

Biorefineries: New growth potential for the pulp and paper industry

Jori Ringman, Director General, Cepi

INTRODUCTION:

Biorefineries represent a critical intersection of innovation, sustainability, and economic opportunity for the pulp and paper industry. By expanding beyond traditional products and embracing the full value of biomass, the sector can help lead Europe—and potentially the world—toward a more resilient, low-carbon, and circular bioeconomy.

Advancements in biorefining have significantly expanded the range of products that can be derived from trees—far beyond traditional pulp and paper. Simultaneously, global demand is growing for sustainable, bio-based alternatives to fossil-derived products. The pulp and paper industry, with its scale, infrastructure, and technical expertise, is uniquely positioned to lead this transition.

A recent study commissioned by Cepi—the European confederation representing pulp, paper and biorefinery sectors—highlights the rapid evolution of Europe's forest-based biorefinery sector. This development opens pathways to replacing many fossil-based products with renewable alternatives.

A Natural Complement to Pulp and Paper

Biorefineries produce a wide range of green alternatives, encompassing materials, chemicals, fuels, energy, food and feed, pharmaceuticals, and cosmetics—sectors traditionally dominated by the petrochemical industry.

The International Energy Agency (IEA) defines biorefining as “the sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat).” As industries—from aviation to textiles—seek to reduce their reliance on fossil-based feedstocks, the demand for these sustainable alternatives is increasing rapidly.

Importantly, biorefineries do not displace traditional pulp and paper manufacturing. Rather, they complement it by valorising biomass components that previously had limited or no commercial application. This enables industry players to create new revenue streams while improving the overall efficiency of biomass use.

Climate Impact and CO² Substitution

Biorefineries also contribute to climate change mitigation. The Cepi-commissioned study quantifies a conservative “substitution effect” of over 3.1 million tonnes (Mt) of CO² equivalents, reflecting the emissions avoided by replacing fossil-based products with bio-based alternatives such as biodiesel, man-made cellulosic fibres (MMCF), turpentine, and lignin oil.

This figure is based on a production volume of only 1.4 Mt per annum of biodiesel, MMCF, turpentine, and lignin oil. When the broader range of bio-based products—representing a total capacity of 3.0 Mt/a—is included, the potential CO² substitution could be substantially higher. This offers significant potential for companies aiming to reduce Scope 3 emissions across their value chains.

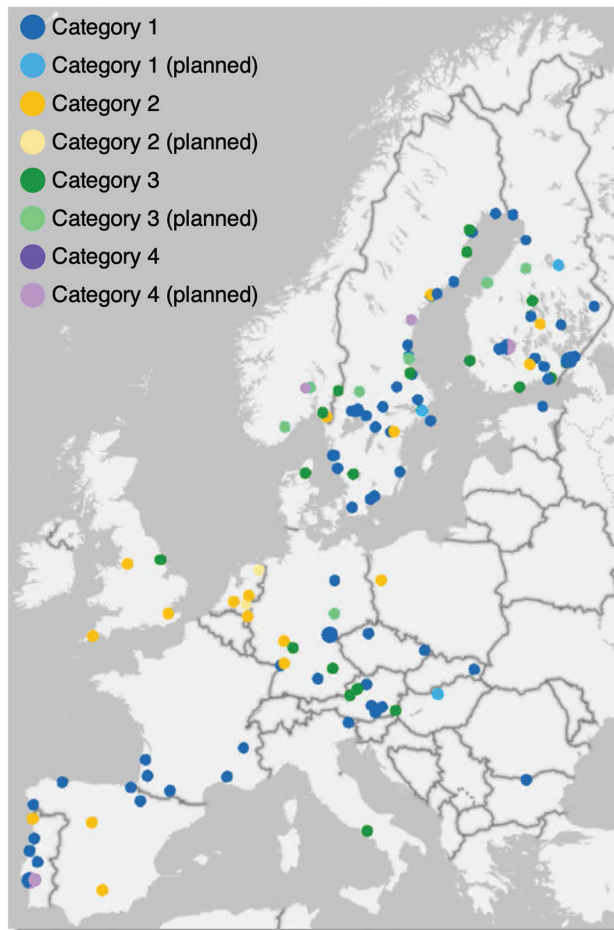


Biorefineries represent a critical intersection of innovation, sustainability, and economic opportunity for the pulp and paper industry.

