

Biopathways to Carbon Neutrality – SHORT VERSION

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Introduction

This document provides a review of central EU-level documents concerning the bioeconomy focusing on carbon and climate issues. Other reviews [1-4] were used to support the analysis.

Documents

The EU Bioeconomy Strategy and Action Plan [5-6] was published in 2012. The strategy supports four Flagship initiatives of the Europe 2020 strategy (innovation, resource-efficiency, industrial policy, new skills and jobs) as well as four priorities of the Juncker Commission. The bioeconomy sectors are those supplying biomass as well as those using biomass. Services, both immaterial ones like recreation and the ecosystem services like pollination, are mentioned only in passing. The strategy makes several references to the need to reduce GHG emissions. Bio-based industries are seen as sources of GHG, but are also noted to store important amounts of carbon in their products.

The EU is laying down its **climate policy for the years 2020-2030**, affecting the future bioeconomy operating environment. Three pieces of legislation - currently in the making - are especially of interest: the Effort Sharing Regulation (ESR) [7-9], the Land Use, Land Use Change and Forestry Regulation (LULUCF) [10], and (3) the Renewable Energy Directive. While reducing emissions to meet the targets countries also need to make sure that the consumption share of renewable energy is increased. The **Renewable Energy Directive** [11-13] sets the target of raising the share of renewables to 27% of total EU energy consumption by 2030. The directive sets binding national targets and establishes sustainability and GHG emissions saving criteria for biofuels, bioliquids and biomass fuels.

EU **Biodiversity Strategy** [15] sees protecting biodiversity as a way to speed up the transition to a resource efficient and green economy. Although protecting biodiversity has costs, biodiversity loss is particularly costly for the economic sectors that depend on ecosystem services (e.g., agriculture and forestry). European Parliament [19] has emphasised that protecting biodiversity is an investment that brings great economic benefits and that its protection cannot rely on public funding alone. The Parliament also stresses the need to upkeep carbon sinks, and to combine biodiversity protection with climate change adaptation and mitigation, and expresses concern over the biodiversity losses as a result of e.g., energy use of biomasses in both in and outside the EU.

The **Circular Economy Action Plan** [20] guides Europe's transition towards a circular economy. Priority areas are plastics, food waste, critical raw materials from electronic devices, construction and demolition, and biomass and bio-based products. The bioeconomy is specifically discussed as being significant in providing alternatives to fossil-based products and energy. Circular economy is considered essential in the EU's effort to develop a sustainable, low carbon economy, and has therefore strong synergies with EU's climate objectives.

The CE legislative proposals focus on waste. EC **communication on the role of waste-to-energy** [23] emphasises the waste hierarchy which favours waste prevention, re-use and recycling over energy recovery from waste. Anaerobic digestion of organic waste which results in biogas production and digestate that can be used as a fertiliser is classified in the Communication as recycling rather than energy recovery. A **cascading** use of renewable resources, with several reuse and recycling cycles, is encouraged. **Waste framework directive proposal** [21] includes directions on the collection of biowastes and the reduction of food waste. A new **proposal for regulating organic fertilisers** [22] has the aim of easing the access of organic and waste-based fertilisers to the EU market. **The packaging and packaging waste directive** [24] has the objective of reducing waste. Transition towards carbon-neutrality through substituting fossil-based packaging materials with bio-based alternatives is not yet in the directive. **European Strategy for Plastics in a Circular Economy (draft)** notes that plastics production and the incineration of plastic waste give rise to ~400 million tonnes CO₂ per year (2012), and that plastics dependence on virgin fossil fuel may create problems of security of supply. Bio-based feedstocks are noted to be an important area of development. Biodegradable plastics are a challenge in recycling.

EU **Industrial Policy** has several sector-specific action plans and legislation that supports a wide variety of industrial sectors. Calls have been made to reform some pieces of legislation to better promote the bioeconomy, e.g., **Ecodesign directive** [26-29], **Construction Directive** [30], and EU **Ecolabels** [31, 32]. Further analyses are needed to examine how the EU industrial policy affects the transition to carbon neutral society.

EU **Cohesion/Regional policy** investments complement EU policies dealing with e.g., energy, the environment, research and innovation. Although a systematic review of the funding mechanisms was beyond the scope of this paper, it seems that the carbon neutral circular bioeconomy can be – and sometimes is – encouraged through them. A key initiative to take advantage of regional strengths is the **Smart specialisation** approach that aims to boost growth and jobs by enabling each region to identify and develop its own competitive advantages.

