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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE
COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE
COMMITTEE OF THE REGIONS**

**EU Bioeconomy Strategy Progress Report
European Bioeconomy policy: stocktaking and future developments**

{SWD(2022) 162 final}

EXECUTIVE SUMMARY

The European Green Deal sets the EU's ambition to become climate neutral by 2050, safeguarding people, planet and prosperity. The transition to a modern, resource-efficient, prospering and competitive economy, in which environment, health and wellbeing are priorities, requires deep and widespread action across all sectors of the economy. By 2022, in light of this new policy context, the European Council asked the European Commission¹ to provide a progress report on the implementation of the EU 2018 Bioeconomy Strategy and to assess whether or not the Strategy and/or its Action Plan requires updating.

The Bioeconomy Strategy, with its systemic perspective, plays an important role in achieving climate neutrality and environmental, economic, and social sustainability.

Bioeconomy encompasses all sectors and associated services and investments that produce, use, process, distribute or consume biological resources, including ecosystem services. As such it is a natural enabler and result of the European Green Deal transformation.

Bioeconomy policies take a **cross-sectoral perspective** to improve policy coherence and **identify and resolve trade-offs**, for example on **land and biomass demands**. Bioeconomy policies contribute to build a bioeconomy addressing all three dimensions of sustainability:

- (1) Environment: management of land and biological resources within ecological boundaries;
- (2) Economy: sustainable value chains and consumption; and
- (3) Society: social fairness and just transition.

The 2018 Bioeconomy Strategy complements sectoral policies and **enables countries and regions to design transition pathways** according to their specific challenges and opportunities, benefitting from a non-prescriptive, integrated and systemic framework.

This Progress Report shows that the **actions** are on track in achieving the main objectives of the Bioeconomy Strategy:

- An **increasing number of national and regional bioeconomy strategies** promote cross-sectoral cooperation and sustainability principles, and invest in bioeconomy innovation.
- **Progress on bioeconomy deployment has been achieved in Central and Eastern European countries**, aided by significant EU funding contributions and the establishment of new fora and networks.
- Mobilisation of private **investments** and **research and innovations** in food and other bio-based industries are increasing and **show promising developments**. Europe has a strong position in the global market for bio-based chemicals and materials.

This review has also identified **gaps in the current Action Plan** that require further action. First, increased focus on how to better manage land and biomass demands to meet environment and economic requirements in a climate neutral Europe. Second, work on more sustainable consumption patterns to ensure environmental integrity.

¹ Council conclusions on the updated EU Bioeconomy Strategy, 14594/19

The **bioeconomy** is now more important than ever to contribute to the **green and fair transition** in Europe. The EU Bioeconomy Strategy has shown to be successful; yet continued implementation of the Action Plan should put an increased focus on better management of biological resources and sustainable consumption patterns.

1. INTRODUCTION

Our current fossil-based economy has reached its limits² and the transition to a new societal and economic model, based on the sustainable and circular use of resources, has become one of the Union's core tasks.

To tackle this challenge the European Commission adopted a Bioeconomy Strategy in 2012³, and updated it in 2018⁴ (see Figure 1). The updated Strategy reaffirmed the five original objectives: (i) ensure food and nutrition security, (ii) manage natural resources sustainably, (iii) reduce dependence on non-renewable, unsustainable resources, (iv) mitigate and adapt to climate change and (v) strengthen European competitiveness and create jobs. These objectives, in line with the targets of the European Green Deal, are now more relevant than ever, following the unprovoked Russian invasion of Ukraine and the need to speed up achieving independence on energy⁵ and to strengthen food security⁶. The **EU Bioeconomy Strategy** enables a green and just transition and **covers all three dimensions of sustainability**: environment, society and economy.

To reach these objectives, the updated Bioeconomy Strategy was accompanied by a targeted Action Plan along three main action areas: (1) strengthen and scale-up the bio-based sectors, unlock investments and markets; (2) deploy local bioeconomies rapidly across Europe; and (3) understand the ecological boundaries of the bioeconomy.

The Council of the European Union recognised the importance of the **bioeconomy as a major component for the implementation of the European Green Deal**⁷ in a Europe of regional diversity. It has asked the European Commission to provide a progress report on the implementation of the Bioeconomy Strategy by 2022, marking the **10th anniversary of the first EU Bioeconomy Strategy**. This document aims to reply to the Council request.

² Statement by Commission President von der Leyen on delivering the European Green Deal, 14 July 2021 (https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_21_3701)

³ COM(2012)60. Innovating for Sustainable Growth: A Bioeconomy for Europe

⁴ COM(2018)673 and SWD(2018)431. A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment.

⁵ REPowerEU: Joint European Action for more affordable, secure and sustainable energy, COM(2022) 108

⁶ Safeguarding food security and reinforcing the resilience of food systems, COM(2022) 133

⁷ Council conclusions (14594/19) on the updated Bioeconomy Strategy "A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment"



Figure 1: Development of the EU Bioeconomy Strategy and structure of this report.

2. WHAT IS BIOECONOMY?

Key messages:

- Bioeconomy is a natural enabler and result of the European Green Deal transformation
- Bioeconomy governance is crucial to maximise synergies and resolve trade-offs
- Bioeconomy policies should be built on all sustainability dimensions: (1) management of land and biological resources within ecologic boundaries; (2) sustainable value chains and consumption; and (3) social fairness and just transition.

The concepts of bioeconomy and of bioeconomy policy have evolved from the first EU Bioeconomy Strategy in 2012⁸, to the updated 2018 Bioeconomy Strategy⁹ (see Figure 1). The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, organic waste), their functions and principles. The EU Bioeconomy Strategy can help to **identify, assess and address trade-offs** between policy targets and competing uses of land, sea and biomass¹⁰ in order to optimise the use of material resources and services, including ecosystem services. This allows to identify **win-win solutions** that generate economic gains, preserve the environment, and increase resilience and capacity for recovery.

Bioeconomy governance is crucial to maximise synergetic effects of sectoral policies¹¹, create a level playing field and to frame coherent sustainability criteria across policy areas. Fostering **interministerial cooperation, policy coherence** and vertical **coordination at local, national, EU and international levels** allows the bioeconomy to fulfil its potential.

Bioeconomy policies help to build a bioeconomy based on all sustainability dimensions¹². They enable all people to **enjoy a 'bio-based' lifestyle**, providing them with bio-based material (food, fibre, bio-based materials, energy) and non-material (clean air and water, biodiversity, climate mitigation and adaptation, recreation) products and services, thus contributing to the objectives of the New European Bauhaus¹³ and its values of sustainability, inclusion and quality of experience.

⁸ COM(2012)60. Innovating for Sustainable Growth: A Bioeconomy for Europe

⁹ COM(2018)673. A sustainable Bioeconomy for Europe.

¹⁰ <https://materialeconomics.com/latest-updates/eu-biomass-use>

¹¹ See recommendations of the Policy Support Facility <https://op.europa.eu/s/vzU7>

¹² In line with the Sustainable Development Goals: <https://sdgs.un.org/goals>

¹³ COM(2021)573. New European Bauhaus: Beautiful, Sustainable, Together.

2.1. Environmental sustainability: Management of land and biological resources within ecological boundaries

By optimising the use of biological resources from land and sea, the bioeconomy maximises **co-benefits**¹⁴, such as production of **biomass**, mitigating **climate change** and enhancing **biodiversity**, while safeguarding and benefiting from **other ecosystem services**. This implies dedicating land and aquatic area to preserving and restoring ecosystems, as well as achieving the targets set out in, for example, the EU Biodiversity¹⁵ and Sustainable Blue Economy strategies¹⁶, the EU's and national Adaptation Plans¹⁷, and regulations on Land Use, Land Use Change and Forestry (LULUCF)¹⁸ and deforestation-free products¹⁹. Nature based solutions and sustainable management of terrestrial and aquatic ecosystems help regenerate natural ecosystems and respect maximum sustainable yields²⁰, safeguard multi-functionality of forests²¹, avoid harmful pollution²², and improve ecosystem resilience.

