

## The emerging bio-economy in Europe: Exploring the key governance challenges

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**Abstract:** The purpose of this paper is to identify, analyse and discuss the key governance challenges for the emerging Knowledge-Based Bio-Economy (KBBE) in Europe focusing on bioenergy, particularly biofuels for transport and the biorefinery concept. This paper is based on a literature review, discussions with European researchers and practitioners, and questionnaires of bioenergy industry associations. The growing bio-economy and bioenergy in Europe face a host of socio-technical issues that comprise a mix of technological, economic, social, political, environmental, regulatory and cultural aspects. More specifically, this research work highlights three key governance challenges of increasing relevance for the bio-economy, including: the important role of public-private networks; city-regions as drivers for the KBBE, especially through climate governance; and consumer-citizens and NGOs as key players in the development of the bio-economy.

**Keywords:** Bio-economy, Bioenergy, Governance, Socio-technical, Sustainability

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### 1. Introduction

The emerging Knowledge-Based Bio-Economy (KBBE) in Europe represents a significant transformation from economic, social and environmental perspectives. In short, the concept of the KBBE can be understood as an economy where the basic building blocks for materials, chemicals and energy are derived from renewable biological resources, such as plant and animal sources [1]. Worth nearly €2 trillion, the existing bio-economy in Europe currently employs around 22 million people across sectors as diverse as agriculture, forestry, fisheries, food, and bioenergy [2]. The increased attention on the bio-economy is being driven by the recent surge in scientific knowledge and technical competences that can be used to harness biological processes for practical applications as well as efforts to reduce greenhouse emissions and dependency on oil and fossil fuels.

Within the KBBE, the focus of this paper is on bioenergy – particularly biofuels for transport and the biorefinery concept (see Box 1). The purpose of this paper is to identify, analyse and discuss the key governance challenges for the emerging bio-economy in Europe. There are two underlying objectives. The first is to investigate different perspectives and understanding of the bio-economy and its key components. The second is to consider the bio-economy in terms of positive and negative impacts as well as drivers and constraints. Overall, this paper begins to explore the complexity of the socio-technical issues (covering technological, economic, social, political, environmental, regulatory and cultural aspects) that surround the bio-economy. It is timely to investigate the role of governance for the bio-economy as a European KBBE strategy is expected to be launched in 2011 [3].

### 2. Approach

The emerging bio-economy in Europe is attracting the attention of a diversity of actors (with different interests and values) since it affects a range of sectors and activities. Furthermore, biofuels for transport (and the biorefinery concept) are under intense debate regarding sustainability issues. In this paper, governance is considered as encompassing complex processes, which involve multiple actors in decision-making and policy-making [4]. This

paper further defines governance in two ways. First, it refers to the different tiers at which governance takes place and the interactions between the tiers, which for Europe is local municipalities, national governments and the EU. Second, it refers to the myriad of networks between public and private actors that shape governance activities.

*Box 1: Bioenergy*

Humans exploit biomass (plant and animal matter) for many purposes. When it is utilized to produce heat, electricity or fuels for transport it is commonly called **bioenergy**. Biomass can be considered as ‘stored’ solar energy because the process of photosynthesis ‘captures’ energy from the sun in growing plants. Utilizing biomass for energy purposes is in fact tapping into the vast energy available from the sun. Bioenergy systems comprise both technical aspects, such as conversion technologies, and non-technical aspects, such as government policies.

**Biofuels for transport** are commonly categorised as follows: first generation biofuels made from food crops, such as wheat and sugar beet; second generation biofuels from non-food biomass, such as lignocellulosic materials; and third generation biofuels from algae. At present only first generation biofuels can be produced on a large-scale. However, the commercialisation of second generation biofuels is expected over the coming decades. The third generation biofuels are in a research and development phase.

The **biorefinery concept** offers exciting potential to better manage and capture value from biomass resources. Similar to petroleum refineries, which produce multiple fuels and products from petroleum, biorefineries imply the integrated production of energy, fuels and chemicals from biomass. Biorefineries have been identified as one of the most promising routes towards the KBBE. While partial biorefineries exist today, considerable research, development, demonstration and commercialisation is required to make advanced biorefineries a reality.

