



Expert Group Report

Review of the EU Bioeconomy Strategy
and its Action Plan



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Expert Group Report

Review of the EU Bioeconomy Strategy and its Action Plan

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CONTENTS

EXECUTIVE SUMMARY	4
INTRODUCTION	7
1 BACKGROUND	9
1.1 Definition of Bioeconomy	9
1.2 Objectives and Expectations of the Bioeconomy Strategy and Action Plan	9
2 ASSESSMENT OF THE ACTION PLAN.....	13
2.1 Methodology	13
2.2 Results of the Assessment of the Implementation of the Action Plan	14
2.2.1 Summary of Results.....	14
2.2.2 Overlaps between Actions	16
2.2.3 Recommendations to the European Commission for Specific Actions and Sub-actions	17
2.3 Main findings of the Assessment of the Implementation of the Action Plan	19
2.4 Impact of the Strategy and Action Plan.....	20
3 REVIEW OF THE BIOECONOMY STRATEGY AND ACTION PLAN	22
3.1 Analysis of STRENGTHS and WEAKNESSES of the EU Bioeconomy Strategy	22
3.1.1 Strengths of the Strategy and Action Plan	22
3.1.2 Weaknesses of the Strategy and Action Plan	23
3.2 Overall Review of Bioeconomy Strategy and Action Plan	24
3.3 The Bioeconomy and Blue Growth.....	30
4 BIOECONOMY AND CIRCULAR ECONOMY	31
4.1 Definitions and Relationship between the Bioeconomy, Cascading Use and Circular Economy.....	31
4.2 Overlap between the Bioeconomy and Circular Economy.....	33
4.3 Differences between the Bioeconomy and Circular Economy.....	34
4.4 Contribution of the Bioeconomy to the Circular Economy	36
4.5 Limits of Cascading Use and Bio-based Circular Economy.....	37
5 CONCLUSIONS	39
6 RECOMMENDATIONS FOR THE BIOECONOMY STRATEGY AND ITS ACTION PLAN	41
7 LIST OF ANNEXES	44

EXECUTIVE SUMMARY

The European Commission's (EC) Communication "Innovating for Sustainable Growth – A Bioeconomy for Europe" launched a Bioeconomy Strategy¹ in 2012, and the accompanying Staff Working Document provided a detailed Action Plan².

This review by the Expert Group found that **significant achievements were made during the implementation and addressing major societal challenges**, especially through Research and Innovation (R&I), including the end of Framework 7 and more especially Horizon 2020. There is evidence of **major investments in research, innovation and skills**, for example the Blue Growth projects, the Rural Renaissance projects, Marie-Sklodowska-Curie Actions (MSCA) and *Erasmus Mundus*. There is also **significant reinforcement of policy interaction and stakeholder engagement**, for example the stakeholder panel and the stakeholder conferences. The **progress in policy implementation and enhancement of markets in the main bioeconomy sectors is clearly demonstrated**, for example by the successful establishment of the Bio-Based Industries Joint Undertaking (Public-Private Partnership).

The review of the Bioeconomy Strategy is not a formal evaluation under the Commission Better Regulation³ guidelines **but a partly-quantitative and qualitative assessment of the progress of the 2012 EU Bioeconomy Strategy**. The **timeframe for the review was rather short**, less than 5 years after the adoption of the Strategy (2012-2016), which limited the analysis of the impacts as some of the impacts (e.g. jobs, turnover, policy coherence) will only become evident in the future. Nevertheless, **an indication of the progress is that several Member States have developed or are developing national bioeconomy strategies and action plans**, albeit with some differences that mainly reflect national and regional priorities. This shows the **potential of the bioeconomy as a unifying agenda**, at the Member State level, the regional level (e.g. through INTERREG), the EU level and the global level (e.g. with respect to COP 21 Paris Agreement and Sustainable Development Goals, 2015).

The main positive and negative findings are summarised in the table below. Wherever possible, these are placed adjacent to each other for comparison.

Positive Aspects	Negative Aspects
Several EC Directorates-General (DGs) (Research & Innovation, Agriculture & Rural Development, Enterprise & Industry, Environment, Maritime Affairs & Fisheries) participated in the adoption of Bioeconomy Strategy and Action Plan.	Not all relevant DGs were included (e.g. DG Energy was not included). The commitment and involvement of DG's in the implementation phase is heterogeneous, this may be because the Action Plan does not define which DG's are to lead and contribute and in what governance and accountability framework.
The cross-cutting vision of the bioeconomy is multidimensional and comprehensive. Multi-disciplinary and cross-sectoral knowledge is generated.	The interconnection and cross-cutting aspects were partially lost in implementation, probably due to the fragmentation into 54 sub-actions.
The Bioeconomy Observatory (BISO) was established and now replaced by the Bioeconomy Knowledge Centre. SCAR has formed a Strategic Working Group Bioeconomy.	Monitoring data for assessment of the bioeconomy is insufficient.
Stakeholder engagement increased. Creation of Bioeconomy Stakeholder Panel . Increased role of stakeholder-based conferences and activities focused on the bioeconomy, which make policy development more socially inclusive and visible.	

¹ COM (2012) 60: "Strategy for Innovating for Sustainable Growth: A Bioeconomy for Europe"

² SWD (2012) 11 final

³ http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

The Bioeconomy Action Plan is relevant for science-based EU directives and links to EU policy (e.g. Blue Growth Strategy, RED, WFD, MSFD, CAP, CFP).	The sub-actions in general do not refer to the policies. Exceptions (good examples) are sub-actions 7.1, 9.8.
Member States are developing bioeconomy strategies.	Involvement of Member States is uneven, approaches differ.
Links to regional policy and regional programmes (e.g. BONUS, BLUEMED, Atlantic).	
Links to new international policy such as the Sustainable Development Goals 2030 and the COP 21 Paris Agreement.	
The EU is a global leader in bioeconomy research in supporting technology developments, platforms and private actors, as well as establishing links across bioeconomy-related industries. International cooperation with China, Africa has increased. Participation in the Global Bioeconomy Forum.	
The overall level of implementation of the Action Plan is good . Excellent implementation of a number of sub-actions, for example A1.6, A9.8, A10.1, A11.7.	The implementation of the Action Plan is not always coordinated nor homogeneous. There is no evidence of activity for some sub-actions, for example A3.2, A4.3, A8.2.
Several MSCA and Erasmus Mundus programmes linked to the bioeconomy.	Capacity building activities maybe insufficient to meet the needs of a highly skilled workforce. This could be addressed with specific MSCA and Erasmus Mundus actions.
The setting-up of the public-private partnership BBI JU is one of the most successful actions implemented. The BBI JU is a world leader in upscaling bio-based demonstration projects. Increased private sector funding and investment.	
The bioeconomy involves many different value chains on land and the sea, traditional and emerging with high potential for sustainable growth.	The diversity and varied potential of the bioeconomy value chains have not been fully highlighted in the Strategy, especially in relation to the blue bioeconomy.
The 2012 Bioeconomy Strategy already anticipated concepts of sustainability, ecosystem services and circularity (cascading use).	Links, synergies and coherence between the circular economy and the bioeconomy not fully developed.

The main conclusions are:

- **The Bioeconomy Strategy is still highly relevant**, even more in the current context (SDGs, Paris Agreement).
- **The bioeconomy and the circular economy are different but highly complementary** concepts, for example the 2012 EU Bioeconomy Strategy has anticipated circularity principles (cascading use of biomass, bio-waste).
- There is a future potential in a **sustainable, circular bioeconomy**.
- There is future potential in **the marine bioeconomy**, for example the development of sustainable aquaculture and use of waste from sea-food processing.

- Bioeconomy developments should be carefully assessed in order not to compromise **ecosystem services** and **health** (use of waste streams).
- **The Strategy and its Action Plan should be revised and updated for optimised delivery.**

The main **recommendations** on **drafting an updated Bioeconomy Strategy and Action Plan** are that it should follow the **Better Regulation Guidelines**⁴ and specify the logical link between the objectives and the actions. It should also contain a monitoring framework thus allowing a quantitative review to be made.

- **Inconsistencies** in definitions and use of terminology were detected in the Bioeconomy Strategy⁵ and in the detailed Action Plan⁶.
- The **definition** of bioeconomy should be clearly specified, taking into account the legitimate diversity of this term used in different countries and concepts such as ecosystem services;
- The **objectives** of the Strategy need to be clearly **stated and updated** for an optimised delivery in the current context;
- The Bioeconomy Strategy should include clear **priorities, objectives, targets, indicators and milestones** to allow monitoring, assessment and evaluation;
- The Action Plan could be streamlined, to meet specific targets relevant to the current socio-economic and political context. The Action Plan should include **fewer, focused actions** and remove overlaps, replacing these with specified links.
- The synergies with the **circular economy** should be specified and developed, noting that the original Bioeconomy Strategy anticipated the circularity principles as applied to the biological components.

Recommendations with respect to future implementation:

- The implementation needs **better coordination** between the EC services between different yet interconnected policies;
- The implementation should **involve the different actors in the governance framework** (European regions, Member States, European Parliament, Council);
- The implementation should **involve the public and private stakeholders and civil society organisations.**

There is great **potential** in a sustainable, circular bioeconomy. Specific applications could contribute to deliver energy and food security, better nutrition, new materials, less contamination, less GHG emissions, sustainability, adaptation and mitigation to climate change. However, it is unrealistic to expect that all these will be resolved by the bioeconomy alone; lifestyle, dietary and food choice behaviours must also play a role.

Nevertheless, there are **risks** that should not be underestimated and carefully assessed. These include competing uses of biomass (e.g. food-fuel), land use change and loss of habitat, or those that lead to more emissions. Hence, it is important to emphasise and assess sustainability, **ecosystem services**, biodiversity and habitat.

The challenge is to find the optimum mix and level of deployment. This could be achieved through harnessing biological processes and bio-based solutions without compromising ecological function, recognising and boosting ecosystem services to **work with nature** rather than merely exploiting nature.

Finally, the whole bioeconomy is greater than the sum of its parts. However, the strength of the bioeconomy is only that of its weakest link.

⁴ SWD(2015) 111 final - http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

⁵ COM (2012)s60: "Strategy for Innovating for Sustainable Growth: A Bioeconomy for Europe"

⁶ SWD(2012) 11 final

INTRODUCTION

The European Commission (EC) adopted a Communication on "*Innovating for sustainable growth: A Bioeconomy for Europe*"⁷. This was accompanied by a Commission Staff Working Document⁸ including a detailed Bioeconomy Action Plan. The Action Plan specifies that the Strategy and Action Plan shall be reviewed and updated at mid-term. The review furthermore responds to the Circular Economy package⁹ and the June 2016 ENV Council Conclusions¹⁰, which requested that the EC "*examine the contribution of bioeconomy to the Circular Economy and update the Bioeconomy Strategy accordingly*".

After 4 years, the EC initiated this review to assess implementation and the impact of the Bioeconomy Strategy and Action Plan. The EC selected and appointed a panel of experts¹¹ to provide this review and provided them with appropriate Terms of Reference (ToR).

Based on these Terms of Reference, the two **main objectives** of this review are to:

- (1) Analyse the Strategy by evaluating actions implemented, projects financed, achievements and impacts so far;
- (2) Examine the current and future contribution of the Bioeconomy Strategy and bioeconomy generally to the EU circular economy objectives.

The expert group assessed the progress and delivery of the EU Bioeconomy Strategy and Action Plan (BSAP) implementation. The experts made a very detailed analysis and assessment of the implementation of the 12 Actions of the Action Plan and the 54 sub-actions. This is provided in the annex 1 and summarised in the report.

The experts reviewed the strength, weaknesses and impacts of the Strategy in the development of the bioeconomy. In addition, the experts examined the current and future contribution the Bioeconomy Strategy can make to the EU circular economy objectives.