2.2. Economic sustainability: Sustainable value chains and consumption

Use of biomass and other biological resources obtained from land and sea must fulfil and respect human needs and rights, such as the right to adequate and nutritious food²³ and the right for land managers and primary producers to fair living and working conditions²⁴. The bioeconomy contributes to most of the Sustainable Development Goals (SDGs), among others SDG 2 (Zero Hunger), 12

¹⁴ Co-benefits: The positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors. Co-benefits are also referred to as ancillary benefits. IPCC, <https://www.ipcc.ch/sr15/chapter/glossary/>

¹⁵ For example protection of at least 30 %, and strict protection of 10 % of land and sea areas, https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en

¹⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:240:FIN>

¹⁷ https://ec.europa.eu/clima/eu-action/adaptation-climate-change/eu-adaptation-strategy_en

¹⁸ For example, climate neutrality of the land sectors by 2035 and net GHG sink of 310 Mt CO₂eq yr⁻¹ by 2030. <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52021PC0554>

¹⁹ https://ec.europa.eu/environment/publications/proposal-regulation-deforestation-free-products_en

²⁰ CFP, sustainable blue economy

²¹ COM(2021)572 final. New EU Forest Strategy for 2030

²² EU Zero Pollution Action Plan https://ec.europa.eu/environment/strategy/zero-pollution-action-plan_en

²³ <https://www.ohchr.org/Documents/Publications/FactSheet34en.pdf>

²⁴ COM(2021)102 final. The European Pillar of Social Rights Action Plan.

(Sustainable Consumption and Production), and 13 (Climate Action). **Sustainable consumption patterns**²⁵ ensure wellbeing for all within planetary boundaries.

Bioeconomy policies **boost sustainable innovation**²⁶ and create solutions for sustainable food and bio-based products, bio-based and bio-derived chemicals, advanced biofuels and the bioenergy of the future. Several Horizon 2020, Bio-Based Industries Joint Undertaking and regional projects showcase **industrial modernization** and **sustainable value chains** (SWD Chapter 7). **Resource and energy efficiency** are achieved through principles such as the **circular economy**, the **cascading use**, the **waste hierarchy**, or the **Avoid-Shift-Improve** approach²⁷.

2.3. Societal sustainability: Social fairness and just transition

Bioeconomy policies enable a green and socially fair transition²⁸ by developing sustainable business models²⁹ based on the principles of due diligence and by promoting sustainable trade and social fairness in Europe and beyond. This will reduce disparities, and generate new green jobs in emerging circular, bio-based and food industries and services, adding value to the regional economies. Examples such as the Rhenish coal mining area in Germany (BioeconomyREVIER³⁰) or the Bulgarian Stara Zagora region (BE-RURAL³¹) show that the bioeconomy contributes to **rural and coastal development** and helps a **fair and just transition**.

3. GENERAL TRENDS IN THE DEVELOPMENT OF THE BIOECONOMY IN EUROPE

Key messages:

- National bioeconomy strategies are becoming more numerous throughout Europe
- The main use of biomass is for food and feed; woody biomass is increasingly used
- The cascading principle must apply to the use of all biomass

²⁵ E.g. in line with the New Consumer Agenda https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12464-A-New-Consumer-Agenda_en

²⁶ Supported by actions on carbon removals via carbon farming and industrial solutions, https://ec.europa.eu/clima/eu-action/forests-and-agriculture/carbon-farming_en#ecl-inpage-1624; see also www.bbi.europa.eu/projects

²⁷ Avoid unsustainable and shift to more sustainable consumption, improve production systems elaborated in Creutzig et al., Nature Climate Change, 2021. <https://doi.org/10.1038/s41558-021-01219-y>

²⁸ Proposal for a Council Recommendation on ensuring a fair transition towards climate neutrality, COM(2021) 801 final

²⁹ e.g. the Farm to Fork Strategy's EU Code Of Conduct on Responsible Food Business and Marketing Practices, https://ec.europa.eu/food/system/files/2021-06/f2f_sfpd_coc_final_en.pdf

³⁰ <https://www.biooekonomierevier.de/home>

³¹ <https://be-rural.eu/>

- Important innovations in food and other bio-based industries show the potential of the bioeconomy
- Public involvement in R&I has shown good results so far and should be strengthened

In this section, latest available data from the European Commission's Knowledge Centre for Bioeconomy³² are used to outline the situation of the bioeconomy in Europe. Section 3.1 provides an overview of currently existing national and regional bioeconomy strategies in Europe, while Section 3.2 shows the development of biomass supply and use until 2017. Section 3.3 provides an overview of economic figures of the bioeconomy and outlines the current role of bio-based research and innovation.

3.1. Development of bioeconomy strategies at national and regional level

Successful deployment of bioeconomies depends on local environmental, social and economic potentials and challenges.³³ The 2018 Bioeconomy Strategy Action Plan included specific actions to encourage the adoption, update and coherence of national and regional bioeconomy strategies throughout Europe. Since its adoption, substantial progress has been achieved. There are currently **ten EU Member States** with **dedicated bioeconomy strategies** and **seven EU Member States that are in the process of developing their respective strategies** (Fig. 1, details see SWD Chapter 2.1). Hence, since 2018 three more Member States have developed a national strategy, while five more Member States started the process of developing one.

Many EU Member States are also involved in three macro-regional level initiatives: BIOEAST³⁴ bringing together eleven Member States from Central and Eastern Europe, the Nordic Bioeconomy³⁵, or the Bioeconomy in the Baltic Sea Region initiative.³⁶

The sectorial scope of those strategies generally reflects the scope of the European Strategy. Their actions focus on measures to:

- promote the implementation of principles for cascading use of biomass, circularity, and resource efficiency, investments in bioeconomy research, innovation and market development;

³² <https://knowledge4policy.ec.europa.eu/bioeconomy>

³³ See action on 'Integrated bioeconomy land and sea use assessment' in the Sustainable Carbon Cycles Communication

³⁴ The Central-Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy – BIOEAST – offers a common political commitment and shared strategic research and innovation framework for working towards sustainable bioeconomies in the Central and Eastern European (CEE) countries: Bulgaria, Czechia, Estonia, Croatia, Hungary, Lithuania, Latvia, Poland, Romania, Slovenia and Slovakia.

³⁵ Three Member States: Denmark, Finland and Sweden: <https://www.norden.org/en/bioeconomy>

³⁶ Eight Member States: Germany, Denmark, Estonia, Finland, Lithuania, Latvia, Poland, Sweden, <http://bsrbioeconomy.net/>

- integrate bioeconomy concepts or priorities within existing regulatory frameworks;
- facilitate intra-governmental and stakeholder collaboration;
- promote public procurement of bio-based products, national labels and standards, and actions that enhance knowledge and promote bioeconomy education or training (SWD Table 1).

Furthermore, 28 EU regions³⁷ have in place their own dedicated bioeconomy strategies and another region is in the process of developing one; 69 other EU regions are in the process or have already adopted strategies in which the bioeconomy is one of the key elements and 96 other EU regions have strategies with a minimum bioeconomy content (SWD Figure 1). Sector-specific regional strategies that guide the management of specific biological resources and/or bioeconomy sectors as well as broader, overarching and cross-cutting strategies (on e.g. circular economy, research and innovation, etc.) also exist and support the deployment of regional bioeconomies³⁸.

