Environmental Development ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Environmental Development

journal homepage: www.elsevier.com/locate/envdev

The role of biomass and bioenergy in a future bioeconomy: Policies and facts

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ARTICLE INFO

Article history:
Received 1 December 2014
Accepted 31 March 2015

Keywords:
Bioeconomy
Green economy
Biomass
Bioenergy
Bio-materials
Policies

ABSTRACT

The European Commission has set a long-term goal to develop a competitive, resource efficient and low carbon economy by 2050. Bioeconomy is expected to play an important role in the low carbon economy. This paper provides a review of the policy framework for developing a bioeconomy in the European Union covering energy and climate, agriculture and forestry, industry and research. The Europe has a number of well-established traditional bio-based industries, ranging from agriculture, food, feed, fibre and forest-based industries. This paper proposes an analysis of the current status of bioeconomy in the European Union and worldwide until 2020 and beyond. We estimate the current bio economy market at about € 2.4 billion, including agriculture, food and beverage, agro-industrial products, fisheries and aquaculture, forestry, wood-based industry, biochemical, enzymes, biopharmaceutical, biofuels and bioenergy, using about 2 billion tonnes and employing 22 million persons. New sectors are emerging, such as biomaterials and green chemistry. The transition toward a bioeconomy will rely on the advancement in technology of a range of processes, on the achievement of a breakthrough in terms of technical performances and cost effectiveness and will depend on the availability of sustainable biomass.

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http://dx.doi.org/10.1016/j.envdev.2015.03.006

Please cite this article as: Scarlat, N., et al., The role of biomass and bioenergy in a future bioeconomy: Policies and facts. Environmental Development (2015), http://dx.doi.org/10.1016/j.envdev.2015.03.006

1. Introduction

The European Commission has set a long-term goal to develop a competitive, resource efficient and low carbon economy by 2050 (COM(2011)112 final) (EC, 2011a) and the green economy concept was incorporated into the general framework at different levels of EU policy. According to UNEP (2011), a green economy is defined as ´low-carbon, resource efficient, and socially inclusive', whose overall objective is ´improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities'. It aims at 'getting the economy right' by reducing polluting emissions, increasing resource efficiency, preventing the loss of biodiversity and valuing ecosystem services (UNEP, 2014).

The high-level horizontal strategies have enshrined the green economy concept, the main ones being the Europe 2020s flagship initiatives 'An industrial policy for the globalisation era' (EC, 2011c) and 'Resource efficient Europe' (EC, 2011d). As stated in the former mentioned flagship initiative focused on industrial policy, ´the Commission will work to promote the competitiveness of Europe's primary, manufacturing and service industries and help them seize the opportunities of globalisation and of the green economy´. The objective of the Resource efficient Europe flagship initiative is ´to support the shift towards a resource efficient and low-carbon economy that is efficient in the way it uses all resources. The aim is to decouple our economic growth from resource and energy use, reduce CO_2 emissions, enhance competitiveness and promote greater energy security´. In this sense, policies related to resource efficiency need to be seen as efforts for shifting towards a resource-efficient and low-carbon economy within the global context of green economy transition EC (2011c).

In the frame of the wider concept of green economy, *bioeconomy* vision is centred on the use of renewable raw materials and application of research, development and innovation and industrial biotechnology in sectors such as food, feed, paper and pulp, and biofuels production. In comparison to the environmental emphasis of green economy, the bioeconomy's focus is on new growth opportunities in both traditional and emerging bio-based sectors, while considering global challenges (e.g. raw material supply insecurity) and resource and environmental constraints (IEEP, 2014; EC, 2014). A bioeconomy entails the use of biotechnology on a large scale. The OECD defines *biotechnology* as 'the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services' (OECD, 2014). In the European Commission's approach, bioeconomy covers 'the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy', including both traditional and emerging sectors, i.e. 'agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries' (EC, 2012). This multi-sector perspective of bioeconomy differs significantly from US bioeconomy strategy's exclusive focus on synthetic biology (US, 2012).

In order to set a framework for bioeconomy deployment, the European Commission has put forward the European strategy for building a sustainable bio-based economy as an opportunity to address several challenges, such as food security, natural resource scarcity, fossil resource dependence and climate change, with emphasis on the sustainable use of natural resources, competitiveness, socioeconomic and environmental issues. The policy model brings together several stand-alone policy areas (e.g. climate change, agricultural and industrial policy, R&D and innovation, environmental policy, etc.), as an attempt to provide an integrated response to several broad challenges—i.e. climate change; food and energy insecurity; resource constraints. A number of sectoral policies have been put in place at European level to support the development of a bio-based economy, including for instance the Biodiversity Strategy (EC, 2011b), which makes reference to the maintenance of natural capital as a critical economic asset (Mazza and ten Brink, 2012). In addition, the existing sector policy frameworks —such as agriculture, fisheries, forestry, manufacturing industry, (renewable) energy, transport, transport, water management, etc., already include sufficient elements capable of sustaining the development of green economy in the EU.

As part of a green economy, the bio-based economy plays a key role, being able to replace fossil fuels on a large scale, not only for energy applications, but also for chemicals and materials applications. The

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