Based on the findings of the review, the experts made **recommendations for the update and revision of a Bioeconomy Strategy and Action Plan**.

The review also considered the interaction between the Bioeconomy Strategy and other relevant policy initiatives such as the discussions on the future of the Common Agriculture policy, the review of the EU Forest Strategy, the Action Plan on the recently adopted "*Action Plan for nature, people and the economy*", the progress under the Energy Union (in particular the proposals for the recast of the Renewable Energy Directive and the Regulation on Land Use, Land/use Change and Forestry), as well as funding programmes such as European Fund for Strategic Investment (EFSI) and European Structural and Investment Funds (ESIF).

The review also coincides with other exercises such as the Standing Committee on Agricultural Research (SCAR) position paper on Bioeconomy Strategy, the mid-term review of Horizon 2020¹², preparations for the next framework Programme, the Interim Evaluation of the BBI¹³, the Joint Research Centre (JRC) Bioeconomy Report 2016¹⁴, and the Review of the Blue Growth Strategy¹⁵. The review report focuses on the Terms of Reference. However, the experts also identified aspects that went beyond the strict remit during the review process, in particular in the recommendations. These additional parts are included in the Annexes for completeness, while the body of the report concentrates on the tasks in the Terms of Reference.

⁷ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>.

⁸ Accompanying Staff Working Document: SWD/2012/0011 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2012:0011:FIN>

⁹ COM/2015/0614 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614>

¹⁰ <http://www.consilium.europa.eu/en/press/press-releases/2016/06/20-envi-conclusions-circular-economy/>

¹¹ <http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3479>

¹² Interim Evaluation of Horizon 2020. SWD(2017) 221 final -

[https://ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd\(2017\)221-interim_evaluation-h2020.pdf#view=fit&pagemode=none](https://ec.europa.eu/research/evaluations/pdf/archive/h2020_evaluations/swd(2017)221-interim_evaluation-h2020.pdf#view=fit&pagemode=none)

¹³ Interim Evaluation of the Bio-based Industries Joint Undertaking (2014-2020) operating under Horizon 2020 - Roland Wohlgemuth, Lucia Gardossi, Tiina Pursula, Danuta Cichocka, Erick Vandamme, Alistair Reid. Doi: 10.27777/557859

¹⁴ JRC 2016 Bioeconomy Report DOI 10.2760/20166 (online)

¹⁵ Report on the Blue Growth Strategy: Towards more sustainable growth and jobs in the blue economy SWD (2017) 128

The review is structured into 7 parts and additional annexes.

- The 1st section presents the contextual **background** in which the Bioeconomy Strategy was developed.
- The 2nd section briefly explains the **methodology** followed by the expert group during the review and then presents the **summary assessment** of the implementation of the Bioeconomy Action Plan, corresponding to objective (1).
- The 3rd section is the **review of the Bioeconomy Strategy** and impacts.
- The 4th section addresses objective (2), the contribution of the bioeconomy to the **circular economy**.
- **Recommendations** are provided in the 6th section.
- Finally, references, a glossary, as well as additional and detailed information are provided in the **Annexes**.

1 BACKGROUND

This first, contextual background section addresses two main questions:

- What is the definition of bioeconomy?
- What were the objectives and expectations of the European Commission?

1.1 Definition of Bioeconomy

There are various definitions of the bioeconomy concept, which emphasise different aspects often from a sectoral point of view. There is also an overlap of terminology with other related concepts such as the bio-based economy. A glossary of terms related to the bioeconomy is provided in the annex. The expert group found **several implicit definitions but no clearly stated explicit definition**, either in the Communication or in the staff working document.

- The communication states (COM): The bioeconomy encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy."¹⁶
- The staff working document (SWD) includes the following statement: "The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnical and energy industries"¹⁷.
- FP7 specific programme defined the bioeconomy as "the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products and bioenergy". This is almost the same wording as the Communication.
- Another definition used by the EC, for example in presentations, states: "The Bioeconomy encompasses those parts of the economy that uses renewable biological resources from land and sea to produce food, biomaterials, bioenergy and bioproducts".

A clear, explicit and updated definition of the bioeconomy concept is needed as the basis for a shared policy agenda. This could include concepts such as Ecosystem Services, health and nutrition as well as Sustainable Development Goals.

1.2 Objectives and Expectations of the Bioeconomy Strategy and Action Plan

The **aim** of the Bioeconomy Strategy and Action Plan document as specified in the Communication as follows: "...**aim** to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection". There follows what appears to be a **mission statement**, to "inform research and innovation agendas in bioeconomy sectors and contribute to a more coherent policy environment, better interrelations between national, EU and global bioeconomy policies and a more engaged public dialogue"¹⁶.

The objectives are not clearly stated as such in the Communication. There is a section on "Tackling societal challenges" (Section 1.2¹⁶), but **it is unclear whether these are the objectives of the Strategy**. Furthermore, **the Societal Challenges do not correspond to the Societal Challenges in Horizon 2020**, although there are overlaps, and this is a source of confusion.

The document includes a statement about the focus of the Strategy (p12 SWD) "**three large areas: the investment in research, innovation and skills, the reinforcement of policy interaction and stakeholder engagement and the enhancement of markets and competitiveness in bioeconomy sectors**", but **it is unclear whether these areas are the objectives of the Strategy**.

A passage in the SWD(p16) states "**One of the major objectives of the Bioeconomy Strategy is to contribute to achieving the full potential of the bioeconomy by providing the knowledge base for a coherent policy framework and promoting relevant innovation activities, thereby giving specific support to markets and policies related to the bioeconomy**". No other objectives are referred to in this passage, although the text alludes to more than one objective. There is also a statement (p33

¹⁶ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>

¹⁷ Accompanying Staff Working Document: SWD/2012/0011 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2012:0011:FIN>

SWD) “The Bioeconomy Strategy includes a set of **objectives** and actions”, but these **objectives are not specified**. The text continues on the same page “The detailed Action Plan below describes the Commission’s actions for the implementation of the Bioeconomy Strategy **objectives**”, but once again these **objectives are not specified**.

The section on scenarios (p42 SWD) states that “four scenarios will allow for identification of the most efficient one to achieve the **objectives**”, but these are not stated. Further on (p46 SWD), there is the mention “**objectives** of increasing efficiency, production and jobs in market activities of the bioeconomy as well as improving health, social and environmental conditions, expanding the provision of non-market services and related employment”¹⁸, but does not refer to where these objectives come from.

In conclusion:

- **The aim of the Strategy is clearly stated;**
- **There is no clear statement of objectives;**
- There is mention of “societal challenges” that could be interpreted as objectives. However, this is confusing, as these do not correspond to the Horizon 2020 societal challenges;
- The actions are subdivided into “areas” that could also be interpreted as objectives.

This lack of clarity also makes it challenging to structure the report. The experts have reviewed the 12 actions to assess the implementation.

Expectations: This section sets the historical context and the expectations of the EC at the time of drafting the Bioeconomy Strategy and Action Plan. A brief overview of the historical setting, in which the Strategy was devised, is necessary to understand the current assessment within the changing geopolitical context. The Bioeconomy Strategy was a response to the projected population growth of 9 billion, with severe consequences for the viability of the biosphere at the global scale (p3 COM¹⁹).

The EC Bioeconomy Strategy and Action Plan was developed in the context of the [Europe 2020 Strategy](#), which considers the bioeconomy to be a key element for the sustainable, smart and green economic growth of Europe, while comprehensively addressing **societal challenges**: ensuring food security, managing natural resources sustainably, reducing dependence on non-renewable resources, mitigating and adapting to climate change as well as creating jobs and maintaining European competitiveness

The context related to these societal challenges is summarised in the following sections. The expectations are mentioned here and in more detail in the review of achievements (section 3.2 of this report).

Ensuring food security: The projected increase in global population and the middle class would significantly increase the demand for food and protein. Food security and nutrition is about feeding an increasing population of 9 billion by ensuring that there is enough, safe and nutritious food available and accessible for all.

The main expectations with respect to ensuring food security were:

- Knowledge base for a sustainable increase in primary production;
- Changes in production and consumption patterns;
- Healthier and more sustainable diets;
- Reduce food waste.

Managing natural resources sustainably: Unprecedented and unsustainable exploitation of natural resources leads to continued loss of biodiversity (p2 COM²⁰). EU agriculture provided more than 40% of total OECD food production values and the EU had an 18% share in world food exports, worth € 76 billion (p19 SWD²¹). The expected increase in world food demand by 2050 and a steep increase in the demand for biomass for industrial purposes would cause a supply reaction of EU agriculture, as one of the suppliers to global agricultural markets.

¹⁸ Accompanying Staff Working Document: SWD/2012/0011 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2012:0011:FIN>

¹⁹ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>

²⁰ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>

²¹ Accompanying Staff Working Document: SWD/2012/0011 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2012:0011:FIN>

Population needs sometimes exceed the productive capacity of the ecosystems and lead to scarcity of food and energy. Such limits²² have been reached many times and in many localities in the past. They have caused societies to collapse, but sometimes have been overcome by developing new techniques and processes. Modern industrial society overcame these constraints through the use of fossil fuels that allowed mechanisation, the application of synthetic fertilisers, in particular nitrogen, and changes in land-use. Even with the considerable improvements of productivity, agriculture had to expand to meet demand and remained the main cause of deforestation and biodiversity loss. These developments allowed food production to increase with population, but also resulted in food production becoming dependent on fossil fuels, contributing to global greenhouse gas emissions and nitrogen pollution. In this way, humans have increased both the number and the intensity of uses of the biosphere.

The main expectations with respect to managing natural resources sustainably were:

- Smart, sustainable production of biomass;
- Reduce and reverse environmental degradation, loss of ecosystem services and biodiversity;
- Implementation of an ecosystem-based management approach;
- Sustainable use of natural resources, resource efficiency and alleviation of stress on the environment;
- Smart, sustainable farming, fisheries and aquaculture.

Reducing dependence on non-renewable resources: The EC Bioeconomy Strategy was preparing for the transition to a post-oil era, when oil scarcity would have economic consequences. It was also a partial solution to decrease the dependence of Europe on fossil fuels such as coal, oil and gas for energy security. Oil prices were extremely high (150\$/B at the beginning of 2008) and decreased to 40\$/B by the end of the year. The price rose to 120\$/B in 2012 and fell again to 30\$/B in 2016. Such instabilities were a threat to European growth. The Russo – Ukrainian conflict threatened the supply of energy to Europe. For the first time, Europe was feeling the reality and the precarity of a dependence on Russian oil and gas.

Europe identified the need to become a low carbon society, based on resource efficient industries, bio-based products and bioenergy. This would decrease the vulnerability of Europe's economy, which arises from its heavy dependence on fossil resources, while maintaining competitiveness. The questions centred on the pace of energy transition and the choice of the new energy sources. From the different kinds of available possibilities, biomass and its transformation into bioenergy and especially liquid biofuels was preferred. If bio-based chemical and biomaterial production is also taken into consideration, demand for biological resources becomes even more challenging. Solar and wind energy, as well as geothermal, wave and tide, were therefore a more long-term solution.

Also, relevant for the political context surrounding the adoption of the Bioeconomy Strategy were the negotiations on the international climate change regime post the first commitment period for the Kyoto Protocol, which at EU level concretised in the adoption of the energy-climate legal package in 2009, with the 20-20-20 political objectives.

The main expectations with respect to reducing dependence on non-renewable resources were:

- A low carbon society, where resource efficient industries, bio-based products and bioenergy all contribute to green growth and competitiveness;
- A diverse energy sector (e.g. biofuels, biomass, as well as wind, solar, wave, tide...);
- Bio-based materials (e.g. bio-plastics);
- An increased market uptake of bio-based value chains and;
- Development of new industrial processes and bio-based value chains, new bio-based material as well as to support and foster market players (e.g. SMEs).