The emissions from energy use in **agriculture** are regulated through the ETS, and those resulting from land use changes in the LULUCF regulation. Dedicated agricultural policy, particularly in the form of the **Common Agricultural Policy (CAP)** has had a minor role. The current CAP measures which are relevant to GHG emissions fall into two groups: decisions about the maintenance of permanent grassland, and decisions about which options to allow as ecological focus areas (EFAs). Recent EC Communication on the future of the CAP [39] argues for a higher level of climate ambition. There are specific references to the bioeconomy: particularly as a sustainable business model, combined with circular economy, the bioeconomy should become a priority for the CAP plans.

The EU does not have a common **Forest Policy**, although forest issues have been addressed in the fields of biodiversity, rural development, industry and climate. The 2013 **New EU Forest Strategy** [25] aims at establishing a framework for forest-related actions. **Rural Development Regulation** [40] provides EU-level funding. In the Strategy, forests are noted to be vulnerable to climate change. Mitigating climate change through the forests' role as sinks and the provision of bio-materials that can act as temporary carbon stores is also noted, as well as the products' use as substitutes that replace fossil-based materials and fuels. The Strategy also notes that forests have multiple uses and that their multifunctional role in delivering goods and services, incl. ecosystem services, needs to be

ensured. The **Staff Working Document** accompanying the Strategy [41] notes that the use of wood for bio-energy may sometimes be the practical first or only option. In addition, as part of a mix of outputs from wood-working plants, bioenergy from wood residues may be sensible.

In the Horizon2020, the current **EU Framework programme for research and innovation**, themes dealing with different aspects of carbon neutrality are included in several societal challenges. The EU also engages in public-private-partnerships of which an important example is BBU JU (**Bio-Based Industries Joint Undertaking**), jointly implemented by the EU and the Bio-based Industries Consortium (BIC). In the next framework program (FP9) the Commission aims to tackle the societal challenges with a mission approach [42]. The transition to a carbon-neutral circular bioeconomy would benefit from an ambitious and concrete mission in the FP9.

Analyses and comments on the current Bioeconomy Strategy, as well as calls for its revision and better implementation have recently been made by both EU bodies and various stakeholders [2, 3, 43-47]:

- 1) **Scope of the bioeconomy** is suggested to be both widened and given more detail. The role of **services** in the bioeconomy should be better understood and advanced. The potential contribution of **cities** and **regions** to the bioeconomy remains largely unexploited.
- 2) There is a need to clarify the role of the bioeconomy with current international initiatives, particularly the **Paris Agreement** and the **UN Sustainable Development Goals**. The contribution of the bioeconomy in combating and adapting to **climate change** should be clearer and given more priority.
- 3) **Coherence** between various EU policies is essential. The Bioeconomy Strategy should be revised to create **circular bioeconomy**. Links to the Energy Union, the CAP, Smart Specialisation strategies, the Common Fisheries Policy, FP9 and EU Forest Strategy should be developed and clarified
- 4) **Sustainability of biomass** needs to be ensured, particularly in terms of life-cycle impacts and biodiversity.
- 5) **Awareness** of the bioeconomy and what it entails is still lacking in the EU.
- 6) Bioeconomy **markets need to be supported** through dedicated policy tools such as public procurement standards. Certification and standardisation of bioeconomy products and processes is called for. A stable regulatory environment is required for the mobilisation of investments.
- 7) **Funding and investments** are needed for fundamental research, applied research, near-to-market activities, and for rolling out solutions to diverse contexts. Investments in integrated bio-refineries are considered to require specific support.
- 8) Non-technological **research** is also needed for finding new concepts, novel business models, and understanding consumer needs. **Education** and training is needed for creating understanding of the bioeconomy and for teaching the various skills needed.
- 9) Better **monitoring and assessment frameworks** are needed to assess the progress, taking into account the ecological, economic and social sustainability and impacts of the bioeconomy. There should be “SMART” (i.e. Specific, Measurable, Attainable, Relevant and Timely) targets and indicators.
- 10) **Sector specific organisations** have also raised issues that are of particular importance to them.

Conclusions

This analysis focussed on carbon and climate issues. Therefore many important aspects of the bioeconomy were excluded, e.g., food security and clean water. Although agriculture and food processing represent a very large share of the bioeconomy in the EU, they have not yet had a very visible role in the bioeconomy efforts from the GHG emission reductions point of view. Therefore they received relatively little attention here. In the future, the role of agriculture in carbon sequestration is likely to increase, as well as the avoidance of food waste and its use as a feedstock for bio-based products.

