

## **Chapter 1. Overview of bio-based industries**

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### **Abstract**

The increasing population, rapid depletion of non-renewable resources, and global warming are major driving forces to radically change our production and consumption approaches. Focusing at processing, storage, recycling, and disposal of biological resources, bio-based industries are leading the transition towards a more sustainable Bioeconomy worldwide. These industries use starch-based, sugar-based, lignocellulose, algal biomass, and waste-derived feedstocks to produce a wide range of biofuels, polymers, and other significant products within a biorefinery perspective. The present chapter provides a general overview of prominent bio-based industries working on in Europe and globally and lists some of the most relevant projects that are leading the transition to a non-fossil era.

**Key Words:** Bioeconomy, Sustainability, Waste management, Biomass valorization, Product development

### **1.1. Introduction**

Sustainable development is among the most important issues for both global research and political agenda today. This is due to the serious challenges that our society is facing, including climate change, resource depletion, and environmental degradation. The implementation of the so-call Bioeconomy will promote the use of renewable biological resources to produce food, materials, and energy, while balancing, for instance, waste production and/or greenhouse gas emission.

Targeting at reducing our dependence on fossil-based products and meeting the global sustainability objectives, a strong bio-based industrial sector is needed to lead such

transition. Bio-based industries are therefore in charge of using renewable biomass (i.e. any biological resource that can be used as raw material) to deliver and place in the market a full pallet of products with application in different sectors, ultimately creating new jobs opportunities and economic growth. Moreover, within the concept of a *circular economy* where the value of products, materials, and resources should be extended in the economy for as long as possible, the bio-based industry contributes to a better management of current biological resources, thus minimizing waste generation.

Bioindustry mainly use animal fats, vegetable oils (rapeseed oil, palm oil, soybean oil, etc.), sugar and/or starch crops (maize, wheat, sugar beet, etc.), lignocellulosic and algal biomass (wood, straw, sugarcane bagasse, corn stover, seaweed, etc.), and waste-derived feedstocks (brewer's spent grain, the organic fraction of municipal solid waste, residues from the paper and pulp industry, etc.) as bio-based raw materials. Intermediate compounds and other co-products such as glycerol or ethanol are also considered as platform chemicals by these companies. Special attention must be paid to the use of food-derived residues as raw material, since the Food and Agriculture Organization of the United Nations has estimated the production of about 1.3 billion tons/year worldwide (FAO, 2011). Food waste can either be of animal and plant origin and may be converted into a wide range of products such as antioxidants, dietary fibers, essential oils, carotenoids, oils rich in omega-3 fatty acids, or chitosan polymers for biomedical applications (Galanakis 2012; Bastidas-Oyanedel et al. 2016).

Bio-based products traditionally include wood, cork, natural rubber, paper, textiles, and/or wooden construction materials. Notwithstanding, bio-based chemicals, bioplastics, and biofuels are also relevant products, thus covering a long list of **organic acids** (e.g. lactic acid, succinic acid, acetic acid), **alcohols** (e.g. ethanol, lauryl alcohol, furfuryl alcohol), **polymers** (e.g. polyethylene terephthalate, polyhydroxyalkanoate, starch-based plastics), **surfactants** (e.g. glycolipids, sophorolipids, carboxymethyl starch), **solvents** (e.g. isobutanol, ethyl acetate, acetone), **adhesives** (e.g. methacrylates, epoxy resins, tall oil rosin), **cosmetics** (e.g. limonene, xanthan, vanillin), **lubricants** (e.g. isoalkanes, fatty acid methyl esters), etc. (Spekreijse et al. 2019). Moreover, bio-based products can be classified into “drop-in” alternatives, when they are homologous to those obtained from

fossil resources, and novel products, when having new functionalities and potential markets (European Commission 2018).

The most important drivers for the development of the bio-based industry are the economic impact and process sustainability (Nattrass et al. 2016). These drivers include the profitability of the company and the environmental performance of the products. Policy may also be considered a significant driver with a secondary role, although it may become more important in the future. Although it is an important driver, the economic impact exhibits a dual role by representing one of the most prominent constraints at the same time. Major economic constraints include production costs, the availability of funds to invest in production capacity, and the variable feedstock prices. In this context, several countries have launched different national investment programs and public-private partnerships to promote research and innovation as well as cooperation between both academy and industry, such as the European Horizon 2020 program (<https://ec.europa.eu/programmes/horizon2020/en>), the European Bio-Based Industries Joint Undertaking (BBI-JU) action (<https://www.bbi-europe.eu>), the US BioPreferred program (<https://www.biopreferred.gov/BioPreferred>), the US BETO program (<https://www.energy.gov/eere/bioenergy>), the Brazilian BIOEN-FAPESP program (<http://bioenfapesp.org>), the Canadian BIOTECanada (<http://www.biotech.ca>), the Indian BIRAC (<http://www.birac.nic.in>), the Malaysian Bioeconomy Transformation Program (<http://www.bioeconomycorporation.my>), the Bio-industry to expand action of the Chinese 13<sup>th</sup> Five-Year Plan (<http://en.ndrc.gov.cn>), or the Argentinian PROBIOMASA Program (<http://www.probiomasa.gob.ar/sitio/es>) among others.

Besides Europe (EU-28), USA, Brazil, Canada, China, and Malaysia are the global leading countries of the bio-based sector according to the existing production capacity, the planned production capacity, the industrial innovation, and the availability of feedstock (Nattrass et al. 2016). The present chapter is intended to provide a general overview of the bio-based sector, highlighting major industries and the most relevant projects working on in Europe and globally.