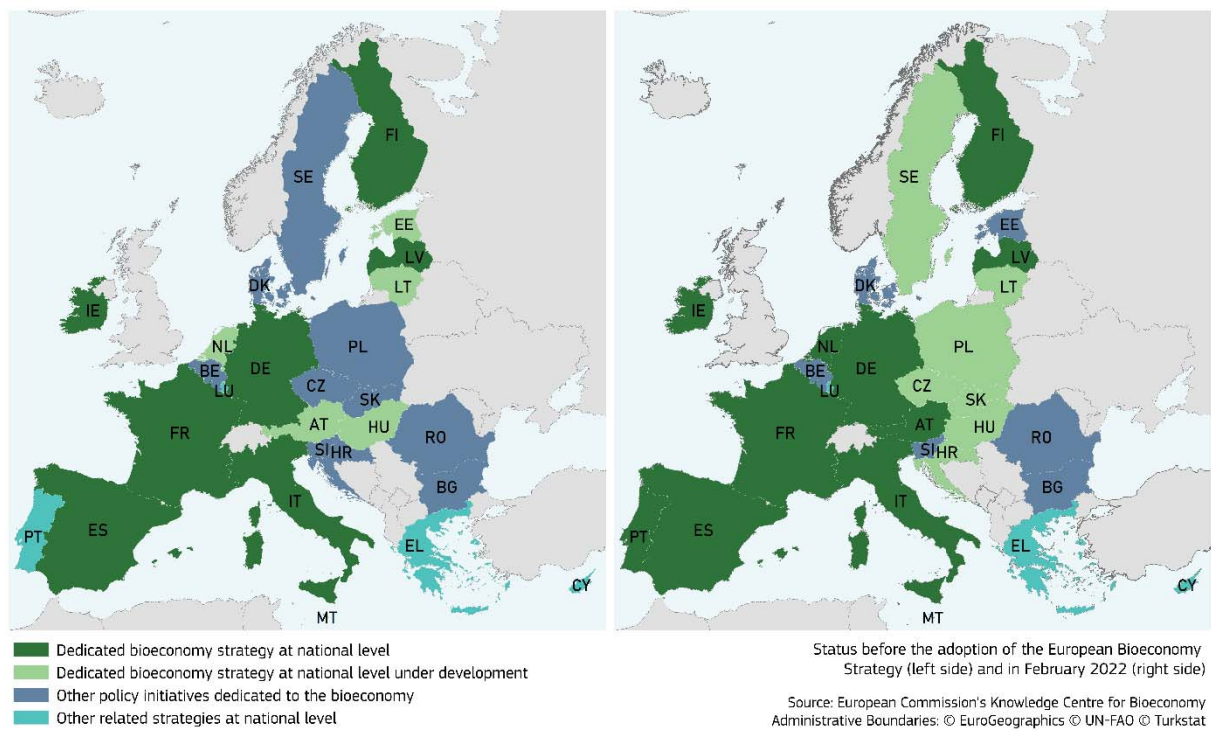


Figure 2. National bioeconomy strategies in the EU before the adoption of the European Bioeconomy Strategy³⁹ (left side) and in February 2022 (right side).⁴⁰

³⁷ At NUTS1, NUTS2 and NUTS3 scale, or a combination thereof.

³⁸ JRC (2022), <https://publications.jrc.ec.europa.eu/repository/handle/JRC128740>

³⁹ SWD(2018)431. A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment

⁴⁰ JRC (2022), <https://knowledge4policy.ec.europa.eu/visualisation/bioeconomy-different-countries>

3.2. Supply, transformation and use of biomass

The EU-27 sources roughly 1 billion tonnes dry matter of biomass per year. This biomass is mainly from the agriculture and forestry sectors, while fisheries and aquaculture supply less than 1 % of biomass dry matter. The biomass used for food purposes amounts to about half of all biomass used in the EU-27 (see Figure 3 and SWD Figure 2).

Approximately 80 % of the biomass produced for food in the EU-27 are destined for animal-based food, while 20 % is plant-based food⁴¹. The increase of the use of biomass in the period 2009-2017 was in the order of 1 % for food and 10 % for non-food purposes over the past two four-year periods of available data (2010-2013 and 2014-2017). Primary⁴² and secondary⁴³ woody biomass use has increased by 25 % and 29 % respectively in the past two decades. Energy-use of woody biomass has increased in the EU by about 12 % over the past two four-year periods of available data (2010-2013 and 2014-2017).⁴⁴

⁴¹ In 2017, approximately 416 M tonnes of vegetal material used for feed and bedding result in a production of 53 M tonnes of animal-based food, of which 23 M tonnes are exported in the form of live animals or animal-based food. In the EU27, 27 M tonnes of animal-based food are available for consumption (46 % fats, 32 % proteins, 13 % carbohydrates and 9 % others) by the population. As for plant-based food, 93 M tonnes (71 % carbohydrates, 12 % fats, 8 % proteins and 9 % others) are available for human consumption. All figures are in net trade terms. JRC (2022), <https://publications.jrc.ec.europa.eu/repository/handle/JRC128384>

⁴² Approximately 551Mm³ Solid Wood Equivalent (SWE) https://knowledge4policy.ec.europa.eu/glossary-item/primary-woody-biomass_en, https://knowledge4policy.ec.europa.eu/glossary-item/solid-wood-equivalent_en

⁴³ Almost 260 Mm³ SWE https://knowledge4policy.ec.europa.eu/glossary-item/secondary-woody-biomass_en

⁴⁴ JRC (2021), <https://publications.jrc.ec.europa.eu/repository/handle/JRC126552>

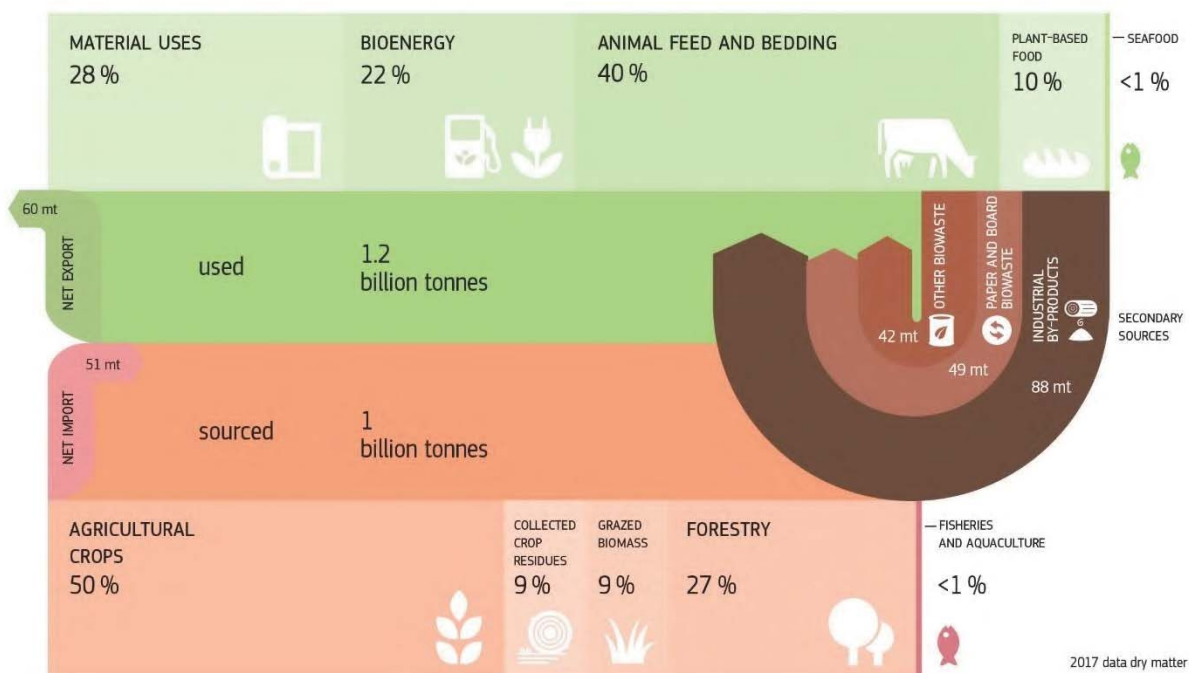


Figure 3. Biomass sources and uses in the EU-27 (based on 2017 data⁴⁵, units in tonnes dry matter)

At least half of all woody biomass used in the EU for energy (49 %), and about 19 % of all woody biomass entering the industrial process for materials, is from secondary sources and post consumer wood⁴⁶. Although the use of the secondary woody biomass emphasises the cascading use of biomass in the forest-based industries, it could be improved by reinforcing the implementation of the cascading principle⁴⁷ and more emphasis on long-lived materials and products, for example in buildings and furniture. Such materials and products can enable the transformation of the built environment into a carbon sink rather than a source of emissions, helping to protect and expand the biosphere, stabilise the climate, and ensure human health and well-being, in line with the New European Bauhaus objectives.⁴⁸ Moreover, in order to improve the circularity of the wood-based

⁴⁵ JRC Biomass Mandate, <https://knowledge4policy.ec.europa.eu/projects-activities/jrc-biomass-mandate>

⁴⁶ JRC (2022), <https://ec.europa.eu/knowledge4policy/publication/forestry-sankey>

⁴⁷ The Cascading Principle as applied to woody biomass, is when woody biomass is used according to its highest economic and environmental value in the following order of priorities: Wood-based products; Extending their service life; Re-use; Recycling; Bioenergy; Disposal.