Source: [5]

This research work utilised different research methods to meet the requirements of ‘method’ triangulation, including a literature review, discussions with European researchers and practitioners, and questionnaires of bioenergy industry associations. The World Bioenergy Association (WBA), the European Biomass Association (AEBIOM), the Swedish Bioenergy Association (SVEBIO), the Spanish Bioenergy Association (AVEBIOM), and the Renewable Energy Association (REA) in the UK, which represents bioenergy interests, completed questionnaires. The discussions with informants from a range of sectors and different backgrounds also ensure ‘informant’ triangulation.

### 3. Analysis

#### 3.1. *What is the bio-economy? What are the key components of the bio-economy in Europe?*

Bioenergy industry associations show some diversity in perspectives on the bio-economy. Heinz Kopetz (questionnaire, 18 June 2010) of AEBIOM states: “The bio-economy is a rather new word. It is that part of the economy that relies on energy and raw materials originating from green plants.” Tricia Wiley (questionnaire, 3 September 2010) of the REA points out the UK Biomass Strategy provides a definition of the bio-economy as “economic activities which capture the latent value in biological processes and renewable bioresources to produce improved health and sustainable growth and development”. The UK Biomass Strategy is based on the definition of the OECD [6]. Furthermore, the OECD [6] highlights the important role of biotechnology in the emerging bio-economy (see Box 2).

*Box 2: Biotechnology*

Biotechnology can be understood as the science of using living things to produce goods and services. It therefore involves manipulating and modifying organisms to create new and practical applications. **Industrial biotechnology** or **white biotechnology** uses enzymes and micro-organisms to make bio-based products in a diverse range of sectors, including chemicals, food and feed, bioenergy, paper and pulp, and textiles. **Green biotechnology** is biotechnology applied to agricultural processes. **Blue biotechnology** is a term that has been used to describe the marine and aquatic applications of biotechnology. And finally, **modern biotechnology** is used to distinguish newer applications of biotechnology, such as genetic engineering and cell fusion, from more conventional methods, such as breeding or fermentation.

Source: [6]

Kjell Andersson (questionnaire, 14 June 2010) of SVEBIO states: “I was not aware that there is a concept of an ‘emerging bio-economy’. I think we have a very strong move towards a more sustainable energy system, with more energy efficiency and more renewable energy, which bioenergy is an important component.” Francisco Gonzalez (questionnaire, 4 August 2010) of AVEBIOM states that bioenergy is at the core of the bio-economy. Overall, Kent Nyström (questionnaire, 20 August 2010) of the WBA highlights that the key components of the bio-economy are sustainability in a broader sense including fair competition between energy, food and feed as well as fair competition for water supply and land use. This highlights that sustainability is central to the KBBE but also the challenges of designing and managing the bio-economy.

The concept of the bio-economy has generated considerable ‘excitement’ in Europe and around the world. However, it is immediately apparent that the bio-economy means very different things to different people. A better understanding of the bio-economy and its key components remains a vital foundation for the growth of the KBBE in Europe. Interestingly, the bio-economy is one of the oldest sectors (including all industries and economic activities that produce, manage and exploit biological resources, such as agriculture, food, forestry, fisheries and bioenergy), but it is being transformed into one of the newest sectors. The key components of the bio-economy include biotechnology and the biorefinery concept. Biofuels for transport are a key product and agriculture is the primary source of raw materials.

**3.2. Why promote the bio-economy in Europe? What are the main positive and negative impacts of the bio-economy?**

Not surprisingly, bioenergy industry associations in Europe are largely optimistic about bioenergy. However, there is a strong awareness that supportive policy schemes need to stimulate well-designed bioenergy systems that incorporate strict sustainability standards. Heinz Kopetz (questionnaire, 18 June 2010) of AEBIOM believes that negative impacts will occur if a sustainable production of biomass is not achieved, which includes the fertility of soils and the availability of water, or if more biomass is used than annually produced, and a competition between food and non-food use of biomass takes place. Kent Nyström (questionnaire, 20 August 2010) of the WBA is confident the expanding bio-economy can avoid substantial negative impacts. However, there are challenges ahead for the expanding bio-economy to meet stricter sustainability requirements.

Kjell Andersson (questionnaire, 18 June 2010) of SVEBIO states that the main positive outcomes of the bio-economy are “a more sustainable energy and material system, based on

solar energy and natural processes, instead of depleting finite resources.” Tricia Wiley (questionnaire, 3 September 2010) of the REA suggests there are a number of economic, security and environmental benefits associated with the bio-economy, including job creation as well as investments in industry and deprived areas and communities. Francisco Gonzalez (questionnaire, 4 August 2010) of AVEBIOM argues that the generation of employment opportunities in rural areas and new incomes streams for farmers will be some of the major positive results of the growing bio-economy.