Mitigating and adapting to climate change: The Bioeconomy Strategy was also set in the context of climate change. Climate variability and changes in rainfall (drought/floods) and temperature would impact European agriculture. The bioeconomy would contribute to a decrease of Greenhouse Gas (GHG) emissions and climate change mitigation by using biomass instead of fossil carbon. This is favoured by the methodological accounting of biomass related emissions. The

²² Malthus, T. An essay on the principle of population, Malthus, 1798 (1st ed.)

emission factor of wood burning is higher than that of coal. It is nevertheless assumed to be '0' in the Energy GHG sector, so long as it is accounted under 'harvest' in the Land use, land-use change and forestry (LULUCF) sector.

The main expectations with respect to mitigating and adapting to climate change were:

- A low carbon economy by 2050;
- Increased carbon sequestration in agricultural soils, sea sediments, forests;
- Reduced use of fossil fuels from improvements in efficiency and partial substitution with renewable energy, including biofuels;
- Reduced emissions by all sectors and from the diversification of energy sources;
- Climate resilient primary production systems such as the development of plant varieties that are more resilient to climate change.

Creating jobs and maintaining European competitiveness: The Bioeconomy Strategy was developed from 2010 to 2012, in a context of uncertainty of the world economy. The 2008 financial world crisis increased the debt of the Member States and the fragility of the banking sector, leading to new rules to insure bank stability. Fortunately, the historically low interest rates limited the weight of the debt service, so it was not necessary to reduce drastically public expenditures and cripple economic growth.

The main expectations with respect to creating new jobs and maintaining European competitiveness were:

- New industries such as bio-based materials, bioenergy and bioproducts²³;
- Capacity building and training to prepare a highly skilled workforce;
- Creation of 130,000 jobs and €45 billions in added value (p13 of SWD) ;
- Industrial competitiveness and opportunities for SMEs was expected from direct and indirect private and public investments.

Other expectations: The cross-cutting nature of the bioeconomy was seen to offer a unique opportunity to comprehensively address interconnected societal challenges (section 1.2 of COM²⁴). The Strategy had backing from a broad selection of the EU DGs, namely DG Research, DG Agri, DG Growth, DG Environment, DG Energy and DG Mare. This was an important achievement and provided a good starting point for cross-cutting implementation. However, **the interconnection and cross-cutting nature of the bioeconomy seems to have been lost in implementation.** Nonetheless, aspects of the bioeconomy in the Strategy and Action Plan document contribute to other H2020 Societal Challenges such as Health, demographic change and wellbeing; secure, clean and efficient energy; and Climate action, environment, resource efficiency and raw materials.

In conclusion: The Bioeconomy Strategy was expected to improve the knowledge base and foster innovation for producing quality biomass at competitive prices, without compromising food security, increasing pressure on primary production and the environment, or distorting markets in favour of energy uses. The Bioeconomy Strategy would promote a shift towards a wide, bio-based society capable of resolving the energy and waste problem. It would also contribute to stabilise current and future biomass availability, reduce competition between biomass uses, provide alternative renewable resources, and contribute to climate change mitigation. The Bioeconomy Strategy was expected to develop an international (global) shared understanding of sustainable use of biomass and best practices to open new market opportunities, diversify production and address long-term energy and food security issues.

²³ <https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html>

²⁴ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>

2 ASSESSMENT OF THE ACTION PLAN

The questions to be addressed in the assessment are:

- 1) Has there been progress on the implementation of the Action Plan?
- 2) What are the impacts of the Bioeconomy Strategy and Action Plan?

There are two parts to the assessment and review. The first is to **assess the implementation of the Bioeconomy Action Plan**, action by action. The second is to **review the impact of the Bioeconomy Strategy**. To perform these tasks;

- 1) Each **action** of the Bioeconomy Action Plan was assessed by evaluating projects and actions implemented.
- 2) The Bioeconomy Strategy and Action Plan were reviewed for the achievements and **impacts** to 2016.

2.1 Methodology

The following methodology was proposed by the experts in the progress report (February 2017) and accepted by RTD.

Allocation of tasks: The experts reviewed the Action Plan in plenary and indicated which actions they could best contribute to, based on their expertise. In addition, each expert indicated for which action (s) they would coordinate the assessment.

Activities: The EC provided the experts with a list of activities related to the Action Plan.

Indicators: The Strategy and Action Plan did not include either indicators or targets. The experts therefore analysed the individual actions to suggest possible indicators of implementation and impact. The experts compiled a list of indicators, data needs and possible data sources and sent these to DG RTD (end of February 2017) for approval. The list of indicators is in Annex 2.

Data sources: Internal and external information was provided by the Commission, including information from the Joint Research Centre, the Bioeconomy Observatory and that used as a basis for the upcoming Knowledge Centre. The experts also requested the Commission-based secretariat to organise interviews with selected actors, used to retrieve additional or missing information on selected topics.

Time periods: Two time periods were generally agreed to for the comparison of the “before” and “after” the Bioeconomy Strategy, 2008-2012 and 2012-2016.

Scoring: The scorings of the implementation and/or impacts of the actions and sub-actions were done by individual experts based on their individual assessment, according to a common system agreed during one of the initial group meetings. Group consensus on the scoring was not sought amongst the experts, since the level of expertise varied in the group with respect to different aspects of the bioeconomy and actions analysed. Nevertheless, comments were invited at the last meeting of the experts on ‘low scoring’ actions and sub-actions.

Review: The expert group provided early versions of the report to the EC for internal review, review by Standing Committee for Agricultural Research (SCAR) and review by Inter Service Group (ISG). Presentations on the progress of the report were also made to ISG on May 6th and June 20th, and SCAR on June 1st, 2017 to invite discussion and feedback. Review comments were also received from some Member States. Experts corrected factual errors pointed out in the feedback and addressed feedback whenever possible. However, not all comments were incorporated to keep the report short and balanced.

2.2 Results of the Assessment of the Implementation of the Action Plan

The SWD Action Plan (p33) states that “*The Bioeconomy Strategy includes a set of objectives and actions to be taken at EU and MS level*”²⁵. However, **no concretely defined objectives are stated in the Communication**²⁶, which refers more broadly to societal challenges.

There are 12 actions in the SWD Action Plan²⁵:

- Coherent policy refers to actions 5,6,2 and 8;
- Investment in research, innovation and skills, refers to actions 3,11, 1,2 and 4;
- Participative governance and informed dialogue with society, refers to actions 2,5 and 12;
- New infrastructures and instruments refer to actions 10, 7, 11.

The SWD (p12) states that the focus of the Strategy is on **3 large areas** “*three large areas: the investment in research, innovation and skills, the reinforcement of policy interaction and stakeholder engagement and the enhancement of markets and competitiveness in bioeconomy sectors*”²⁵.

The detailed Action Plan was developed to maximise the impact of the bioeconomy research and innovation. This plan was to contribute to a coherent policy framework, increase in research investments, development of bio-based markets and better communication with the public. The Action Plan contained 12 main actions (54 sub-actions) that the EC put forward for the implementation of the EU Bioeconomy Strategy. In the detailed Action Plan, the 12 actions are placed in 3 groups that correspond to the **Areas** identified above in the Strategy: Investment in research, innovation and skills (A1-A4); Reinforced policy interactions and stakeholder engagement (A5-A8); and Enhancement of markets and competitiveness in bioeconomy (A9-A12).

For the review, the experts analysed the implementation of the Action Plan according to the 12 actions and 54 sub-actions and provided an overview of strength and weaknesses.

2.2.1 Summary of Results

The Action Plan is subdivided into 12 actions, each with several sub-actions, a total of 54. For each sub-action, the experts used one or more indicators to assess the implementation. **The SWD Action Plan did not specify targets, indicators and milestones**, therefore it was not possible to carry out a quantitative assessment. Furthermore, due to the variable availability of suitable parameters, in some cases only one indicator was used to assess an individual action, and in other cases more than one. Some actions have many sub-actions, e.g. Action 11, which has 10 individual sub-actions, while some actions only have a few, e.g. Action 4 which has only 3 individual sub-actions. Since the Action Plan does not specify a method of aggregation, this also makes a quantitative assessment difficult. Finally, some sub-actions are minor in comparison to others, however since the major sub-actions are not prioritised in the Action Plan, they cannot be ‘weighted’ in the assessment.

For these reasons, the assessment was only semi-quantitative and it was decided by the experts in consultation with the EC that the assessment would be given on a qualitative scale of Excellent (score = 5 out of 5) implementation to Bad/None (score = 0 out of 5) with associated colour coding and symbols. An example is given in Figure 2.1.

Despite the methodological difficulties to assess the BSAP, **the experts could identify a good level of implementation of the Action Plan, with a median across all scores of 3/5.**

The details of the assessment are provided in Annex 1 and a summary of the results provided in this section.

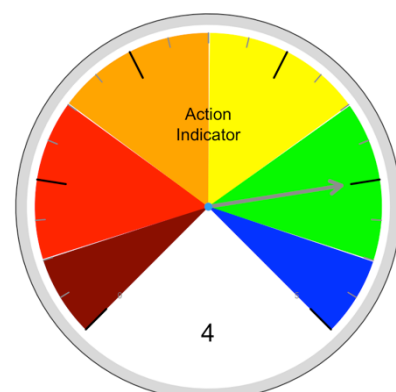


Figure 2.1: Scale used for the assessment of the implementation of individual actions of the Bioeconomy Action Plan

²⁵ Accompanying Staff Working Document: SWD/2012/0011 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2012:0011:FIN>

²⁶ COM/2012/060final <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2012:0060:FIN>

A total of 98 indicators were used for the assessment and the results are summarised in Figure 2.2. In general, the level of implementation was good, with only a few actions identified as poorly or not implemented.

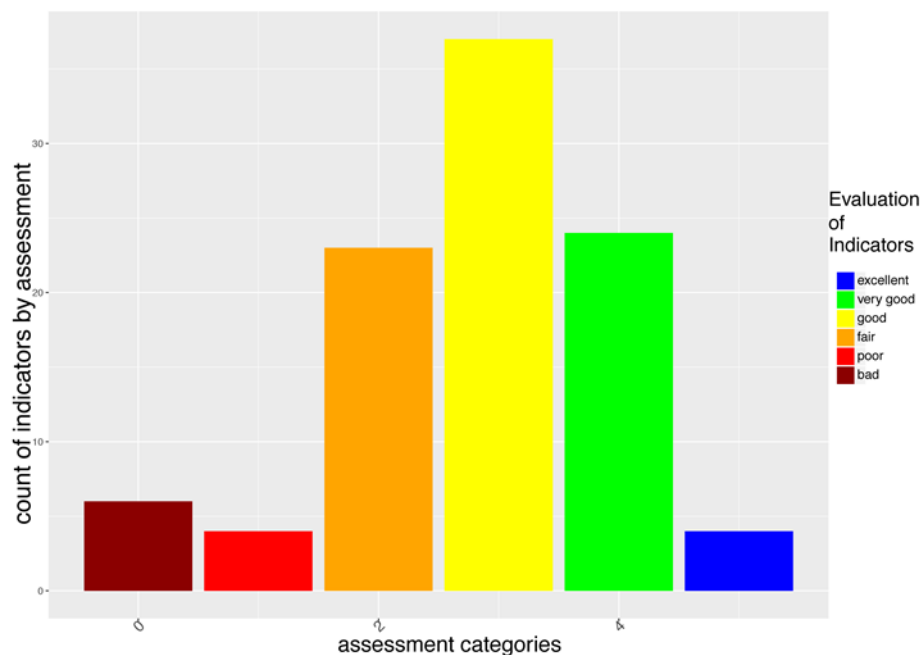


Figure 2.2: Results of the assessment of the 90 indicators of implementation of the of individual actions of the Bioeconomy Action Plan

The 4 actions, for which no evidence of implementation in some indicators was identified, were Action A3, A4, A8 and A9, as shown in Figure 2.2.