⁴⁸ European Commission, Directorate-General for Research and Innovation, Schellnhuber, H., Widera, B., Kutnar, A., et al., *Horizon Europe and new European Bauhaus NEXUS report: conclusions of the High-Level Workshop on 'Research and Innovation for the New European Bauhaus', jointly organised by DG Research and Innovation and the Joint Research Centre, 2022,* <https://data.europa.eu/doi/10.2777/49925>

industries, focus should be put on the recovery and reuse of the post-consumer wood (currently 38 Mm³ SWE). In view of increasing biomass demands and a limited sustainable biomass supply, a gap in biomass availability is expected (see Chapter 4).

3.3. Economy, jobs and R&I in food and other bio-based industries

The biomass production and biomass conversion into food, beverage, manufactured bio-based products⁴⁹ and liquid biofuels and bioelectricity represent 8.3 % of the European labour force and 4.7 % of its GDP in 2019 (i.e. 17.42 million workers and EUR 657 billion value added in the EU's post-Brexit sectorial composition) (SWD Figure 3). The bio-based share of about 3 % in EU's domestic chemical market shows an important growth potential⁵⁰ (SWD Figure 4). Europe's **global market share for bio-based chemicals and materials** of about 31 % is twice the one of the fossil-based sector (16 %).⁵¹ The role of **bioeconomy sectors in generating economic wealth has improved** in the past decade (SWD Figure 5) with gains in labour productivity (value added per worker) observed in all countries⁵² (SWD Figure 6). Highest labour productivity was seen in the production of bioelectricity, the manufacturing of bio-based chemicals, pharmaceuticals, plastics and paper.⁵³

The highest **substitution of fossil-based by bio-based chemical products** took place in bio-based solvents, bio-based polymers, bio-based packaging, biofuels and agrochemicals, with comparable production costs to fossil-based products (SWD Table 2). Substitution of fossil-based inputs for chemical platform products and polymers for plastics is currently at low shares with high future potential.⁵⁴ **Biorefineries** at scale could play an important role (see Section 5). Direct and indirect **impacts on local economies** of circular solutions underpinned by biotechnology have been demonstrated by a municipal waste-based nutrient valorisation strategy for agricultural use in Italy, showing that a total added value of EUR 8.5 million and 85 jobs can be generated for every 100,000 tons of sewage sludge turned into fertiliser.⁵⁵

⁴⁹ The term “manufactured bio-based products” refers here to tobacco products, bio-based textiles, bio-based wearing apparels, leather, paper and wooden products, and bio-based chemicals, pharmaceuticals, plastics and rubber.

⁵⁰ JRC (2021), <https://publications.jrc.ec.europa.eu/repository/handle/JRC112989>

⁵¹ JRC (2021), <https://publications.jrc.ec.europa.eu/repository/handle/JRC124141>

⁵² Ronzon et al., 2020, Sustainability. <https://www.mdpi.com/2071-1050/12/11/4507>

⁵³ JRC (2022), <https://publications.jrc.ec.europa.eu/repository/handle/JRC128361>

⁵⁴ Baldoni et al. (2021). Renewable and Sustainable Energy Reviews. <https://doi.org/10.1016/j.rser.2021.110895>

⁵⁵ Tassinari et al. (2021). <https://biomonitor.eu/wp-content/uploads/2022/02/D8.8-Report-on-case-study-The-Bioeconomy-Pilot-from-the-Vanguard-Initiative.pdf>

While the restructuring of European agriculture⁵⁶ dominates the overall size of the work force, growth in the food and other bio-based industries in the EU27 was higher than the primary sectors. The manufacturing of food, beverage, tobacco, bio-based textiles, wood products and furniture, paper, bio-based chemicals, bio-based pharmaceuticals, bio-based plastics and bioelectricity provides 7.92 million jobs with a value added of EUR 433 billion.⁵⁷ The food, beverage and tobacco sector has with 55 % the largest share of value added (EUR 237 billion). An **increasing number of novel food applications**.⁵⁸

Research and development has progressed quickly in the private sector and regressed in the public sector⁵⁹, indicating that the mobilisation of private stakeholders in research, demonstration and deployment of bio-based solutions has been fruitful. However, public involvement in R&D should further strengthen and expand the bio-based sectors, as was successfully done in the **Bio-based Industries Joint Undertaking** (and its successor **Circular Biobased Europe Joint Undertaking**⁶⁰, see Section 5.1, and SWD 1.1 Box 1).

Service activities, such as scientific research and development, digitalisation, logistics, etc., are an important element in a bioeconomy and could more than double the employment and “bioeconomy size”. Studies point to EUR 400 to 1000 billion of value-added generated by bioeconomy-related services in the EU⁶¹, growing between 2005 and 2015 on average faster than the primary production bioeconomy sectors⁶². However, current statistics are not well adapted to provide reliable information. Also, the scope of service sectors (SWD Figure 7) considered in the bioeconomy varies considerably between Member States.

⁵⁶ Agriculture employs 8.83 million workers in Europe, of which 4.41 million in CEE countries (2019 data). JRC (2022) <https://publications.jrc.ec.europa.eu/repository/handle/JRC128361>

⁵⁷ JRC (2022). <https://publications.jrc.ec.europa.eu/repository/handle/JRC128361>

⁵⁸ Kardung & Drabik (2021). *Ecological Economics*. <https://doi.org/10.1016/J.ECOLECON.2021.107146>

⁵⁹ Based on assessing a representative selection of 10 Member States, Kardung & Drabik (2021). *Ecological Economics*. <https://doi.org/10.1016/J.ECOLECON.2021.107146>

⁶⁰ <https://www.bbi-europe.eu>

⁶¹ JRC (2020). <http://publications.jrc.ec.europa.eu/repository/handle/JRC120324>; Cingiz et al., 2021. *Sustainability*. <https://www.mdpi.com/2071-1050/13/6/3033>; Ronzon et al., 2021. *Structural Change and Economic Dynamics*. <https://www.sciencedirect.com/science/article/pii/S0954349X21001375>

⁶² Cingiz et al., 2021. *Sustainability*. <https://www.mdpi.com/2071-1050/13/6/3033>

4. EU BIOECONOMY STRATEGY OBJECTIVES IN THE CONTEXT OF THE EUROPEAN GREEN DEAL

Key messages:

- Europe is generally moving towards the objectives of the EU Bioeconomy Strategy but environmental challenges persist
- There is a need for policy coordination as a consequence of multiple pressures on land from material demand, notably in sensitive labour markets.
- There is a need to transform and re-skill the work force in all parts of Europe for a just transition.
- The continued implementation of the EU Bioeconomy Strategy and Action Plan should focus on the challenges identified.

This chapter aims to analyse whether Europe is moving towards the five objectives of the EU Bioeconomy Strategy. In a second step, these objectives will be matched with relevant initiatives and policies under the European Green Deal.