When looking at the positive and negative impacts of the bio-economy a distinction needs to be made between the near-future as opposed to the long-term perspective based on visions. There are diverging visions of the bio-economy from wildly optimistic about an industrial revolution in the coming decades [7] to ‘real’ concern about significant negative impacts, especially related to increasing biofuels for transport [8]. Additionally, the current status of the bio-economy remains unclear, despite studies to define the scale and attributes of the existing bio-economy. Finally, there is growing knowledge related to the biorefinery concept and efforts to speed up the development and implementation of biorefineries in Europe, but there is still great uncertainty about the potentials and impacts associated with biorefineries.

### **3.3. How can the bio-economy expand in Europe in a sustainable and competitive way? What are the main drivers and constraints for the bio-economy?**

The marginal understanding of the bio-economy and the ‘missing’ carbon taxes in many European countries are considered key constraints by some bioenergy industry associations. Heinz Kopetz (questionnaire, 18 June 2010) of AEBIOM states: “The basic principle of the bio-economy lies in the fact that the carbon comes via photosynthesis from the atmosphere and not from the earth’s crust. As long as the depletion of the earth’s crust brings more profit than the use of carbon via photosynthesis the development of the bio-economy will be held back.” There are in fact discussions about carbon taxes across the EU, especially based on the positive experiences from Sweden. In addition to expanding bioenergy, Sweden has also made significant progress on biofuels for transport, especially bioethanol (see Box 3).

#### *Box 3: Bioenergy and Bioethanol in Sweden*

In 2009, **bioenergy** overtook oil as the largest source of energy in Sweden. Oil accounted for 30.8% while bioenergy provided 31.7% of the total energy use. A major reason for the growth of bioenergy in Sweden has been the carbon tax established in 1991. It is based on the ‘polluter pays principle’ in that emitters of CO<sub>2</sub> pay for the costs of CO<sub>2</sub> emissions. The carbon tax makes it profitable to use fossil fuels efficiently and switch to renewable energy. The carbon tax has transformed the energy system in Sweden towards bioenergy.

Over 1,400 of Sweden’s 4,000 service stations offer fuels from renewable energy sources, predominantly **bioethanol**. In addition to economic incentives, service stations (of certain sizes) are mandated by law to provide a renewable alternative. Presently, there are some 4.2 million cars on Sweden’s roads and almost 200,000 are flexi-fuel cars (that can operate on bioethanol, petrol or varying blends). There are economic incentives to purchase flexi-fuel cars, and subsidies and tax reforms make bioethanol competitive with regular petrol.

Source: [9,10]

Kjell Andersson (questionnaire, 18 June 2010) of SVEBIO states: “Strong traditional industries lobbying to preserve their dominance (oil, coal, gas, nuclear) and big ‘sunk costs’ in the existing energy systems make it hard for new alternatives to compete. The fossil energy

systems also do not, in most countries, pay for their full external costs, like damage on the economy, climate costs, and safety and security costs (nuclear).” Francisco Gonzalez (questionnaire, 4 August 2010) of AVEBIOM concurs that the main obstacles for the KBBE arise from the capacity of the oil and gas sectors to lobby political and business leaders. For the UK, Tricia Wiley (questionnaire, 3 September 2010) of the REA suggests that complex and inconsistent regulations, and the perceived risks of policy changes, are constraints for the bio-economy.

The drivers and constraints for the bio-economy are mixed together with challenges (and opportunities). There is also a difference between global and European issues and trends, and more ‘concrete’ drivers or constraints at the national and local levels. Supportive policy schemes and social acceptance by a broad range of stakeholders appear to be key ingredients for the growing bio-economy. A more integrated and strategic policy approach is required to stimulate the KBBE in Europe, which is combined with a strong emphasis on engagement with the general public and key stakeholders. While there is an increased effort on research and development, it is imperative to also fund demonstrations and implementation. There are also many difficult policy decisions to make, especially regarding the sustainable supply of raw materials for the bio-economy [11].

## **4. Discussion**

### **4.1. *The importance of public-private networks***

The bio-economy is critically dependent on policy ‘intervention’ that creates a favourable environment for investment. The type of governance that is shaping the bio-economy in the EU is not liberal or market-based or coordinated and state-led, but it is rather characterised by public-private networks. There is a pattern of combined public and private investments in various parts of the bio-economy, which involves a complex interplay between publicly funded science and business firms, regulated markets, emerging professional groups, attempts to integrate activities across government authorities, and efforts to create positive public attitudes to the KBBE [12]. The development of public-private networks appears to be an essential characteristic of the emerging bio-economy, particularly for the biorefinery concept, which requires significant support and investment.