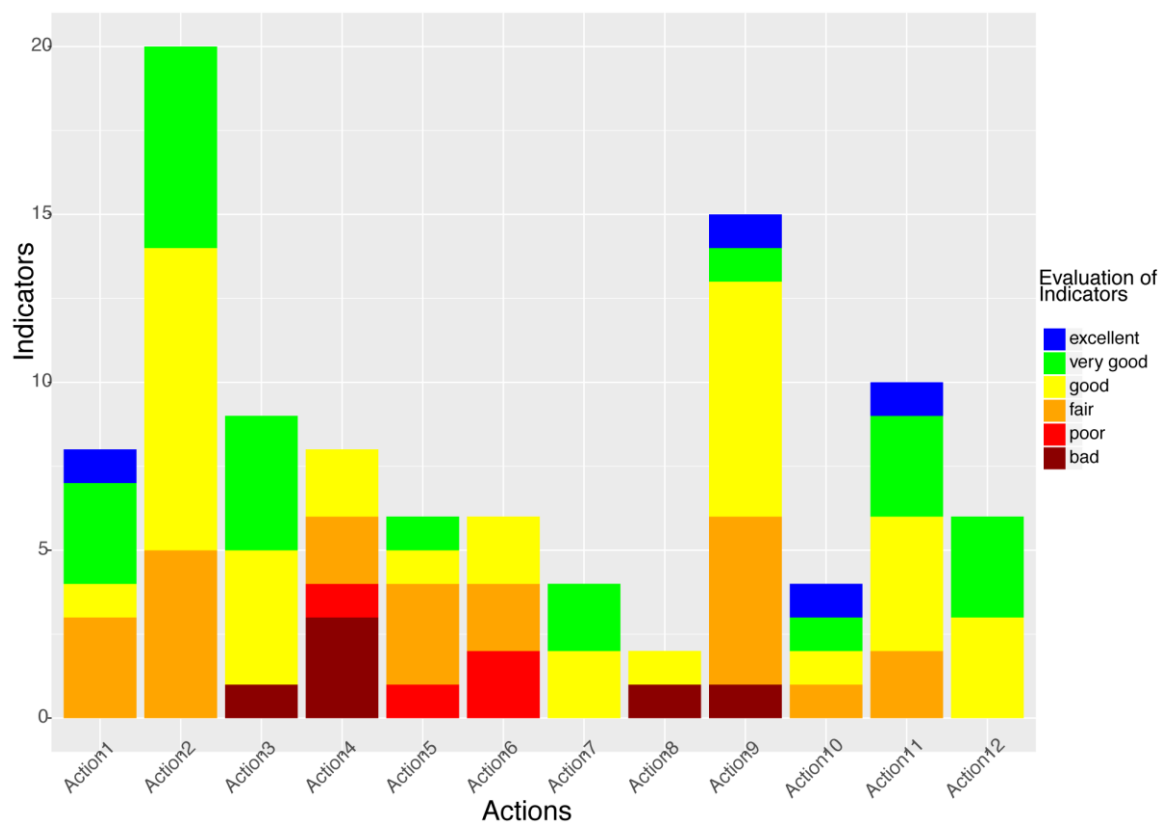


Figure 2.3: Results of the assessment of all indicators by Action

The results of the assessment of the individual actions by Action is summarised in Figure 2.3. The stacked plot allows to appreciate the number of indicators used to evaluate all sub-actions in each Action, and the use of different colours for the evaluation scores shows how the Action overall

performs. In particular, it is relatively straightforward to highlight which actions contain a higher proportion of low-score indicators. The evaluation as “bad” means lack of implementation.

There may be several reasons for the lack of implementation. These include (i) the action was too vague, (ii) the action was thought not to be necessary, (iii) there is overlap with another action, (iv) lack of data did not allow for an evaluation of the implementation, (v) no clear ownership amongst the DGs involved in the bioeconomy and other actors such as MS and regional authorities, (see section 2.2.2).

2.2.2 Overlaps between Actions

Some overlaps (Table 2.2.2) were identified between the actions during assessment of the implementation of the individual actions of the Bioeconomy Action Plan. To avoid ‘double accounting’ different indicators were used wherever possible. However, in some cases it was necessary to use the same indicator for the assessment of more than one individual sub-action.

Table 2.2.2: Examples of overlap between indicators in the assessment of the implementation of the individual actions of the Bioeconomy Action Plan²⁷, where the same indicator was used to evaluate more than one sub-action.

Action	Action Indicator	Indicator Description	Overlaps with
A2	2.3_3	Number of organisations in the B@B platform (evolution since 2015)	5.4_2
A2	2.3_4	Distribution of organisations in the B@B platform per Work Stream	5.4_2
A2	2.4_1	Number of projects under FP7-KBBE and H2020-SC2 (evolution)	1.1_1; 3.1_1
A2	2.4_2	Budget of projects under FP7, KBBE, and Horizon 2020, SC2. (evolution)	1.1_1; 3.1-1
A9	9.8	Knowledge base for policy actions	2.3_1, 2.3_2, 2.4_5, 2.4_6

²⁷ When a sub-action is assessed with more than one indicator, the indicator identifier is given by a number after underscore

2.2.3 Recommendations to the European Commission for Specific Actions and Sub-actions

During the analysis of the implementation of the Action Plan, the experts identified some possible recommendations that are summarised in Table 2.2.3.

Table 2.2.3: Recommendations to the European Commission for the implementation of specific actions of the Bioeconomy Action Plan.

Action	Sub-action	Specific Recommendation
1		
2	2.1	Establish calls for linking ETPs to research projects for engaging ETPs in research and innovation activities
	2.2	Support stronger involvement of EIPs specifically related to the bioeconomy within DG Agri
		Industry to continue and improve its contribution to activities within the BBI JU work programme
		Support the linkage between research organisations and bioeconomy-related industries
		Draft call topics that specifically address the policy challenges of the bioeconomy in the BBI-JU WP
	2.3	Increase the budget dedicated to Advisory Services in the RDP of CAP Pillar 2 (to support policy coherence)
		Increase the budget dedicated to Knowledge Transfer in the RDP of CAP Pillar 2 (to support policy coherence)
		Involve B@B Platform in the research activities through specific calls to ensure the link between biodiversity and industries
	2.4	Make specific calls for bioeconomy within the H2020 SC2 Work Programme
		Industry and EC to continue the support to the involvement of SMEs in the BBI-JU project portfolio (via the work programme)
		promote further the visibility and involvement of the SH Conferences for supporting science -policy dialogue

		Establish policy-relevant calls that will assure evidenced-based policy decisions
	2.5	Support and enlarge visibility of LEIT H2020 WP in the development of the EU bioeconomy competitiveness
3	3.1	Design instruments to promote the diffusion of knowledge in the bioeconomy
		Make specific call to identify barriers in regulations and design policy measures to promote the market of bioeconomy products
		Establish panel for the dialogue between research, business, public administration and civil society on regulatory framework for the bioeconomy
	3.2	Make efforts to establish the European patent with unitary effect
	3.3	Continue the specific SME support
	3.4	Support and develop the activities of the Bioeconomy Stakeholders Panel via generation of proposals for policy making and regulatory framework
4	4.1	Establish separate panel specific for bioeconomy and circular economy
		Make calls that are specific for bioeconomy and circular economy
	4.2	Establish separate panel specific for bioeconomy and circular economy
		Make calls that are specific for bioeconomy and circular economy
	4.3	Prioritise a call for these 3 university networks
5	5.3	Improve access to accurate information on bio-based products for the consumer in Europe in a more pragmatic way.
6	6.1	further develop and expand the list of indicators
		improve the access and completeness of data
	6.2	clearer link between the exercise and the policy development and implementation

	6.3	analytics of collected information is missing (e.g., identify good practices and gaps)
7		
8		
9	9.1	Extend the available information on biomass availability to side streams and waste and communicate the overall knowledge base of the biomass balance (availability and use) when ready
	9.2	Continue and widen the support to market enhancement measures
	9.3	Extend the amount of pilot cases and methodologies to better cover the relevant value chains
	9.4	Put more effort on holistic understanding of the carbon balance
	9.5	Improve understanding of specific land-use conflicts
10	10.1	To continue the efforts to support the development of innovative value chains and to de-risk investments in demonstration and flagships via a public-private partnership structure
	10.2	Support the involvement of the regions in the inventorisation of waste and site streams
11		Stimulate pan-European cluster collaboration
12		

2.3 Main findings of the Assessment of the Implementation of the Action Plan

- Overall, there is evidence of a high degree of implementation of the Action Plan, with the overall result 'good'.
- The Strategy does not contain a clearly defined intervention logic between the Action Plan and the strategic objectives thus the good implementation of the Action Plan is difficult to interpret as a successful way to achieve the objectives of the Strategy.
- An updated Strategy should follow the Better Regulation Guidelines and specify the logical link between the objectives and the actions.
- Furthermore, it is crucial to have a monitoring framework with indicators and targets. The present SWD does not contain a monitoring framework, thus making the quantitative review of the Strategy extremely difficult, inexact and time consuming. This should be corrected in an updated Bioeconomy Strategy and Action Plan.

- The terminology should be updated, with reference to different definitions of the Bioeconomies world-wide, taking into account the diversity of perceptions expressed in the National strategies and action plans.
- The implementation of the Action Plan is not always coordinated nor homogeneous. There is excellent implementation of some actions and none of others.
- Successes include excellent implementation of sub-actions (1.6, 10.1, 11.7).
- There is no evidence of any activity for some other sub-actions, for example 4.3.
- The timeframe for evaluation was rather short (2012-2016) and some of the effects (e.g. policy coherence) will only become evident in the future.
- The Bioeconomy Strategy and Action Plan are still useful, necessary and increasingly relevant to EU policy, especially in relation to global milestones such as the Sustainable Development Goals and the COP 21 Paris Agreement.
- The setting up of the BBI JU (public-private partnership) is generally seen as one of the most successful actions implemented. (A separate independent mid-term evaluation of the BBI JU will soon be completed).
- The Bioeconomy Action Plan stresses the role of research (mainly H2020 WP) in supporting technology developments, platforms and private actors, as well as establishing links across bioeconomy-related industries.
- The bioeconomy Action Plan emphasises the role of stakeholder-based conferences and activities focused on the bioeconomy for supporting policy decisions that are socially inclusive and visible.

2.4 Impact of the Strategy and Action Plan

The lack of clear priorities and indicators also made the analysis of the impact of the Bioeconomy Strategy and Action Plan problematic. The main indicators for impact, based on the objectives of the Strategy, would be increased jobs and increase turnover. However, data for these is only available up to 2014 (in June 2017). This makes the analysis of the impact very difficult for many actions, since it is only 2 years after the 2012 Strategy. Furthermore, the data refer to bioeconomy jobs and turnover in the EU, but cannot be specifically linked to the effects of the Bioeconomy Strategy.

Success stories include:

- **Increased visibility of the bioeconomy** concept and increased awareness among a broad range of stakeholders. Examples are the Stakeholder Panel²⁸, the Bioeconomy Investment Summit Food 2030 and the bioeconomy stakeholder conferences (e.g. IOBE 2014²⁹) held from 2012 to 2016, which also resulted in the development of the **"Stakeholders' Manifesto for the Bioeconomy in Europe"**, a strategic agenda and a shared commitment by industry to shape the bioeconomy through collaboration and dialogue (Utrecht 2016).
- **Good response of the Member Countries and regions:** By June 2017 several Member States published their own national bioeconomy action plans, which clearly indicates the importance and embracement of this concept also at the national and regional level. Also, several EU Regions are investing in research on bioeconomy through the European Structural and Investments Fund.
- **Strengthening of private-public partnerships in Research and Development activities:** The BBI JU Public-Private Partnership enables better competitiveness of industry through closer collaboration with research, the creation of new value chains, and the development of new business models. Currently (Q2/2017), the BBI JU project portfolio includes 65 ongoing projects, of which 20 demonstration projects and 6 flagship projects. SME participation is at a good level: 36% of BBI JU beneficiaries are falling under the category of SME, and they receive 29% of the Union contribution. Whereas currently, at mid-term of the initiative, private investment in the BBI JU is at € 2.6 for each euro of public money, the projections show a possible ratio of more than 4:1.