The bioeconomy has so far been supported particularly through investments and research, much less through legislation. This may change during a revision process, if the UN SDGs, carbon sequestration, biodiversity, circularity and other new priorities are embraced. The bioeconomy is connected to most SDGs, including Good health and well-being, Clean water and sanitation, Affordable and clean energy, Decent work and economic growth, Industry, innovation and infrastructure, Sustainable cities and communities, Responsible consumption and production, Climate action, Life below water, and Life on land.

Hierarchy and coherence of documents

EU strategies are often in the form of Commission communications, and as such are not binding, but they guide and direct the EU legislative work. More detailed legislation in the form of Directives or Regulations are binding. The various documents reviewed in the final section are expressions of opinion, and therefore have the least weight. However, they offer a unanimous view that the Bioeconomy Strategy is important, but it needs to be updated and linked better to important policy agreements, other EU strategies, and sectoral legislation. It is not that the Strategy is in contradiction with them; rather the links have not been developed and clarified enough.

Much work is needed on building the coherence, addressing sustainability, and clarifying the roles of consumers and industry. There is a need to develop the circular economy and the bioeconomy in tandem. In addition to investment and research funding, standards, sustainability criteria and other types of regulation will increasingly be needed to promote the bioeconomy. The situation is also constantly evolving, as new issues and topics emerge. For example, so far the plastics regulation has focussed on packaging, but the recent attention on microplastics has increased the importance of substituting fossil materials with bio-based ones in e.g., textiles.

Scope of bioeconomy

The current Bioeconomy Strategy is limited in scope. Services, ecosystem services, the sustainability of biomass production, and circularity need to be included. There is increasing criticism that the economic dimension of sustainability tends to prevail over social and environmental dimensions [48, 49]. New sectors that have not been widely identified as being relevant to the bioeconomy, such as construction, should also be included in the revision.

A wider group of actors is needed to fulfil the potential of the bioeconomy. These include consumers, cities, regions, the educational and research sectors, service providers, and small-scale biomass producers. The bioeconomy is not only about large-scale industry.

Even the concept of bioeconomy needs clarification. Several definitions exist, and there are parallel concepts, such as bio-based economy and knowledge-based bioeconomy (KBBE). However, all these

concepts and their definitions share the idea of a sustainable economy, in which renewable resources are used in production instead of fossil resources [48, 50].

The EU has so far focused in the bioeconomy policy on investments in research, innovations and skills; reinforcement of policy interaction and stakeholder engagement; and enhancement of markets and competitiveness. Different Member States, regions and sectors have their own foci. For example, Finland has stressed the importance of enhancing markets with e.g., public procurement and tendering, whereas the discussion on the use of cascade principle is weak [48, 50].

The bioeconomy has emerged more strongly in newer documents and the reduction of carbon emissions is a high priority in many present and particularly in future EU policies. However, the exact relation of these two themes is not clear-cut.

Carbon neutrality

The European Union's commitment to climate change mitigation is demonstrated in e.g. the Paris Agreement. Carbon neutrality is a term that has been used to describe a system that has no climate change impacts. However, carbon neutrality is a vague term, and therefore not often used in legislation. It may refer to very significant emission reductions or a situation where the sources and sinks of atmospheric carbon are equal within a production system, country, or the whole globe and within a given time period. EU level documents usually either state quite specific numbers such as emission reduction percentages, or they refer to the climate or need to reduce carbon emissions on a general level.

The bioeconomy can offer solutions to the carbon issue in three ways.

-First, the biomass-producing sectors can upkeep and increase carbon sinks. The new CAP and regulations supporting climate-smart forestry may emphasise this function.

-Second, production of bio-based products having a long lifetime, such as furniture or wooden buildings, may constitute carbon sinks. The cascade principle, waste prevention and sector specific regulations are relevant. Various policy instruments such as economic incentives may be used to encourage increased and prolonged carbon storage in products.

-Third, the bio-based products may substitute non-renewable and fossil-based products, e.g., in chemical industry, packaging, textiles, and energy. Public procurement, various product standards and sectoral policies may be harnessed to increase the markets of these products. It is vital, however, to make sure that the bio-based products really have (significantly) lower GHG emissions over their life-cycle. Sustainability criteria should be drafted for all biomass uses, or carbon impacts could be optimised through comprehensive carbon pricing. It is also vital that the use of bio-based products implements substitution rather than additional production and consumption.