The **EU Bioeconomy Monitoring System**⁶³ assesses the progress towards a sustainable and circular bioeconomy based on the aspirational principles that guide the EU Bioeconomy⁶⁴ **covering all three sustainability dimensions**. In this framework, the five objectives of the EU Bioeconomy Strategy are broken down into more detailed statements that describe the pathways towards them. Europe's trajectory towards a desired bioeconomy is assessed using specific indicators to measure the progress along these pathways. The trends do not yet reflect the impact of the 2018 EU Bioeconomy Strategy⁶⁵ and are confounded by many other factors⁶⁶.

The trends based on data for the year 2012-2021 show that **Europe is generally moving towards the objectives described in the Bioeconomy Strategy** (see Box 1). However, the trends also show some negative developments. Despite substantial benefits delivered by EU environment and climate policies over recent decades, Europe is facing persistent environmental challenges.⁶⁷ Assessments⁶⁸ reveal that terrestrial and marine ecosystems in Europe are under strain mainly due to direct or indirect anthropogenic stressors, such as pollution, persistent human interventions, and climate change (SWD Figure 8).

⁶³ Knowledge Centre for Bioeconomy: <https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring>

⁶⁴ JRC (2021), <https://publications.jrc.ec.europa.eu/repository/handle/JRC123675>

⁶⁵ The time period assessed was from 2012-2017, conditioned by the availability of data for all indicators.

⁶⁶ Such as weather, climate, other policies etc.

⁶⁷ EEA (2019). <https://www.eea.europa.eu/soer/publications/soer-2020>

⁶⁸ JRC (2021). <https://publications.jrc.ec.europa.eu/repository/handle/JRC123783>; IPCC (2021) Sixth Assessment Report <https://www.ipcc.ch/report/ar6/wg1/>; IPBES (2019) Global Assessment Report on Biodiversity and Ecosystem Services <https://ipbes.net/global-assessment>; Leclère et al., (2020). Nature Reviews. <https://doi.org/10.1038/s41586-020-2705-y>; Bardgett et al., (2021). Nature Reviews. <https://doi.org/10.1038/s43017-021-00207-2>.

Table 1 shows the relationship between the European Green Deal initiatives and the five objectives of the Bioeconomy Strategy. Each initiative puts a focus on at least one objective of the Bioeconomy Strategy (dark green) and supports others (medium green). The assessment does not prejudge the actual impact the initiatives will have. In some cases, links with the objective of the Bioeconomy Strategy are only implicit and the initiative does not address or support it directly (pale green), as a consequence of economic or behavioural feedback effects. In such cases, specific attention is required (SWD Chapter 4 for additional details on the assessment).

Table 1 shows that various trade-offs and challenges need to be addressed: (a) increased **pressure on land for mitigation (carbon sequestration) and adaptation, nature protection (e.g. biodiversity) and supply of biomass**, (b) **increased demands for materials and bioenergy**, and (c) a mismatch between the existing and required work force (e.g. skills) calling for **transforming and re-skilling of Europe's work force**. For example, studies project a **biomass gap** by 2050 of **40-70 %** between sustainable biomass supply and biomass demands for materials, and energy.⁶⁹

The current crisis following the unprovoked Russian invasion of Ukraine clearly shows that Europe requires to increase its independence on energy and to strengthen food security, without leaving the path towards a sustainable, resilient, and fair economy as outlined by the European Green Deal. Holistic and environmentally sustainable production models are needed aiming at maximising synergies and minimising trade-offs to avoid potential additional pressure on natural resources and to develop smart and sustainable solutions. The continued implementation of the EU Bioeconomy Strategy and Action Plan and further actions should focus on these challenges.

⁶⁹ Material Economics (2021). <https://materialeconomics.com/latest-updates/eu-biomass-use>

Box 1. Summary of the assessment of indicators in the EU Bioeconomy Monitoring Framework. The detailed indicators are aggregated according to their position within the hierarchical conceptual framework described in the SWD Chapter 3.

Ensuring Food and Nutrition Security.



The EU is already a highly food secure region and is showing an overall tendency towards increasing food accessibility and utilisation. There are variations from year to year however, due to extreme weather events, and the variability in prices and the economic conditions of families. There are discrepancies in food and nutrition security between countries within the EU

Reducing dependence on non-renewable unsustainable resources, whether sourced domestically or from abroad.



The EU is showing strong⁷⁰ progress in biowaste prevention, re-use/recycling, and recovery, energy efficiency, and consumption and demand for bio-based products. In particular, the EU is improving in overall waste recovery. There is a strong negative trend in material footprint and food loss and waste minimisation for the period 2012-2017.

Mitigating and adapting to climate change.



Climate change adaptation is progressing at a stronger pace than mitigation. Mitigation shows a negative trend due to the decline of the forest sink, partly linked to an increase in harvest, which also includes unplanned harvesting due to natural disturbances and pests.

Managing Natural Resources Sustainably.



The increased land and marine areas designated as “Natura 2000 sites” have pushed the indicator group related to conservation areas to show very positive trends. A weak⁷¹ positive trend is reported for structural and functional ecosystem attributes. Pressures from primary production systems vary. Trends are improving for fisheries, neutral for agriculture and negative for forestry. Environmental quality and species diversity are showing stable trends. Although trends are overall positive for the period 2012-2017, ecosystem condition are still overall quite poor.

Strengthening European competitiveness and creating jobs.



Strong positive trends are seen in the value of raw and processed biomass, value added in bioeconomy sectors and contribution of bioeconomy to economic development. Moderate trends are seen in the overall employment in bioeconomy sectors.

⁷⁰ >+1 % or <-1 % = moderate to strong trend

⁷¹ 0 to +/-1 % = weak to moderate trend

Table 1. Assessment of EU Green Deal initiatives in relation to bioeconomy sustainability objectives. The table shows how the European Green Deal initiatives focus on ('dark green') or support ('medium green') the sustainability objectives of the EU Bioeconomy Strategy or if specific attention is required to maintain overall coherence ('pale green').

		Ensuring Food and Nutrition Security	Managing Natural Resources Sustainably	Reducing dependence on non-renewable unsustainable resources, whether sourced domestically or from abroad	Mitigating and adapting to climate change	Strengthening European competitiveness and creating jobs
Circular Economy	[1]					
Industry Strategy	[2]					
Biodiversity Strategy	[3]					
Farm to Fork Strategy	[4]					
Renovation Wave	[5]					
European Climate Law	[6]					
Chemicals Strategy for Sustainability	[7]					
Adaptation Strategy	[8]					
Sustainable Financing	[9]					
Zero Pollution Action Plan	[10]					
LULUCF	[11]					
Renewable Energy	[12]					
Forest Strategy	[13]					
Sustainable Carbon Cycles	[14]					