²⁸ <http://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=panel>

²⁹ <http://bioeconomy.miur.it>

- **Increased economic importance of the bioeconomy sectors:** An analysis by the [Joint Research Centre](#), (JRC, 2017³⁰), shows that the bioeconomy accounted for **18.6 x 10⁶ jobs** and a turnover of **2.2 x 10⁹ Euro** in Europe.

The overall assessment, with average scores by Action can be observed in the radar chart (Figure 2.4). Lower scores (dark-red and red) are plotted closer to the centre, and higher scores (green and blue) on the external areas of the charts. Individual scores are connected in order to draw a contour, which helps highlighting the areas in need of improvement, as those shrinking the ideal contour of a circle.

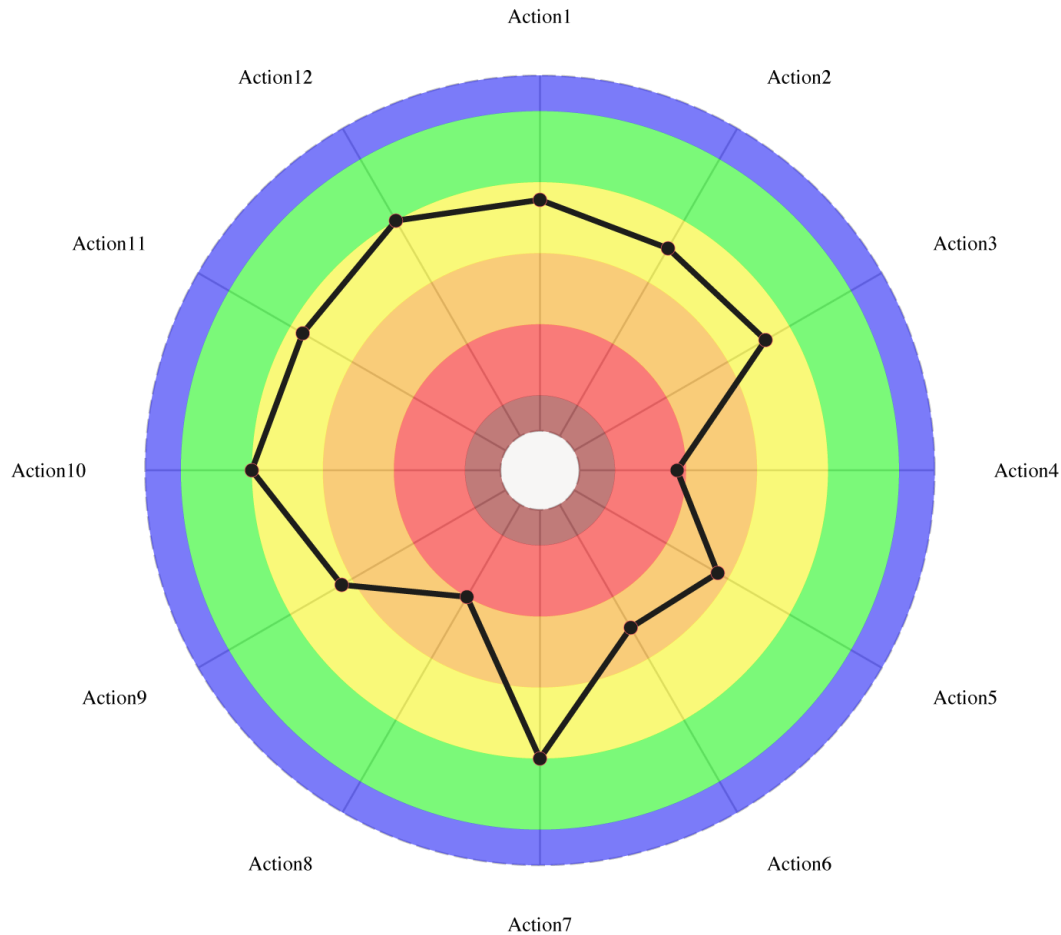


Figure 2.4: Action score - average of all indicators used to evaluate all dependent sub-actions

³⁰ JRC Bioeconomy Report 2016.

3 REVIEW OF THE BIOECONOMY STRATEGY AND ACTION PLAN

The following questions are addressed in this review section:

- What are the Strengths and Weaknesses of the Bioeconomy Strategy and Action Plan?
- Were the societal challenges mentioned in the Strategy addressed?
- What has been the implementation in Blue Growth and the marine bioeconomy?

3.1 Analysis of STRENGTHS and WEAKNESSES of the EU Bioeconomy Strategy

In this section, the Strengths and Weaknesses of the bioeconomy are summarised in two tables with illustrative examples where appropriate.

3.1.1 Strengths of the Strategy and Action Plan

STRENGTHS of the Strategy and Action Plan

Involvement of several policy DGs in developing and writing the Strategy

The overarching vision of the bioeconomy, relating sectors, research, technologies, policies, stakeholders and societal inclusiveness

Significant research funding, world leader in investing in bioeconomy and bio-based industries (see Action 1, e.g. Blue Growth, Rural Renaissance, and Bio-based Value Chains calls)

Appealing vision of bioeconomy, taken up by several Member States with national strategies and action plans, and 10 regions through Smart Specialisation Strategies and Interreg

New synergies created across industrial sectors

(e.g. via The Bio-Based Industries projects such as ValChem, BioForever, AgriMac, BioRescue; or the IDREEM project for multi-trophic Aquaculture)

Strengthened industrial competitiveness by improved, sustainable use of raw materials

(e.g. food and beverage industries)

Improved integration of research, development from primary production (marine and terrestrial) to end user (e.g. uses of algae for food, fertiliser, animal feed, biofuels, biotechnology and bioremediation, pharmaceuticals)

New thinking: sustainable use of renewable biological resources with circularity principles (cascading use, biowaste) and ecosystem approaches.

Creating synergy between marine and terrestrial bioeconomy

(e.g. seaweed used as animal feed; sustainable algae biorefinery for agriculture and aquaculture)

Developed new practices: primary production & processing can also provide ecosystem services (e.g. perennial biorefinery crops, can stimulate biodiversity and limit run-off of nutrients, hence polluting less; bivalve aquaculture provides a biofilter mitigating algal blooms from eutrophication)

Implementation of main EU policies and anticipation of new ones: resource efficiency, sustainability

(including SDGs) and circularity

Strengthened technological leadership

(e.g. The Bio-Based Industries demonstration projects; some SPIRE projects; The SEA on a CHIP created a prototype of an immune-sensor in a lab-on-a-chip for the analysis of marine waters)

Provided improved basis for 3rd country collaboration, e.g. Marine Research is one of the main thematic fields addressed by the INCOBRA Horizon 2020-project seeking to focus, increase and enhance R&I cooperation activities with Brazil.

3.1.2 Weaknesses of the Strategy and Action Plan

WEAKNESSES of the Strategy and Action Plan

The EU definition of bioeconomy is present but not explicit in the Communication of 2012. However, due to the multiple definitions in use in Europe and worldwide, the concept remains unclear and leads to a lack of a common understanding of bioeconomy among key stakeholders. The related terms (bioeconomy, Knowledge Based BioEconomy, bio-based economy) have also evolved throughout the years and reference to the historical evolution might help a clearer understanding.³¹

The lack of clear intervention logic in the Strategy: No clear priorities, objectives and targets (e.g. see footnote 76, p33 SWD states that the actions are not placed in priority order).

There was a poor match of actions in the Bioeconomy Strategy and the Work Programmes at the end of FP7. This improved with the Societal Challenges in Horizon 2020, with several calls relevant for some sub-actions, but still none for others.

The holistic and cross-cutting vision is broken up and compartmentalised in 12 actions and many (54) sub-actions

The policy coherence and reinforced policy interaction would be enhanced by specifying the link to the various relevant policies (Action 5) (e.g. environment and agriculture; use of forest products and climate change actions; resource efficiency and regulatory barriers for upgrading)

The Action Plan tables indicate Member States or EU as 'Actors'. The DG (s) that are most relevant for a specific action are not indicated, and not all relevant DGs were included in the development of the BSAP. This results in uneven implementation across DGs, hence more commitment from some DG's than others. Notwithstanding this weakness, the Research & Innovation related actions were largely implemented.

The different scales of expression of the Action Plan Member States and European miss the important REGIONAL aspects (e.g. differences in agriculture and forestry in N and S Europe).

Balance between regions and Member States (beneficiaries and investments) is not fully achieved.

The EU Bioeconomy Observatory (sub-action 6.1) found it difficult to generate evidence-based feedback mechanisms on regulations and policy measures. Nevertheless, it has provided evidence

³¹ See reviews, e.g. "Thirty years of European biotechnology programmes: from biomolecular engineering to the bioeconomy", [N Biotechnol.](#) 2013 Jun 25;30(5):410-25

relevant to this report on jobs and turnover.

The contribution of bioeconomy solutions to future demands, (e.g. food, energy and materials) is not clearly explained in the Strategy.

Dynamic links to evolving strategies such as the CAP, CFP, Blue Growth and Energy and Climate strategies. The bioeconomy is one of a plethora of linked strategies. No clear mechanism of interlinking these various strategies and synergies is included in the BSAP.

Not enough investment in upscaling (e.g. scaling up pilot plants is a barrier to development of bioprocesses).

3.2 Overall Review of Bioeconomy Strategy and Action Plan

This section of the review addresses whether the Strategy addressed the objectives: Ensuring food security; Managing natural resources sustainably; Reducing dependence on non-renewable resources; Mitigating and adapting to climate change; Creating jobs and maintaining European competitiveness.

The expectations of the Strategy were mentioned in the Introduction (Section 1.3). In the present section, these expectations are compared with what was achieved (table 3.2.1).