Technological Innovation and Economic Growth

Particularly in Europe, biorefineries represent a key area of technological innovation and a technology-driven growth opportunity. As economic growth becomes increasingly tied to sustainability, the bioeconomy—and pulp and paper-based biorefineries in particular—emerges as a strategic priority.

Because bio-based resources are renewable only at the condition that they are used sustainably and efficiently, new investments in biorefineries should be grounded in local availability assessments and sustainable forest management practices, ensuring both fair economic returns for biomass producers and long-term resource resilience.



A biorefinery has been defined as the concept of a processing plant where forest-based feedstock is converted and extracted into a spectrum of added value products. They have been classified according to the following sub-categories:

- Category 1: Biorefineries based on chemical pulping operations to produce biobased products
- Category 2: Biorefineries using virgin pulp and/or paper for recycling to produce evolving biobased products
- Category 3: Other biorefineries not related to pulp & paper manufacturing using lignocellulose as raw material to produce various existing or evolving biobased products
- Category 4: Category 1-3 refineries that implement Carbon Capture and Utilisation (CCU) technologies to capture and utilise biogenic carbon to produce bio-based products.

EMERGING BIO-PRODUCTS



Aviation



Electronics



Civil construction



Pharmaceutical & medical



Printing & publishing



Furniture



Packaging



Chemicals



Food



Textile



Automotive and batteries



Energy



Cosmetics & personal hygiene



... Various industries

Market Growth and Industry Expansion

According to the study conducted for Cepi by the German-based nova-Institute, turnover in the forest-based biorefinery sector has more than doubled over the past three years, reaching €6 billion. These facilities, which convert biomass into a diverse array of value-added products, are integrated into pulp and paper operations, where similar processing technologies have long been used to meet internal energy needs, and can now be used for higher value added.

Biorefineries are no longer just theoretical—they are already being implemented across the continent. The study identifies 143 biorefineries in Europe: 126 operational and 17 in development. The highest concentrations are found in Sweden, Finland, Germany, Portugal, and Austria. In total, 18 European countries currently host operational or planned forest-based biorefineries.

Biorefinery products currently account for approximately 6% of the total turnover of Europe's pulp and paper sector. However, based on identified investment plans, the study projects that this share will grow significantly, with an annual sector growth rate of up to 5% expected through 2050.

Cascading Use and Maximised Value

A key principle guiding the future of biorefineries is the cascading use of biomass—the prioritisation of biomass applications that deliver the highest added value. State-of-the-art biorefineries can fractionate lignocellulosic biomass into cellulose, hemicellulose, and lignin, each of which serves different high-value applications:

- Cellulose: Used in the production of bio-based materials and chemicals.
- Hemicellulose: Converted into platform chemicals or food and feed ingredients.
- Lignin: Thermally processed into materials such as activated carbon for air purification or hard carbon for battery electrodes.

Emerging Bio-Products: The potential for biorefinery product applications is nearly unlimited. Currently, the most common bio-based products are man-made fibres, electricity and district heat, fuels - including for sustainable aviation, lignin, and tall oil products.

Such integrated biorefineries can co-produce food, feed, chemicals, and materials from a shared biomass input, maximising both economic return and resource efficiency.

Policymakers and stakeholders increasingly recognise the need to align bioenergy strategies with the cascading use principle. This approach ensures biomass is first used for high-value materials and only later for energy applications, thereby enhancing sustainability and supporting the development of a circular, bio-based economy.