[1] COM(2020)98. A new Circular Economy Action Plan. For a cleaner and more competitive Europe. [2] COM(2020)102. A New Industrial Strategy for Europe. And COM(2021)350 final. Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. [3] COM(2020)380. EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Targets include protection 30 % of the land and sea area, strictly protection of 10 % of land and sea area; reverse decline of pollinators; 50 % reduction in the number of Red List species threatened by invasive alien species; significantly reduce by-catch of species; three billion new trees are planted in the EU; aligned to targets of the farm to fork strategy. [4] COM(2020)381. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. Targets by 2030 include 50 % reduction in the use and risk of chemical pesticides and a 50 % reduction in the use of the more hazardous pesticides, hazardous chemicals, nutrient losses, and sales of antimicrobials in farming; 25 % of agricultural area under organic farming. [5] COM(2020)662. A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. See also COM(2021)802 proposal for a directive on the energy performance of buildings (recast). [6] EU(2021)1119. 'European Climate Law'. Targets include by 2030 reduction of GHG emissions by 55 %; achieving climate neutrality by 2050. See also Carbon Border Adjustment Mechanism COM(2021)564 final. [7] COM(2020)667. Chemicals Strategy for Sustainability - Towards a Toxic-Free Environment. [8] COM(2021)82. Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change. [9] COM(2021)390. Strategy for Financing the Transition to a Sustainable Economy and EU(2020) 852. Taxonomy Regulation. [10] COM(2021)400. Pathway to a Healthy Planet for All - EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'. Targets by 2030 include reduce number of premature deaths by air pollution by 55 % and share of people chronically disturbed by transport noise by 30 %; sign. waste generation, residual municipal waste and plastic litter at sea (by 50 %), microplastics released into the environment by 30 %; nutrient losses and chemical pesticides' use by 50 %; EU ecosystems where air pollution threatens biodiversity by 25 %. [11] COM(2021)554. Proposal for amendment of the LULUCF regulation. Target of -310 Mt CO₂eq/yr net greenhouse gas removals in the EU-27 LULUCF sector, with individual targets by Member State. [12] COM(2021)557. Amendment of EU(2018) 2001. On the promotion of the use of energy from renewable sources. Targets of amendment include increased to 40 % share renewable energy, increased sustainability criteria

incl. cascading principle. [13] COM(2021)572. New EU Forest Strategy for 2030. [14] COM(2021)800. Communication on Sustainable Carbon Cycles; including a target of 20 % of the carbon used in the chemical and plastic products from sustainable non-fossil sources by 2030 and announcing an action on Integrated Land Use Assessments.

5. PROGRESS OF BIOECONOMY ACTIVITIES UNDER THE EU BIOECONOMY STRATEGY ACTION PLAN

Key messages:

- Overall implementation of the EU Bioeconomy Action Plan is well on track and has already contributed to the objectives of the European Green Deal.
- Strongest progress has been made in developing bio-based solutions through R&I and increasing public and private investments (action area 1).
- Improved cooperation with Member States and demonstration projects have laid the basis for regional and national bioeconomy deployments, with a focus on less developed countries (action area 2).
- Understanding of ecological limits of the bioeconomy has improved (action area 3). However, gaps remain on how to better manage biosphere use to meet environmental and economic requirements in a climate neutral Europe, and how to promote more sustainable consumption patterns to guarantee environmental integrity.

This chapter summarises the progress made on the **14 actions under three action areas** of the 2018 Bioeconomy Strategy and Action Plan. Most of the activities have medium and long-term processes and will deliver their final results in the future. More details on the actions can be found in the SWD Chapter 5.

5.1. Strengthen and scale up the bio-based sectors, unlock investments and markets

The first action area aims to strengthen and scale-up the bio-based sectors and unlock investments and markets. The actions also promote research and innovation along value chains and improve coordination in innovation activities. Promising innovations⁷² in the bio-based sectors include analytical techniques and bioprospecting, design and engineering of biomolecules, and solutions for more sustainable biomass exploitation.

The **Bio-based Industries Joint Undertaking** (BBI JU, 2014-2021)⁷³ will have attracted private investment of EUR 2.73 billion by 2024 (end of last projects), matched with EUR 835 million support by the EU (details SWD Box 1). The new **Circular Bio-based Europe (CBE) Partnership**⁷⁴ (2021-2031) receives EUR 1 billion EU contribution to further strengthen and scale up the EU bio-based sectors in all stages of the innovation cycle, to be coupled with at least the equal contribution by the private partner, the Bio-based Industry Consortium.

The **Bioeconomy Strategy Accelerator Toolkit**⁷⁵ (BSAT) integrates bioeconomy tools and support material developed within Horizon 2020 project POWER4BIO⁷⁶, e.g. the catalogue of bio-based

⁷² European Commission (2021). <https://op.europa.eu/s/vWEB>

⁷³ EU(560)2014 amended by EU (2018) 121 <https://www.bbi-europe.eu> and Impact Assessment COM(2021) 87

⁷⁴ EU(2021)2085

⁷⁵ See activity 1.1.2 in SWD Chapter 5; <http://bioeconomy-strategy-toolkit.eu/>

solutions⁷⁷. Investment readiness of the EU regions is supported by the Commission through a **Self-Assessment Tool**.

The EU Bioeconomy Strategy intended to facilitate the development of **new sustainable biorefineries** in Europe at scale, to provide emerging applications substituting fossil-based products⁷⁸ (SWD Infographic 1). As also confirmed by an **outlook for biorefineries for 2030 in Europe**⁷⁹, they could play a key role in transforming industrial facilities⁸⁰. More than 300 chemical and material-driven biorefineries are operational in the EU (e.g. see Figure 4, BBI JU flagships and their value chains). For example, there are 139 woody biomass-based biorefineries in Europe, with another 28 planned to double their turnover by 2030. The policies and regulations, especially those taken since 2018, have been pivotal for investment decisions of private companies on biorefineries. However, market access remains challenging due to the lack of a comprehensive regulatory policy approach and the large gap between the current costs of bio-based products and the willingness of consumers to pay.

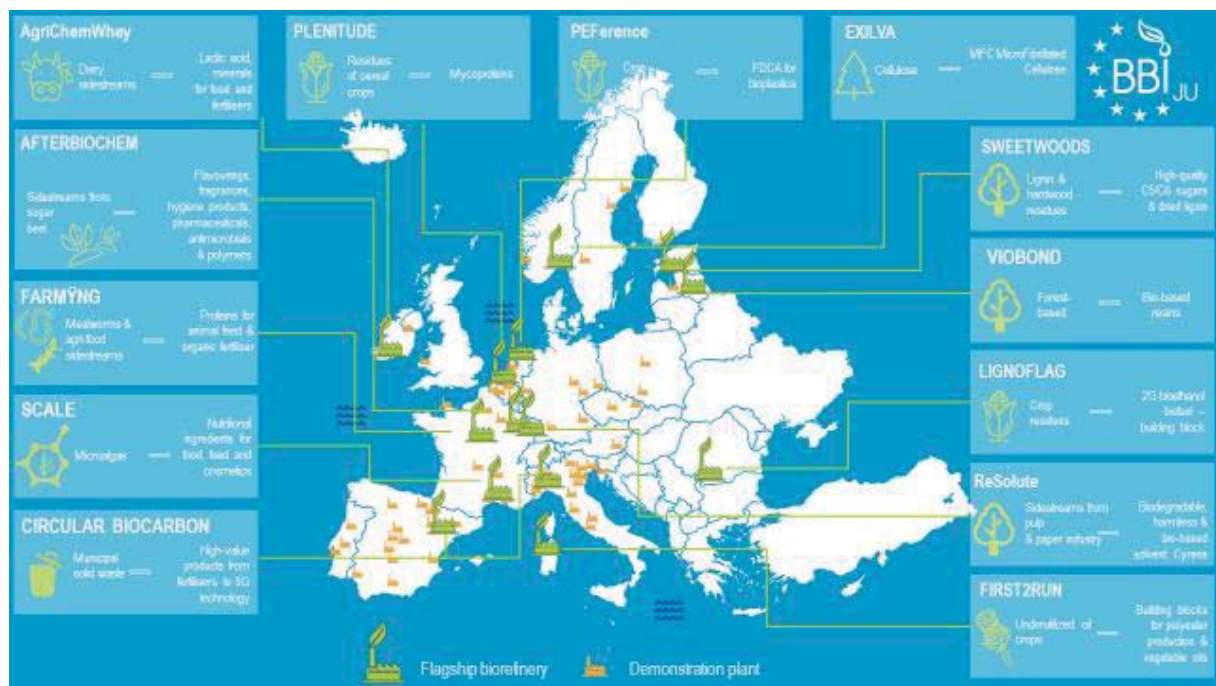


Figure 4. BBI-JU flagship biorefineries and demonstration plants across Europe.