Table 3.2.1 – Expectations and Achievements

Societal challenge: <i>Ensuring food security</i>	
Expected (also refer to 1.2)	Achievements
<p>The increase in global population would significantly increase the demand for food and feed, thus affecting food security. At the same time, this would lead to new market opportunities opened by new public demand for healthy, safe and sustainably produced food. The EU Bioeconomy Strategy was expected to develop the knowledge base for a sustainable increase in primary production, taking into account a diverse range of options from cutting-edge science to local knowledge. It was also expected to stimulate and encourage changes in production, taking in environmental concerns as well as the livelihood of people working in agriculture, forestry, and fishery -including the entire sets of industries in primary production based value chains. It was further expected to provide for and stimulate healthier (and climate change friendly) consumption patterns as well as development of products providing for healthier and more sustainable diets. To address the food waste issues in Europe, the Strategy would also support improved resource-efficiency in the food supply chains, and to use residues, side-streams and wastes as basis for new productions.</p>	<p>The overall finding is that the Strategy and Action Plan prioritised the societal challenge of Sustainable Food Security. Blue Growth has delivered significant results on increasing the sustainable harvesting of food and feed from marine resources (fish and aquaculture, bivalves and algae) and the development of knowledge, technologies and products from marine bioresources. Rural Renaissance has stimulated the development of knowledge, technologies and products providing the basis for rural (and coastal) livelihood through improved agriculture, forestry, aquaculture and fishery. Breeding of improved varieties (needing less nutrients and water) gave significant new added value. The Bio-Based Industry (BBI) Joint Undertaking (PPP) has developed biorefinery technologies and products for improved food and feed. The resilience of primary production, coping with resource depletion and climate change, and research and innovation along the food value chain, as well as sustainable and healthy consumption and lifestyle, was the focus of Sustainable Food Security call.</p> <p>The Expert group found strong activity on food and nutrition security. This was evidenced through papers such as "European Research and Innovation for Food and Nutrition Security" presented in the interrelated event FOOD 2030, showcasing the progress. Furthermore, there are benefits to the large food export industry. European products have an excellent reputation, the basis for continued global positioning and competitiveness. Advances in nutritional quality were identified and the EU 'Food First' approach gave importance to nutrition as well as food security.</p> <p>Stakeholders engagement in the dialogue about the dilemma 'Food versus Fuel' has been stimulated with active participation of Non-Governmental Organisations (NGO), politicians, decision makers-led and the public at large. The scope within the bioeconomy to use biomass to its full potential (not just the energy content) took the dialogue to a level of better, mutual understanding.</p> <p>The development of new agricultural practices, using less annual crops and more perennials and lignocellulosic sources, improves biodiversity, and gives a larger harvest per hectare.</p> <p>The technology developments have made it possible to obtain food, feed and non-food from the same hectare land and crop. Now the non-food products can be bio-refined to produce an add-on to the existing yield of food and/or animal feed. The biorefinery products increase the yield and value. Examples of such products are food ingredients, soil improvement products, bio-based chemicals and biofuels, such as commercial cellulosic ethanol production.</p>

Expected (also refer to 1.2)	Achievements
<p>The new Bioeconomy Strategy and Action Plan was expected to ensure sustainable primary production (incl. auxiliary biomass), while also avoiding the depletion or loss of essential ecosystem services. This was to be achieved through the development of smart, sustainable practices in agricultural farming, forestry, fisheries and aquaculture, to produce 'more from less'. The Bioeconomy Strategy should further improve the knowledge and technology base and promote innovation to ensure productivity increase, sustainable use of resources and a reduction of environmental degradation (e.g., loss of biodiversity). The Bioeconomy Strategy should therefore support the implementation of an ecosystem-based management approach. The Strategy was further expected to develop an international (global) shared understanding of sustainable use of biomass and best practices to open new market opportunities, diversify production and address long-term food security issues.</p>	<p>The experts found that research and innovation activities (FP7 and Horizon 2020) have focused on improving the use of natural resources (land and water; soil and nutrients), throughout the Bioeconomy Strategy period under review (2012-2016). In addition, there has been an increase in research focusing on waste reduction as well as on unlocking the full potentials of bioresources. This will decrease the environmental pressure per ton produced.</p> <p>Specific outstanding challenges, related to primary production practices, negatively impacting the environment and harming the biodiversity, have been identified. Although there have been significant efforts and excellent results, there are still challenges for which new knowledge, practices and technologies are needed.</p> <p>Aquaculture and agriculture practices often result in the release of significant surplus of organic matter and nutrients to the environment. Bio-remediation (e.g. using bivalves and seaweeds) is possible, but spatial issues and location are still a challenge.</p> <p>Precision farming and IT tools decrease the amount of pesticides and fertilisers that are applied. However, agricultural practices still lead to nutrient and pesticide contamination of surface and groundwater. There have been advances in bio-based crop protection to substitute chemical pesticides. However, a challenge is to develop bio-based substitutes for fertilisers and other soil improvement products.</p> <p>Forest biodiversity is under threat in many parts of Europe, however, sustainable forestry can contribute significantly to the bioeconomy. New uses of wood and technologies that upgrade the processing of forestry residue have been developed and implemented. The use of wood by the construction sector as a durable material to replace more emission-intensive materials or carbon storage (e.g. wood for constructions) is preferable. Another challenge is to unlock the full potential of wood chips by biorefinery, to produce higher value products (textiles, colorants, adhesives, etc.), substituting fossil resources, and reducing GHG emissions.</p> <p>Southern Europe freshwater resources are under threat from climate change. There is also the issue of sufficient water for agriculture <i>and</i> tourism. Coastal and marine tourism, one of the activities of the Blue Growth Strategy, is promising. Furthermore, regional Initiatives like BLUEMED give particular attention to the sustainable use of bioresources, to which forests directly contribute.</p>

Expected (also refer to 1.2)	Achievements
<p>The Bioeconomy Strategy would support the development of biomass production systems with reduced greenhouse gas (GHG) emissions, adapted to and mitigating the impacts of climate change to match the expected growth in demand for biomass for food and for industrial uses.</p> <p>The Strategy would also promote the substitution of carbon, energy and water intensive processes by more efficient and environmentally friendly ones and the partial replacement of non-renewable by more sustainable bio-based alternatives.</p>	<p>The Expert Group's review and assessment documented that the EU Bioeconomy Strategy has contributed to climate change mitigation primarily through research and innovation efforts following three routes:</p> <ul style="list-style-type: none"> (a) enabling production of bio-based chemical building blocks, bio-based materials and biofuel, which can decrease carbon emissions under certain circumstances (b) increased bio-resource efficiency by using all parts of the crop plants, the trees, the husbandry animals, waste-streams and aquaculture products (fish and bivalves), which decreases the emissions per ton produced; (c) reducing wastes in landfills, thereby lowering the methane emission from anaerobic microbial conversion of the organic waste. <p>Furthermore, work on coastal and ocean health is essential given the potential of the seas to act as blue sinks.</p> <p>The Bioeconomy Strategy has contributed through extending the knowledge base to reduce emissions from meat production of pigs and ruminants, (methane from pig manure and from the anaerobic rumen digestion). Seafood low down the food chain (e.g. bivalves) presents one of the lowest footprints of all protein food when they are not dredged.</p> <p>Climate change threatens agriculture with irregular and scarce rainfall, as well as high temperatures and changes in seasonality (both longer and shorter periods). This makes the current crop varieties a sub-optimal choice. Research is supporting climate change adaptation through plant breeding, aiming to develop varieties that are drought, heat and flooding tolerant, and varieties with improved water- and resource efficiency. In addition, there is on-going research on developing microbial strains that can be sown with the seed and add to the robustness of the crop plants itself.</p>

Societal Challenge: *Reducing Dependence on non-renewable resources*

Expected (also refer to 1.2)	Achievements
<p>Decreasing the vulnerability of its economy, which arises from heavy dependence on fossil resources, while maintaining the competitiveness. Europe needs to become a low carbon emission society, based on resource efficient industries, bio-based products and bioenergy.</p> <p>The Bioeconomy Strategy was expected to improve knowledge base and foster innovation for producing quality biomass at competitive prices, without compromising food security, increasing pressure on primary production and the environment, or distorting markets in favour of energy uses. It should also contribute to understanding current and future biomass availability and demand (including alternative renewable resources), and to understanding the competition between biomass uses, including their climate change mitigation potential.</p>	<p>The Expert Group's review found that the EU bioeconomy has contributed to reducing dependence on non-renewables. Furthermore, sustainable options, bio-based processes and value chains for production have been developed for: (a) bio-chemicals, (b) bio-materials and (c) bioenergy and biofuels. Especially important are the developments of the bio-based routes for bio-based production of: (a) bio-chemical aromatics, because of the increased demand; (b) bioplastics, from both plant components (e.g. starch) and microbial bioplastic polymers; and (c) bioethanol and advanced drop-in fuels made from renewable sugar production from lignocellulosic crop residues.</p> <p>The Strategy also reduced the dependence on fossil resources by developing renewable, bio-based products with new functionalities. These deliver new solutions by energy saving (e.g. lightweight, bio-based polymers for transport).</p> <p>A renewed focus was noted on developing bio-based crop protection products that decrease dependence on inorganic and chemical/fossil-based pesticides. The newest developments (in BBI call topics) include a call for developing new types of bio-based fertilisers, which will reduce the dependence on fossil or inorganic based fertiliser component (e.g. phosphorous, facing global scarcity).</p>

Societal Challenge: *Creating jobs and maintaining European competitiveness*

Expected (also refer to 1.2)	Achievements
<p>The EU bioeconomy sectors needed to innovate and diversify to remain competitive and maintain jobs in the context of major societal challenges and rising markets in developing countries. The creation of many new jobs was also expected to provide a positive balance of employment. It was expected that the direct research funding associated to the Bioeconomy Strategy (Horizon 2020) would generate about 130,000 jobs and €45 billions in value added in bioeconomy sectors by 2020.</p> <p>The bioeconomy would potentially create new jobs in new industries such as biobased materials, bioenergy and bioproducts³². Further growth of these sectors was expected, from industrial competitiveness and opportunities for SMEs resulting from both direct and indirect, private and public investments³³.</p> <p>However, there could be some job losses in other more traditional sectors related to fossil industry.</p>	<p>It is too early fully to assess the creation of jobs, based on the new research-and technology-based developments of the bioeconomy. Current analysis in the field of jobs and economy³⁴ indicates significant job potential still to be unlocked through the development of the bioeconomy. Of special societal interest is the potential of the bioeconomy for developing jobs in rural and coastal areas. Furthermore, the bioeconomy could contribute to the future growth and opportunities for the European agriculture and forestry sectors.</p> <p>Job potentials are connected to a broad spectrum of industries: larger industries, middle size industries and SME's, many of which are already clustered as in the maritime domain; utilising and exploiting each other's side streams and waste streams. A Europe specialised in harvesting bioeconomy mediated synergies could be a new global stronghold.</p> <p>A new development of the circular bio-economy, where local bio-resources are being developed to add value in the local rural, coastal and urban areas: e.g. development of local protein resources to substitute for import of soy for animal feed, green vegetable roofs and vertical walls, aquaponics, production of local specialty food, with authenticated origin, etc.</p> <p>With regard to industrial competitiveness, European industries (e.g. the agricultural, and the food and feed processing) have been strengthened by improving the efficiency of use of raw materials, as well as unlocking the full potentials of the primary product and the feed stock.</p> <p>Other trends and developments are pulling in the opposite direction, via robotics and automation, as well as decreased activities in the fossil based industries.</p>

³² <https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html>

³³ http://ec.europa.eu/research/bioeconomy/pdf/bioeconomycommunicationstrategy_b5_brochure_web.pdf

³⁴ JRC, Bioeconomy 2016 study (2017)

3.3 The Bioeconomy and Blue Growth

Blue Growth has been one of the twelve focus areas of the first H2020 calls and actions supported the EU Blue Growth Strategy and relevant EU policies, as well as provide international cooperation, in particular for Atlantic Ocean research. The calls in this area invited, for example, proposals on Atlantic observation systems, an integrated response capacity to oil spills and marine pollution, climate change impacts on fisheries and aquaculture and ocean literacy.

Blue Growth calls were a very significant development, they significantly widened the scientific community within the Societal Challenge 2 (SC 2)/bioeconomy.

[Blue Growth](#) is the long-term Strategy to support sustainable growth in the marine and maritime sectors as a whole. **The marine bioeconomy shows enormous potential** for innovation and growth, especially in [sustainable aquaculture](#) and [marine biotechnology](#), (also see³⁵). However, the ocean is fundamentally different from land and this has **important consequences for sustainable management of marine resources**. For example, the ocean is much larger and far less known than land. The lack of ownership and responsibility in the ocean can have serious consequences for sustainability, more so than on the land. The ocean is fluid and interconnected, therefore pollutants and non-indigenous species can be spread easily by currents and/or vessels for much greater distance than on land. Nutrients and pollutants can be retained for a long time for example in the sediments, and this can impact the long term³⁶. The ocean is also far more 3-dimensional than land, but remote sensing technologies cannot penetrate deeply, because water is less transparent than air. This makes **monitoring and assessing the status** of the vast ocean a special challenge³⁷, see for example the [DEVOTES](#) project. Nevertheless, marine life occurs from the sea surface down to the deepest ocean trench, marine species can potentially travel much longer distances than terrestrial ones. Clusters of animals in the water column can very easily shift from one location to another and this complicates mapping, protection measures, and makes the **monitoring, assessment and management of marine related activities very challenging**.