EuropaBio [13] states that the main challenges in Europe are that a more integrated and strategic approach is needed for the EU to develop a globally competitive bio-economy within the next decade. This paper suggests that such an integrated approach should be focused on long-term opportunities and open to partnerships between public and private actors within the EU (and around the world). For EuropaBio [13] it should involve five key aims, including: improving and securing access to renewable raw materials; supporting targeted research, training and innovation; developing technologies and systems, and bridging the gap between research and markets; stimulating demands for bio-based products; and improving awareness of the bio-economy through communication and educational activities.

### **4.2. *The role of city-regions***

In a European context, many of the policies and strategies that are implemented by local municipalities were formulated by the EU and filtered through national governments. Silvestrini et al. [14] examine the implementation of the Biofuels Directive in Germany, the UK, Italy and Finland by looking at the role of city-regions, namely Berlin, London, Milan and Helsinki. Interestingly, and extremely relevant for the emerging bio-economy, is that networking between city-regions is allowing an exchange of knowledge and experiences, and

contributing to practical and policy learning around the Biofuels Directive [14]. This paper argues that city-regions and local municipalities are well-positioned to play an important role in the KBBE, especially in relation to biofuels for transport.

The scope for action by local municipalities is defined by their jurisdiction and responsibilities, and their financial independence. However, Gupta et al. [15] suggest that local municipalities are often able to establish more ambitious goals and policies than national governments, which is particularly evident in regards to climate governance. Furthermore, the goals and policies of city-regions related to the bio-economy can be framed through climate governance, which can help to mobilise actors and coordinate diverse interests. For the bio-economy, climate governance by local municipalities and city-regions can be an important mechanism to translate abstract visions of the KBBE (often framed by national or international actors) into concrete agendas based on local and regional contexts.

#### **4.3. *The engagement of consumer-citizens***

Creating awareness amongst the general public and key stakeholders about the KBBE appears to be a vital foundation for expanding the bio-economy in Europe. This paper argues that an EU strategy for communication and stakeholder involvement is necessary, which is combined with actions across countries and city-regions. However, it is clear that increased information and communication do not directly translate into public acceptance. On the contrary, the success of the bio-economy will likely depend on active public and stakeholder engagement both in policy formulation and specific projects. Demonstrating the benefits of expanding the bio-economy in parallel with trade-offs to consumer-citizens will be required to create the foundations for the KBBE in Europe [16].

The concept of consumer-citizens can be utilised to shape communication strategies. On the one hand, the bio-economy needs to be marketed to ‘consumers’, and on the other hand, proponents of the bio-economy need to also actively engage ‘citizens’ in planning and implementation processes. Additionally, there is a need to identify and positively engage with target audiences, particularly opinion-formers, such as NGOs, that can influence the general public. NGOs are currently establishing their positions on the KBBE. It can be expected that NGOs will become further engaged as the bio-economy grows. NGOs are likely to be important opinion-formers for the implementation of the biorefinery concept and they are already deeply engaged in debates on biofuels for transport.

## **5. Reflections**

This paper concludes with two reflections. First, serious concerns have been raised about the sustainability of biofuels for transport, which are an integral part of the KBBE. The underlying message is that biofuels only make sense if the raw materials are based on truly renewable and sustainable sources. The European Commission has decided to establish binding sustainability criteria for biofuels, which will become stricter over time. The efforts by the European Commission all point towards increased emphasis on the sustainability for bioenergy generally and biofuels for transport specifically. Furthermore, the biorefinery concept offers the potential to move towards more sustainable production of biofuels combined with other bio-based products.

Second, while sustainability appears to be on the top of the political agenda, it is impossible to measure the sustainability of biofuels, the biorefinery concept or the bio-economy, without taking into consideration the scale and pace of growth. This challenges current thinking and

ideas about the economy. Put simply, the bio-economy cannot replace the fossil-based economy as it is set-up today. On the contrary, the emerging bio-economy demands attention on consumption issues as much as the production side. For example, biofuels for transport must be integrated into broader mobility strategies that encompass more than the introduction of ‘new’ fuels. Ultimately, the move towards a sustainable KBBE is directly connected to achieving sustainable development on a ‘grand’ scale.

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