⁷⁶ www.power4bio.eu

⁷⁷ <https://www.bio-based-solutions.eu/#/>

⁷⁸ JRC (2021), https://datam.jrc.ec.europa.eu/datam/mashup/CHEMICAL_BIOREFINERIES_EU/

⁷⁹ EC DG R&I (2021), <https://op.europa.eu/en/publication-detail/-/publication/7223cd2e-bf5b-11eb-a925-01aa75ed71a1>

⁸⁰ JRC (2021), <https://data.jrc.ec.europa.eu/dataset/ee438b10-7723-4435-9f5e-806ab63faf37>

The **Blue Bioeconomy Forum** identified several solutions that have been implemented in the coastal area. The Forum's recommendations have been one of the starting points for the forthcoming EU Algae Initiative, which the Commission intends to adopt in Q4/2022. The algae or shellfish aquaculture can serve as bioremediation tools by removing nutrients, carbon and pollutants from marine waters. The **BlueInvest platform** and the **European Maritime, Fisheries and Aquaculture Fund (EMFAF)** support investment in the broader blue economy including on algae. An increasing number of projects under Horizon 2020 and Horizon Europe, including the mission "Restore our Ocean and waters by 2030" support plastics free seas and oceans and algae related projects.

To unlock investments, the new **European Circular Bioeconomy Fund**⁸¹ is a first venture fund exclusively focused on the bioeconomy and the circular bioeconomy in Europe, providing funding from Horizon 2020 and the European Investment Bank. The fund targets investments of EUR 250 million, with a further EUR 206 million in capital raised by the end 2021. Assessments show uneven distribution of bioeconomy activities among different EU macro-regions and Member States (e. g. distribution of chemical and material biorefineries⁸², investment in the European Circular Bioeconomy Fund⁸³ and insufficient innovation intensity in bio-based sectors⁸⁴), correlating at least to some extent with the innovation performance measured by the European Innovation Scoreboard.⁸⁵

5.2. Deploy local bioeconomies rapidly across the whole of Europe

The European Commission has set up several work streams with Member States to deploy local bioeconomies rapidly across Europe. The **European Bioeconomy Policy Forum** facilitates exchange of knowledge and best practices between Member States for developing and implementing national and regional bioeconomy policies. Collaboration between Member States was facilitated via the **Bioeconomy Policy Support Facility** as a **Mutual Learning Experience**, identifying ten key policy messages⁸⁶ to guide national bioeconomy strategy and/or action plan development. A group of experts conducted the **BIOEAST Foresight exercise** which is the first of its kind in the region and raised awareness of the importance of investing in specific research and innovation and in national bioeconomy development programmes.⁸⁷

⁸¹ Launched in December 2019, <http://www.ecbf.vc/team>

⁸² See activity 1.5.1 in SWD Chapter 5

⁸³ See activity in SWD Chapter 5

⁸⁴ CBE Partnership - IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a Council Regulation establishing the Joint Undertakings under Horizon Europe European Partnership for a Circular Bio-based Europe {COM(2021) 87 final} - {SEC(2021) 100 final} - {SWD(2021) 38 final}

⁸⁵ ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en

⁸⁶ EC DG R&I (2021), <https://op.europa.eu/en/publication-detail/-/publication/2cf89630-e2bc-11eb-895a-01aa75ed71a1/>

⁸⁷ https://bioeast.eu/wp-content/uploads/2021/10/BIOeast-Report-2021_FINAL_compressed-1.pdf

Several pilot actions to support coastal, rural and urban bioeconomy development demonstrate the bioeconomy's potential on the ground and **have been supported** through various EU instruments, such as the Common Agricultural Policy (CAP), the European Regional Development Fund (ERDF), the European Maritime and Fisheries Fund (EMFF), LIFE, the Innovation Fund, and Horizon 2020 and Horizon Europe with their partnerships (the BBI-JU and CBE) and missions (e.g. soil and ocean missions). To improve synergies and complementarities between EU initiatives, regional policies and their instruments, further investments in infrastructure are needed to tap the biomass potential.⁸⁸ A project on a strategic deployment agenda will address the fragmentation in the research and innovation landscapes, and strengthen interactions and complementarities between initiatives, instruments and policies.

The new **CAP** includes the bioeconomy explicitly under one of its specific objectives. The new CAP allows Member States to set out interventions adapted to their local realities to promote the development of the Bioeconomy in rural areas, providing the possibility to move from individual projects to a more systemic approach and supporting primary producers in their efforts to innovate and drive the bioeconomy.

EU structural funds remain significant financial contributors to bioeconomy deployment, including the European Maritime, Fisheries and Aquaculture Fund that has committed EUR 36 million to the blue bioeconomy.⁸⁹

Horizon 2020 project HOOP received EUR 7.9 million as a EU contribution to support a pilot group of European cities to attract EUR 51 million of investments for the implementation of urban circular bio-based economy strategies, creating additional jobs and recycling/reducing waste.

In 2021 the European Commission established the **Circular Cities and Regions Initiative**⁹⁰ that will provide further support to circular bio-based economy projects at local and regional scale through demonstrations and project development/technical assistance.

Mainstreaming of bioeconomy relies on the next generation. Young people are important knowledge multipliers and ambassadors. Successful deployment also demands a workforce that is well-equipped for the shift towards better sustainability and circularity.⁹¹ As activity under the EU Bioeconomy Strategy and in line with SGD 3, the Commission launched a study to explore the **development of bioeconomy educational and training content**.

5.3. Understand the ecological boundaries of the bioeconomy

In the third action area the European Commission's Knowledge Centre for Bioeconomy builds the knowledge base on key issues, for example on sustainable biomass supply and demand and guidance

⁸⁸ See activities 1.1.1, 1.1.2, and activity 2.2.1.1 in SWD Chapter 5

⁸⁹ Additionally, the Technical Support Instrument provides additional support to design and implement reforms in EU Member States in the context of EU priorities such as the green and the digital transition.

⁹⁰ https://ec.europa.eu/info/research-and-innovation/research-area/environment/circular-economy/circular-cities-and-regions-initiative_en

⁹¹ Action: 2.4 - Promote education, training and skills across the bioeconomy

on how to manage healthy and resilient ecosystems in the bioeconomy⁹², and the development of a Europe-wide monitoring system⁹³ to assess the environmental, social and economic sustainability of the EU Bioeconomy (see Chapter 4). The forest information system for Europe (FISE) provides access to forest related data and acts as a motor of new harmonised forest information. The mapping and assessment of ecosystem services (MAES) provides information on the condition of terrestrial, freshwater and marine ecosystems as data foundation for future assessments and policy developments.

Major initiatives are being adopted to set up living labs accelerating the transition to agroecology and to increase the understanding of microbial biodiversity and to develop microbiome-based solutions. Living labs are also developed in the context of the EU mission “A soil deal for Europe” to re-establish soil fertility. To further deepen our understanding of microbiome solutions and applications, the Commission collaborates with international partners via a dedicated working group under the EU-led **International Bioeconomy Forum**.⁹⁴ An EU-wide pollinator scheme is being developed. The new European co-funded biodiversity partnership Biodiversa+ includes as one of its objectives support for biodiversity monitoring, including an EU Pollinator Monitoring Scheme (EUPOMS).

Overall, the activities under the third action area have contributed to a better understanding of the ecological limits of the bioeconomy. Yet, more work needs to be done in order to move from a better understanding towards a better implementation of the bioeconomy within the planetary boundaries. Knowledge gaps remain on how to better manage biosphere use to meet environmental and economic requirements in a climate neutral Europe, and how to promote more sustainable consumption patterns to guarantee environmental integrity.

