern semi-natural forests (see page 14 for more details), as well as Essity's Life Cycle Assessments. Further improving the efficiency of cascading, reusing and recycling will be essential to strengthen the forest-based materials value chain's contribution to the circular economy. By integrating regenerative forestry, the value chain's sourcing also aligns more closely with circular economy principles.

To fully enable integration of regenerative forestry into the value chain, the concept must be further developed. While still in its early stages, regenerative forestry has recently shown signs of evolving with new frameworks emerging that focus on revitalising and rehabilitating ecosystems. For example, in the UK, the Soil Association has outlined regenerative forestry principles to guide future methods.

Other examples include frameworks based on notions such as 'nature positive' or 'closer to nature' forestry. These systems encourage new working methods that enable the renewal of soil resilience, better water cycle management, and an enhancement of biodiversity, creating self-sustaining systems and environments.

Despite these recent advancements, the development of regenerative forestry frameworks remains somewhat fragmented, with initiatives being developed independently and in the absence of consistent policy support. The lack of a standardised, internationally agreed-upon definition for regenerative forestry complicates efforts to establish a cohesive approach, limiting the potential for widespread implementation across the sector.

To enhance the effectiveness and scalability of these frameworks, increased collaboration among stakeholders—including policymakers, industry representatives, environmental organisations, and academia—would be beneficial. Standardising definitions and aligning approaches across regions could facilitate the integration of regenerative forestry principles into existing forestry practices and regulatory frameworks.

A key step to start this journey would be to establish standardised and science-based biodiversity assessments that favour a holistic regenerative approach. This is crucial to promote regenerative practices, but it is also challenging given regional differences as well as the complexity of ecosystems and the interdependence of species.

There also needs to be a consensus on other impact metrics and baseline references that span the entire lifetime of forests and their associated supply chains. Metrics should adequately reflect various sustainability facets while also considering the dynamic nature of forests over time.

Next steps:
Three recommendations to move towards a circular economy for wood-based materials

1

Recognise and develop circular properties of wood-based materials:

- Forest-based value chains are part of both biological and technical cycles. The technical cycles need to be supported and further developed according to circular economy R-principles (reduction, reuse, recycling etc.) as well as by avoiding using substances or processes detrimental to the environment, health, or recycling processes.
- The substitution potential impacts of biobased materials should be better recognised and quantified as part of climate, product, and circular economy policies. This requires a comprehensive understanding of the social, environmental, and economic impacts of using one material over another.

2

Create international and consensus-based definitions for terminologies related to regenerative concepts:

- There is a pressing need for the evolution of forest management frameworks that accentuate the importance of biodiversity and ecosystem resilience.
- Terms such as ‘nature positive’, ‘closer to nature’, and ‘regenerative forestry’ all underscore the significance of biodiversity, yet they represent distinct concepts. It is essential to clarify and standardise these varied notions.
- There should be a determination of which aspects of terminology and metrics ought to remain generic across all regenerative frameworks irrespective of the industry, and which should be tailored to specific sectors.
- Clarification is required on what constitutes a ‘regenerative’ product or material, as opposed to one that is merely renewable or recycled.

3

The collaborative development of biodiversity metrics is paramount to establish a basis for a regenerative paradigm:

- Approaches to enhance biodiversity vary significantly, contingent upon the forest type and geographic context, with strategies ranging from land-sparing to land-sharing. Identifying and standardising the most effective practices in each situation will be essential for widespread adoption and environmental benefit.

On the journey: current developments by steering group members

Three examples of circular economy practices for wood-based materials, drawn from the steering group companies that commissioned this report.

Metsä Group

Metsä Group Plus forest management model

In spring 2023 Metsä Group committed to the principles of regenerative forestry with the aim to verifiably improve the state of nature in our member-owners forests in Finland by 2030. Commercial forests in Finland are seminatural, meaning that only native tree species are used and wood production is integrated into natural ecosystems without land-use conversion. In regenerative forestry the bar is raised higher than in traditional forest certification: the aim is that various ecosystem services can be measured, and that wood is produced as part of a developing multi-objective production model. The goal is significant for the whole of Finland, as the members of Metsä Group's parent company, Metsäliitto Cooperative, own about half of Finland's privately owned forests. A tangible example of Metsä Group's journey towards regenerative forestry is Metsä Group Plus – the company's new forest management model.

Photo: Metsä Group

SCG Chemicals

Renewable polymers from biobased feedstock

To meet climate targets, the plastics industry needs to focus on reduction, reuse, and recycling, to decouple plastics production from using fossil feedstock. Bio-based and bio-derived plastic products from responsibly-managed sources can contribute to these ambitions.

SCG Chemicals is tackling this challenge and has tapped into the growing demand for renewable polymers from biomass. As part of its product portfolio, SCGC focuses on biomass-based polyolefins, and polymers based on conversion of captured CO_2.

Biomass feedstock can be derived from organic waste such as crop and farm residues, forestry waste and residues, pulping by-products, compost or used cooking oils.

Manufactured with renewable feedstocks, polyolefins significantly reduce CO_2 emissions while offering equally high material performance as conventional fossil-based polymers, and in applications with long life cycles, even serve as a form of carbon storage.

Renewable polyolefins contribute to the decoupling of plastics from the use of fossil feedstocks and to the circular economy by being fully recyclable in existing municipal waste collection schemes and plastics recycling facilities.

Photo: SCG Chemicals

Essity

New improved ways of measuring soil-health and biodiversity in a life cycle perspective.

Essity has been conducting Life Cycle Assessments (LCAs) to measure the environmental impact throughout the entire life cycle of the product since the 90s. It delivers products and services with improved well-being and better environmental performance through smarter designs and less material.

One challenge it experiences is quantitative measuring of the state of impacts related to land use it participates in the EU project Calimero.

Expected benefits are an improved understanding and capability of including the Soil Quality index based on LANCA® in LCAs of wood-based products. Understanding of Soil Quality indexes is highly relevant for any future regenerative models and indicators. A specific focus is put on understanding what data to collect from suppliers and sub-suppliers and how to use any generic data. In addition, the project will also increase the knowledge about the use of different biodiversity and ecosystem services indicators in combination with LCA. Essity has obtained FSC™ (FSC-C003255) and PEFC (PEFC/16-33-1406) certifications.

Photo: Essity

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