The need to reduce the environmental footprint of the blue economy, increase resource efficiency and reduce CO₂ emissions has been a significant driving force for innovation. EU research and investment programmes for Blue Growth contributed to new technologies and sectors that had not yet made their mark on the ocean economy³⁸. The ongoing Horizon 2020 EU research programme (2014-2020) changed marine and maritime research, by **creating opportunities for synergies** between previously separate strands of marine and maritime research. It also shifted the focus of the research from the laboratory to the marketplace. An important development was forming research partnerships with non-EU countries sharing a common regional sea³⁹. **Considerable investment was made, for example a total of EUR 800 million were allocated to marine and maritime research and innovation projects from 2014-2016, more than EUR 260 million a year**. There is still a lot of **scope and potential for [nature-based solutions](#) and boosting ecosystem services**. For example, offshore wind installations at first cause disruption, but later act as small 'marine protected areas' (MPAs), see [CoCoNet](#) project. Bivalve aquaculture can act as a biofilter, removing excessive phytoplankton to obtain a high Nitrogen, low chlorophyll environment, see Ferreira et al, 2009⁴⁰. Significant progress has been made in **ocean literacy** and **consumer awareness** about the choice, sustainability, nutritional and health benefits of [safe](#) seafood. This includes labelling about provenance (e.g. aquaculture, '[farmed in the EU](#)'/line-fish); capture (diver/dredged scallops); traceability (net to plate); date of capture/packing/ sell-by; as well as depuration information. Stakeholder [conferences](#) and events have been organised. The effort continues with **recent calls relevant to the bioeconomy** including wellbeing, health and seafood, innovation in sustainable aquaculture and use of jellyfish bloom biomass.

³⁵ https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/Subfunction%202.4%20Blue%20biotechnolgy_Final%20v140812.pdf
³⁶ O'Higgins, T., Tett, P., Farmer, A., Cooper, P., Dolch, T., Friedrich, J., Goulding, I., Hunt, A., Icely, J., Murciano, C., Newton, A., Psuty, I., Raux, P., Roth, E., 2014. *Temporal constraints on ecosystem management: Definitions and examples from Europe's regional seas*. Ecology and Society, v. 19, n. 4, Art. 46.

DOI: [dx.doi.org/10.5751/ES-06507-190446](https://doi.org/10.5751/ES-06507-190446)

³⁷ Cristina, S., Icely, J., Goela, P., DelValls, T., Newton, A., 2015. *Using remote sensing as a support to the implementation of the European Marine Strategy Framework Directive in SW Portugal*. Continental Shelf Research, v. 108, pp. 169-177.
DOI: [10.1016/j.csr.2015.03.011](https://doi.org/10.1016/j.csr.2015.03.011)

³⁸ EC Staff working document on Blue Growth 2013-2016 (SWD (2017) 128 final of 31.3.2017)

³⁹ Cinnirella, S., Sardà, R., Suárez de Vivero, J., Brennan, R., Barausse, A., Icely, J., Luisetti, T., March, D., Murciano, C., Newton, A., O'Higgins, T., Palmeri, L., Palmieri, M., Raux, P., Rees, S., Albaigés, J., Pirrone, N., Turner, K., ., 2014. *Steps towards a shared governance response for achieving Good Environmental Status in the Mediterranean Sea*. Ecology and Society, v. 19, n. 4, Art. 47. **DOI:** [dx.doi.org/10.5751/ES-07065-190447](https://doi.org/10.5751/ES-07065-190447)

⁴⁰ Ferreira, J.G., Sequeira, A., Hawkins, A., Newton, A., Nickell, T., Pastres, R., Forte, J., Bodoy, J., Bricker, S., 2009. *Analysis of coastal and offshore aquaculture: application of the FARM model to multiple systems and shellfish species*. Aquaculture, v. 289, n.1-2, pp. 32-41 **DOI:** [10.1016/j.aquaculture.2008.12.017](https://doi.org/10.1016/j.aquaculture.2008.12.017)

4 BIOECONOMY AND CIRCULAR ECONOMY

This section of the report focuses on the second objective of this review as stated in the Terms of Reference:

- “Examine the current and future contribution of the Bioeconomy Strategy and bioeconomy generally to EU circular economy objectives.”
- “... in light of the action mentioned in the Action Plan of the Circular Economy Package.”

Several assessment questions were addressed by the reviewers to make their analysis. These are:

- What is the relationship between bioeconomy, cascading use and circular economy?
- What is the overlap, what are the differences between bioeconomy and circular economy?
- How does the bioeconomy contribute to the circular economy?
- What are the synergies?
- What are the limits of cascading use and the circular economy?

4.1 Definitions and Relationship between the Bioeconomy, Cascading Use and Circular Economy

The **bioeconomy** encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy.⁴¹

The bioeconomy promises to:

- introduce healthy, safe and nutritious food, resource efficient and healthy animal feed, new food supplements, new chemicals, building-blocks and polymers with new functionalities and properties;
- develop new, more efficient and sustainable agricultural and marine practices, improved bio-processing and biorefinery concepts, new process technologies such as industrial biotechnology;
- deliver solutions for Green and Sustainable Chemistry.

It can contribute to mitigating climate change through the substitution of petrochemicals by materials with lower GHG emissions in extraction, processing and use. Biomass is the most important renewable carbon source, so long as the direct utilisation of CO₂ is still in an embryonic state. The bioeconomy brings new business opportunities, investment and employment to rural, coastal and marine areas, fosters regional development and supports SMEs.

The utilisation of biomass could be optimised by new biorefinery concepts. The European Commission has stated that:

“biorefineries should adopt a cascading approach to the use of their inputs, favouring highest value add and resource efficient products, such as bio-based products and industrial materials, over bioenergy” and

“the advantages of the products over conventional products range from more sustainable production processes, to improved functionalities (e.g. enzyme-based detergents that work more efficiently at lower temperatures, save energy and replace phosphorus) and characteristics (e.g. biodegradability, lower toxicity)”.⁴²

According to the Commission, the **“circular economy (is the economic space) where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised”**⁴³. The EU Circular economy Action Plan⁴⁴, launched by the Juncker Commission, sets a special focus on the efficiency of resources (economic and ecological) and not

⁴¹ European Commission 2012: Innovating for Sustainable Growth – A bioeconomy for Europe. Publications Office of the European Union, Luxembourg. ISBN 978-92-79-25376-8, doi 10.2777/6462

⁴² European Commission 2012: Innovating for Sustainable Growth – A bioeconomy for Europe. Publications Office of the European Union, Luxembourg. ISBN 978-92-79-25376-8, doi 10.2777/6462

⁴³ European Commission 2015: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Closing the loop - An EU action plan for the Circular Economy. Brussels, 02.12.2015.

⁴⁴ European Commission, 26 January 2017 (http://europa.eu/rapid/press-release_IP-17-104_en.htm)

only on waste, which is treated as a resource, consistent with the previous EC policy. The Action Plan includes: food waste and efficient conversion of biomass as sectoral priorities. *"Food waste is a key area in the circular economy and should be addressed at many levels along the value chain."*

The Ellen MacArthur Foundation developed comprehensive concepts and definitions on circular economy, which are mostly in line with the definition of the EU Circular economy package:

"The concept of a circular economy"

A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. The concept distinguishes between technical and biological cycles.

*As envisioned by the originators, a circular economy is a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. It works effectively at every scale.*⁴⁵

Cascading use of biomass⁴⁶

The cascading use of biomass is strongly overlapping with the concept of the circular economy and is mostly a part of it. In this respect, the Bioeconomy Strategy has been anticipating main concepts that were subsequently further developed in the Circular Economy Package, as applied to the biological resource. The main target of cascading and circular economy is an increased resource efficiency, less demand for fresh materials with both of these frequently linked to added value and job creation.

One of the most comprehensive reports on cascading use was commissioned by DG Growth and published in March 2016. The study defines cascading use (with a focus on wood) as:

*"In this study cascading use is defined as "the efficient utilisation of resources by using residues and recycled materials for material use to extend total biomass availability within a given system". From a technical perspective, the cascading use of wood takes place when wood is processed into a product and this product is used at least once more either for material or energy purposes. In a single stage cascade, wood is processed into a product and this product is used once more for energy purposes; in a multi-stage cascade, wood is processed into a product and this product is used at least once more in material form before disposal or recovery for energy purposes.*⁴⁷

In some bio-based sectors, cascading use has already been established since decades, many years before the term 'circular economy' became mainstream policy. Examples are the pulp and paper industry or the textile industry. Cascading is the result of recycling and remanufacturing in the circular economy and the waste hierarchy (see figure 4.2.2), but cascading starts before the waste hierarchy with the decision, how to use the fresh biomass:

*"If a bio-based product is created from biomass, the waste hierarchy governs cascading use anyway – but not before. **That means that the cascading principle closes the gap between biomass utilisation and the waste hierarchy.***

*It is a paradox situation: Before the biomass becomes a bio-based product, incentives lead the biomass directly to energetic use, while after the biomass has been turned into a bio-based product, incineration is only the least preferred option in the waste hierarchy.*⁴⁸

Policy support for cascading use can be expected to grow in the context of the circular economy: *"This combined with the circular economy initiative and resource efficiency agenda, sees a confluence of policy objectives and a real opportunity to embed the cascading use of woody biomass into EU policy and national and regional implementation."*⁴⁹

⁴⁵ <https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept>

⁴⁶ There is a **Guidance** document on cascading and sustainability criteria in preparation.

⁴⁷ Vis M., U. Mantau, B. Allen (Eds.) (2016) Study on the optimised cascading use of wood. No 394/PP/ENT/RCH/14/7689. Final report. Brussels 2016. 337 pages.

⁴⁸ Carus, M., Dammer, L., Essel, R. 2015: Quo vadis, cascading use of biomass? Policy paper on background information on the cascading principle provided by nova-Institute. (www.bio-based.eu/policy)

⁴⁹ Vis M., U. Mantau, B. Allen (Eds.) (2016) Study on the optimised cascading use of wood. No 394/PP/ENT/RCH/14/7689. Final report. Brussels 2016. 337 pages.

Special features of bioeconomy:

The bioeconomy is characterised by very special features:

- The bioeconomy provides renewable carbon to the industry and can directly replace fossil carbon in almost all applications – unlike minerals and metals.
- Figure 4.2.3 shows these special features of the bioeconomy in the green boxes (see text below).
- It is a challenge to keep the value of biomass cascading, which is much easier with metals and minerals. Thus, the circular economy is dominated by the metal and mineral industry. Biomass is considered minor with respect to the other materials.
- The bioeconomy is adding an additional, organic, recycling pathway that expands the circular economy, (biodegradation, composting, soil, carbon recycling through photosynthesis, see figure 4.2.2). Organic recycling has still to find its position and acceptance in the circular economy, e.g. through the new legislation on fertilisers, including bio-based.