6. UNLOCKING THE OPPORTUNITIES OF THE BIOECONOMY

Key messages on possible future directions of the EU Bioeconomy Strategy:

- The implementation of the EU Bioeconomy Strategy needs to be strengthened for the European Green Deal
- Many activities have been successful and should be strengthened
- Future implementation of the actions of the bioeconomy will focus on understanding further the trade-offs on land-use and contribute to a consumption-based bioeconomy

6.1. Stakeholders' view

Feedback received from Member State experts, members of the European Bioeconomy Policy Forum as well as from external stakeholders show a positive perception of the EU Bioeconomy Strategy with its Action Plan. Numerous complementary activities are taking place at national and regional level

⁹² European Commission (2022), <https://data.europa.eu/doi/10.2779/946677>

⁹³ Knowledge Centre for Bioeconomy <https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring>

⁹⁴ <https://bioeconomy-forum.org/>

(SWD Chapter 6). However, the feedback also identified further needs **to better respond and contribute to the new policy context since the adoption of the European Green Deal** and related initiatives, such as:

- A **stronger focus on sustainability** assessment and sustainable management and use of biological resources⁹⁵, e.g. by **addressing relevant trade-offs** and excessive consumption.
- A **broad multi-stakeholder engagement**, strong engagement of citizen and young people.
- A strengthened and comprehensive evaluation and monitoring system.
- **Socio-economic aspects** such as the impact on the local population and resource price.

6.2. Strengthening successful activities of the 2018 Bioeconomy Strategy Action Plan

Mirroring the views of our stakeholders and based on the findings of the assessment in Chapter 5, we have identified successful activities that could benefit from further engagement.

Transforming and re-skilling of Europe's workforce to be able to work in emerging bio-based value-chains, and ensuring and monitor the **quality of jobs**, remains a crucial task to advance a **socially fair and green transition** in various regions of Europe. **Research and innovation** have been the driving force for the successful development of bioeconomies from the beginning and will continue to be so. **People-centered** and **regional development** remains a core objective of bioeconomy policy.

The BBI JU and R&I breakthroughs have demonstrated the huge potential of the bio-based industries. Yet, a **stronger leverage for bio-based materials and products** must create an even playing field on the market, enhance innovation and co-operation with private sector initiatives, and stimulate start-up creation within industry ecosystems. Building on the European Circular Bioeconomy Fund, further investments are needed to overcome the particularly large “valley of death” in bioeconomy innovations, caused by **lack of financing** to transfer knowledge into innovations and **lack of a long-term policy pull**.

Further, **new standards, labels and the environmental footprint of circular bio-based products** remain an important issue and could also help to inform citizens.⁹⁶ Diversifying bio-based value-chains to meet the challenges of environmental sustainability calls for **more holistic policy in industries⁹⁷ and research**.

The successful deployment of the bioeconomy needs **improved bioeconomy stakeholder engagement** at all levels, in order to bridge policy work with local realities.⁹⁸ An important cornerstone of this engagement will be the collaboration with Member States through the **European Bioeconomy Policy Forum**. The Bioeconomy Policy Support Facility recommended Member States to

⁹⁵ In line with the findings of the CBE Partnership Impact Assessment, COM(2021) 87; SEC(2021) 100; SWD(2021) 38

⁹⁶ See activity 1.6.1 in SWD chapter 5

⁹⁷ For instance CEPI Biorefineries Vision 2030: https://www.cepi.org/wp-content/uploads/2021/11/Future-Mill-Concept-2030_17.11-1.pdf

⁹⁸ See activity 2.2.2 in SWD chapter 5

update their national bioeconomy policies in light of new objectives and policy developments. Tailor-made advice or assistance particular in support for Member States under the **BIOEAST initiative** could be made available through dedicated activities under the European Bioeconomy Policy Forum. Equally, international cooperation should be strengthened, for example under the International Bioeconomy Forum (IBF), in support of global sustainable development.

While the activities under the action areas 1 and 2 of the 2018 Bioeconomy Strategy Action Plan progressed well, more attention is needed for action area 3. A key activity is the continuation of the EC's **Knowledge Centre for Bioeconomy** and its **Bioeconomy Monitoring System**⁹⁹, to increase understanding of the ecological boundaries. Better understanding of potential synergies and trade-offs of technology and policy options through **integrated assessments of policy changes** on the whole socioeconomic and environmental system is needed, accounting for interlinkages and feedback effects, also to increase resilience in times of trade disruptions, as seen during the early times of the COVID-19 crisis.

6.3. Additional focus needed on some key aspects of the bioeconomy strategy

To meet the high stakes and ambitions of the European Green Deal it is essential to ensure **environmental integrity** and to close the projected '**biomass gap**' between supply and demand of **biomass for food, materials and energy**. While the three action areas of the 2018 EU bioeconomy Strategy aim to close this gap, additional focus should be given to resolve multiple pressures on land for mitigation, nature protection and supply of biomass. Also, a better understanding of overall consumption of biological resources is needed to help shifting to more sustainable consumption patterns.

6.3.1. Focus on resolving multiple pressures on land and sea

An additional focus in the implementation of the EU Bioeconomy Strategy Action Plan on achieving socio-economic and environmental sustainability¹⁰⁰ can enable bioeconomy policies to optimise the societal benefit from land, aquatic area and biological resources, including biodiversity and other ecosystem services. In line with the action area 3, *Understanding the ecological boundaries of the bioeconomy*, an **integrated bioeconomy land use assessment** has already been proposed as an action in the Communication on Sustainable Carbon Cycles.¹⁰¹ This action and further focus on the activities of action area 3 of the EU Bioeconomy Strategy will provide the basis for reducing pressures on land and sea. The development of **territorial biomass strategies** from terrestrial and aquatic systems, as proposed by Member States, such as Germany, will further help to ensure the comprehensive integration of policy needs, resources availability, and innovation. In this way, potential conflicts can be identified, e.g. if the supply of sustainably produced biomass in a region is insufficient with regard to the biomass demand for food, materials and energy. On the European level, a **conceptual framework for resolving** such **trade-offs** could be explored, taking into account regional, environmental, technological, and skill needs and opportunities. Such a framework could be

⁹⁹ Knowledge Centre for Bioeconomy https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring_en

¹⁰⁰ Rockström et al., 2021, <https://www.pnas.org/content/118/38/e2115218118>

¹⁰¹ COM(2021)800. Sustainable Carbon Cycles.

based on the work of Johan Rockström and his biosphere stewardship model¹⁰², and must include an **economic valuation for the continuous or improved provision of ecosystem services** such as clean air, water replenishment, biodiversity, carbon sequestration and storage, or recreation. This could also help developing **sustainable and inclusive business models** that empower primary producers and other rural and supply chain actors, and turn climate and environmental challenges into opportunities, enhance and diversify incomes, and create skilful jobs. **Safe nature-human interfaces** for healthy ecosystems, animals and people according to the OneHealth principle, must be further ensured.

6.3.2. *Focus on the overall consumption of biological resources*

Based on the holistic approach of the bioeconomy, and in line with action area 2, *Deploying the bioeconomy rapidly across Europe*, **consumption patterns** need to become more **sustainable** to guarantee environmental integrity, as technological solutions alone are not able to close the gap between sustainable supply of biological resources and demand. With additional focus on the **total demand for biological resources**, more **sustainable consumption choices** based on true costs could be better assessed and measured. Demand-driven bioeconomy action can trigger high **investments in sustainable bioeconomy businesses** and drive the sustainable transformation of regions and Member States.

7. CONCLUSION

Following the unprovoked Russian invasion of Ukraine, the need to enhance the transition towards both clean energy and sustainable, resilient, and fair food systems has never been stronger and clearer. Future implementation of the EU Bioeconomy Action Plan will have to take into account the implications on food and energy prices, as well as prices of energy-intensive products, and global supply chains, and address resulting additional pressure on natural resources within ecosystem boundaries.

A **strong EU Bioeconomy Strategy** with a focus on all three dimensions of sustainability contributes to achieve the goals outlined in the European Green Deal. Progress of the 2018 updated Bioeconomy Strategy is promising and encourages to continue and further strengthen various activities. However, to in order to fully exploit the strength of the Bioeconomy Strategy, additional efforts are needed, especially with regard to further actions on resolving multiple pressures on land and sea and on the overall consumption patterns of biological resources.

¹⁰² We need biosphere stewardship that protects carbon sinks and builds resilience:
<https://www.pnas.org/doi/10.1073/pnas.2115218118>