A key problem is that increased use of biomass for production means reduced sinks. There are tradeoffs between the three ways in which the bioeconomy can contribute to the climate challenge. According to global agreements, we need to equalise the sinks and emissions of GHGs, but the richer countries need to be in the forefront of the development. Therefore, it can be argued that the EU should remove more carbon from the atmosphere than it emits. As the EU also imports a great deal of its energy and raw materials, the overall carbon footprint of the Union is larger than that of its own production.

The LULUCF regulation has a no-debit rule and aims for the preservation of the sinks. Increasing the EU sinks is not a target yet.

What are the real tradeoffs of the transition from the fossil economy to the bioeconomy? Could immaterial forms of the bioeconomy replace some of the material forms of consumption? Can forests, for example, be used for multiple uses while increasing the use of wood? What are the actual climate impacts of various biopaths? These questions remain largely unanswered in the current EU bioeconomy discussion.

Contradictions and risks

- Specific contradictions were rarely discovered in the materials reviewed here, as they were often on a general level. For example, the European Parliament [19] emphasises that biodiversity protection is an investment into the bioeconomy. The conflicts are likely to arise when more specific cases are considered: e.g., the implementation of biodiversity goals and biomass retrieval on a particular site, or the calculation methods for carbon sequestration.

- Although the carbon neutrality and the bioeconomy are stated EU objectives, subsidies to fossil fuels continue.

- The carbon sequestration in agricultural lands, forests, and different products is not sufficiently addressed.

- The focus on the bioeconomy has been on industrial processes and material production. Services and ecosystem services are not sufficiently supported. All goods and ecosystem services cannot be reached at once, meaning that conflicting objectives will cause problems when more specific pieces of legislation are designed and debated, or when individual sites and their uses are discussed. Specifically, the multifunctionality of forests is not yet fully embraced.

- The competing uses for biomass as well as the competition between sinks and harvests are inbuilt risks in the bioeconomy.

- A potential risk is related to biological products and circularity, and this emerged in the Plastic Strategy Draft: recycling processes may be hampered by biological and biodegrading materials. It is important to build systems that can fully embrace the recycling of materials and the sustainable disposal of biodegradable materials.

- The EU 2030 climate and energy framework instructs that emission reductions should be obtained in the most cost-effective manner possible. However, there are several factors that may undermine cost-efficiency. First, transfers of emission reduction allocations between countries are constrained in many ways. On the other hand, the constraints work as a safeguard against potential accounting loopholes in specific sectors, and they ensure that that all sectors contribute to achieving the targets. Second, credits for net removals by managed forests (exceeding the reference level) are capped, and for some Member States the caps may be binding. This de-incentivises using forests to obtain additional emission reductions. Third, overlapping targets may increase climate policy costs. For example, the renewable energy target partly dictates the means to reduce emissions. Separate policies promoting renewable energy and energy efficiency may also cause disturbances in the ETS.

- Restrictions regarding the use of logging residues from peatlands may be of special interest from the point of view of the Finnish bioeconomy, considering the high number of forests on peat soils.

- The exclusion of feed crops from accepted renewable energy sources may make it impossible to use grass in Finland as a feedstock for biogas. As grass significantly improves the usability of manure in biogas production, it may hinder biogas development. This would have negative results for the nutrient recycling and organic fertiliser initiatives.
- Currently sustainability criteria have been designed for energy use only.
- The importance of biodiversity to the bioeconomy is not sufficiently included in the current Biodiversity Strategy, but in recent reviews it has been brought up. However, it is not very explicitly discussed that protecting biodiversity means that not all areas can be in economic use and that not all methods of usage can be employed.
- Conflicts may arise if users competing for the same raw materials will be on the same playing field regardless of usage. For example, the acquisition of palm oil for biofuels has been considered problematic for climate, food security, and biodiversity reasons.
- Cascade use is considered acceptable in principle, but conflicts may arise if the cascade use is controlled at EU level, as it may turn out very inflexible, leading to possibly unsustainable solutions, and hampering practices which a Member State considers particularly important. In Finland a central issue is the use of wood or wood components as energy. In addition to the many industrial applications, a large number of Finnish households, farms and SMEs use wood products for heating.
- The focus in the bioeconomy discussion is on production, economic growth and employment. Critical views about consumption and material growth are largely absent. All currently used fossil and other non-renewable resources cannot be replaced with biomass. It is doubtful that even all material and energy efficiency measures together could lead to flows that were reduced enough from current (or foreseeable future) flows that they could be based on renewable sources. Limiting consumption and growth is an environmentally sustainable approach, but it may not be politically feasible yet. Emphasising circularity, waste prevention and energy efficiency alongside the bioeconomy is therefore crucial, and discussion on sustainable lifestyles should be more prominent.

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