4.2 Overlap between the Bioeconomy and Circular Economy

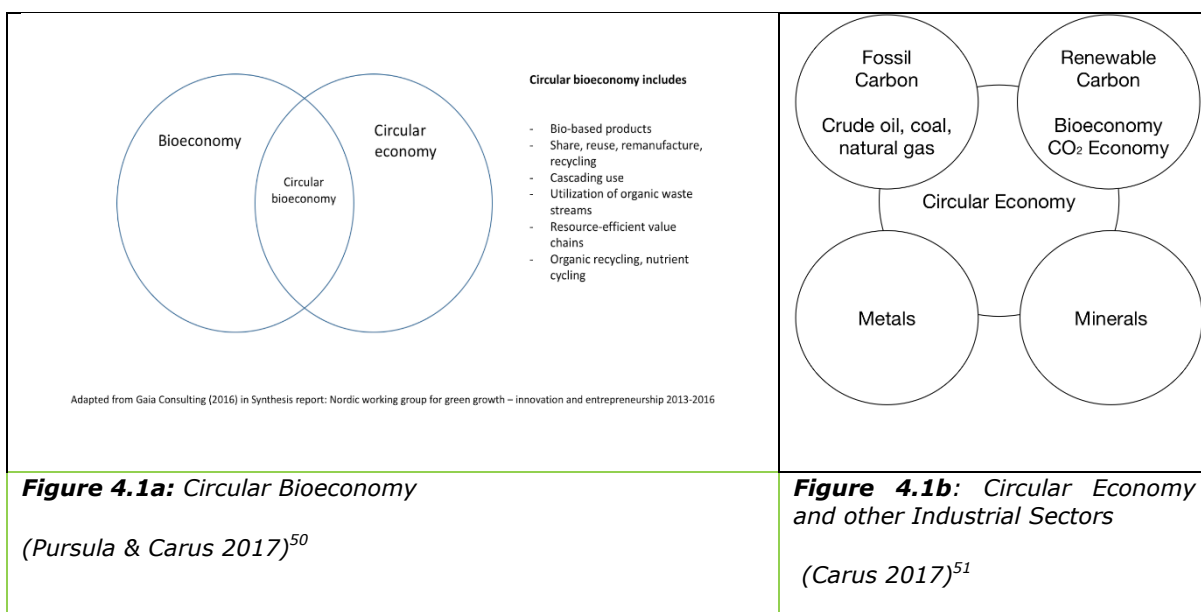
The bioeconomy and circular economy, share some of the targets: A more sustainable and resource efficient world with a low carbon footprint. Both the circular economy and the bioeconomy avoid using additional fossil carbon to contribute to climate targets.

The **circular economy** strengthens the resource-efficiency of processes and the use of recycled materials to reduce the use of additional fossil carbon (either embedded in the material or emitted during manufacturing/extraction processes). The **bioeconomy** substitutes fossil carbon by renewable carbon from biomass (including by-products and wastes) from agriculture, forestry and marine environment. **These are different but complementary approaches.**

The 'Circular Bioeconomy' is the **intersection** of bioeconomy and circular economy, Figure 4.1a. The configuration of the two models and the concept of circular economy are shown in Figure 4.1b.

What do the concepts of bioeconomy and circular economy have in common?

- Improved resource and eco-efficiency
- Low GHG footprint
- Reducing the demand for fossil carbon
- Enhancement of waste and side streams



⁵⁰ First time published in this report.

⁵¹ First time published in this report.

Considering the carbon recycling through photosynthesis, bioeconomy and circular economy are very similar and there is considerable overlap. The use of natural cycles is a strong argument in favour of the bioeconomy in the context of a Circular Economy.

Comprehensive or Holistic Concept of the Circular Economy

Figure 4.2 includes all kinds of material streams and shows all the different utilisation routes belonging to a Circular Economy. Organic recycling (= biodegradation) and even the capture and utilisation of CO₂ from industrial processes or the atmosphere are included. At the top, there are all kind of raw materials entering the cycle: Fossil resources (crude oil, natural gas, coal), minerals, metals, biomass from agriculture, forest and marine and potentially CO₂ emissions from industry. Left and right there are additional raw material flows from manufacturing side-streams and product recycling.

The raw materials will be manufactured to products, traded, used and then will enter the waste hierarchy from share / maintain, reuse / redistribute, remanufacture to recycling (mechanical and chemical). Biodegradable products add organic recycling (biodegradation, composting, carbon recycling through photosynthesis) to the end-of-life options and CCU (Carbon Capture and Utilisation), the recycling of CO₂. The use of landfill is the most undesirable option.

All biomass flows are potentially part of the circular economy, the cascading use is part of the waste hierarchy, especially the remanufacture and recycling of bio-based products.

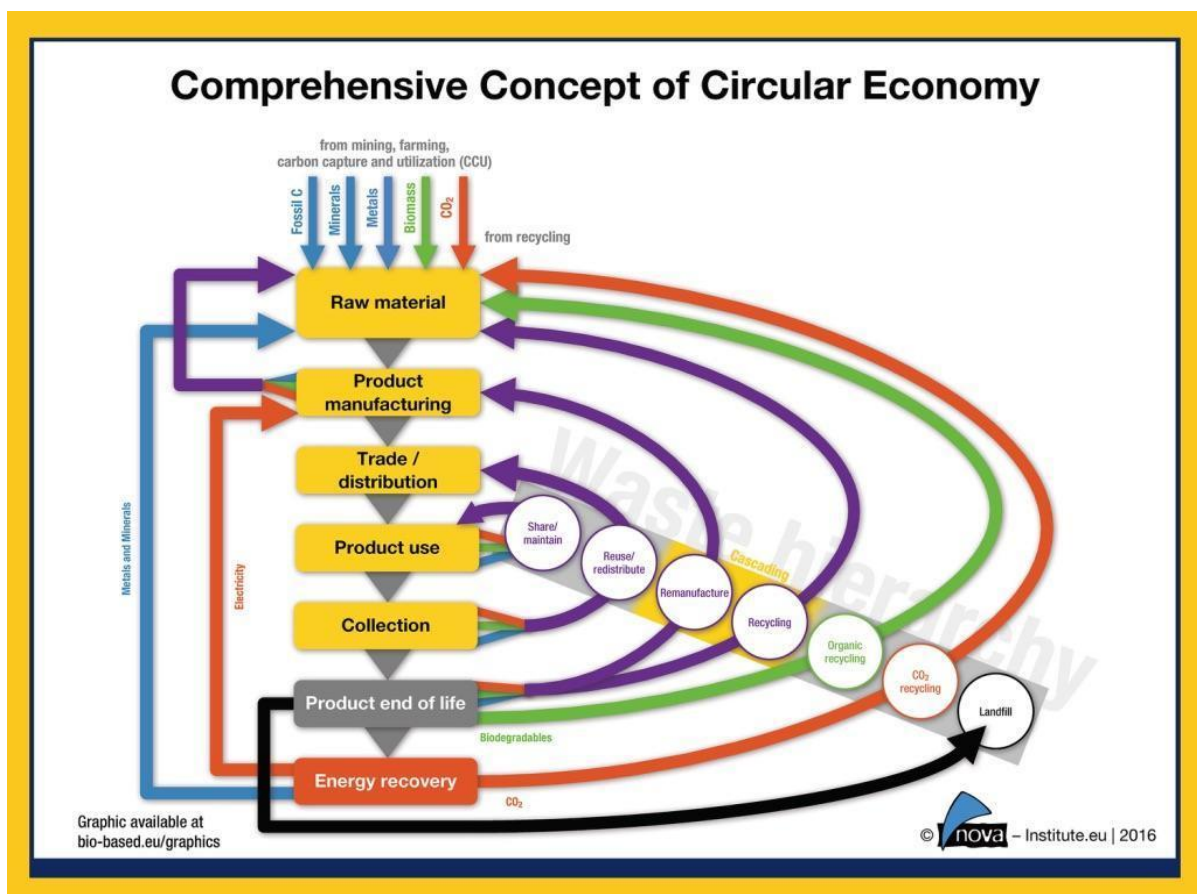


Figure 4.2: Comprehensive Concept of Circular Economy – Biomass includes all kind of biomass, from agriculture, forestry and marine as well as organic waste streams (nova 2016)

4.3 Differences between the Bioeconomy and Circular Economy

The bioeconomy is not fully part of the circular economy, neither are fossil carbon, metals and minerals. The **differences stem from various sources**:

- (i) **At present**, most of the material flows – fossil, biomass, metals and minerals – are NOT part of the circular economy. A large proportion of metals and minerals are not maintained in the economy, but lost in the environment or in landfills. Fossil and renewable carbon is mainly

used for energy purposes (fossil: 93%, biomass: two-thirds) and utilised in this way, it is lost for cascading use. Fossil- or bio-based products often end in landfills or the environment, so they are also lost to the circular economy.

(ii) **Potentially**, a large proportion of all materials can become part of the circular economy, and thus the overlap will increase as we advance in sustainability.

(iii) **Some sectors** of the bioeconomy will never be fully part of the circular economy, as energy cannot be recycled due to the laws of thermodynamics (also waste heat can be cascaded through applications that can use low-grade heat, like space heating). Similarly, carbon in fuels (such as biomass) can be recovered (at an energy cost), but its energy cannot be. Also most detergents, cosmetics, coating and paints cannot currently be collected and recycled, but for some of these applications, biodegradable solutions could be part of organic recycling in the future. Biomass use for energy or fuels, though circular in nature, is not the most resource efficient option. A circular bioeconomy should thus encourage the cascading use of biomass, where energy uses come in the last place.

(iv) The **concept of bioeconomy** is much more than the biomass flow itself (see figure 4.2.3 and text below). Important aspects of the bioeconomy, as well as important aspects of the other material sectors, are structurally outside the circular economy, which focuses on *"maintaining the value of products, materials and resources in the economy for as long as possible"* and increasing the eco-efficiency of processes.

(v) **Bio-degradation**: some non-persistent, bio-based materials are consequently less durable, from the circular economy point of view;

(vi) Bioeconomy goes beyond 'conversion' and connects upstream through the 'production' component to its ecosystem base, which is key to the resource efficiency principle, value chain approach and LCA methodologies.

Biomass utilisation in the European Union

In the year 2013, the demand for biomass in the European Union (EU-27) was 1.07 Billion tonnes dry matter. Food accounts for 10% (food waste is about 18% of this 10% = 2%), feed for 46%, bioenergy and biofuels for 19% and exported biomass for 10%. Only 15% was used for bio-chemicals and bio-materials with the theoretical potential of cascading use (own calculations based on⁵² FAO 2017, Eurostat 2017, Benzing 2015). Most detergents, cosmetics, coating and paints cannot currently be recycled, therefore **currently only about 10 to 15% of the biomass utilisation (including food waste) in the European Union is available to become be the object of cascading use.**

Bioeconomy: Beyond Circular Economy

However, the many elements of bioeconomy are not part of circular economy, including aspects focused on product or service functionality (new chemical building blocks, new processing routes, new functionalities and properties of products) and not only about *"maintain the value of products, materials and resources in the economy for as long as possible"*⁵³ and to increase process efficiency.

In Figure 4.3, the biomass flow (green) starts on the left side with solar radiation, CO₂ and water utilised in agriculture, forestry (and also marine/fishery), biomass, processing to food/feed, bioenergy/biofuels, chemicals/materials and bio-based products. By-products and biowaste can be utilised again in cascading and organic recycling (blue): Bio-based circular economy.

The green boxes in Figure 4.3 show the specific features of the bioeconomy along the value chain, which are mostly not covered or are not usually seen as within the concept of circular economy. This includes the new developments in agriculture and forestry (precision farming, gene editing), new processing pathways with lower toxicities and less harsh chemicals, biotechnology, chemicals and materials with new properties and functionalities as well as more nature-compatible, healthy bio-based products (more details in the green boxes).

⁵² FAO 2017: Online queries of FAOSTAT datasets (Crop production and Food Balance sheets and Forestry Production and Trade), last accessed 17-06-28.

Eurostat 2017: Online queries of Eurostat datasets (EU trade since 1988 by SITC, Supply, transformation and consumption of renewable energies), last accessed 17-06-28.

Benzing, T. 2015: Update (2013 data) on the Quantification of renewable raw materials use in the EU chemical industry, Presentation of the CEFIC Bioeconomy Task Team, 4 June 2015.

⁵³ European Commission 2015: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Closing the loop - An EU action plan for the Circular Economy. Brussels, 02.12.2015.

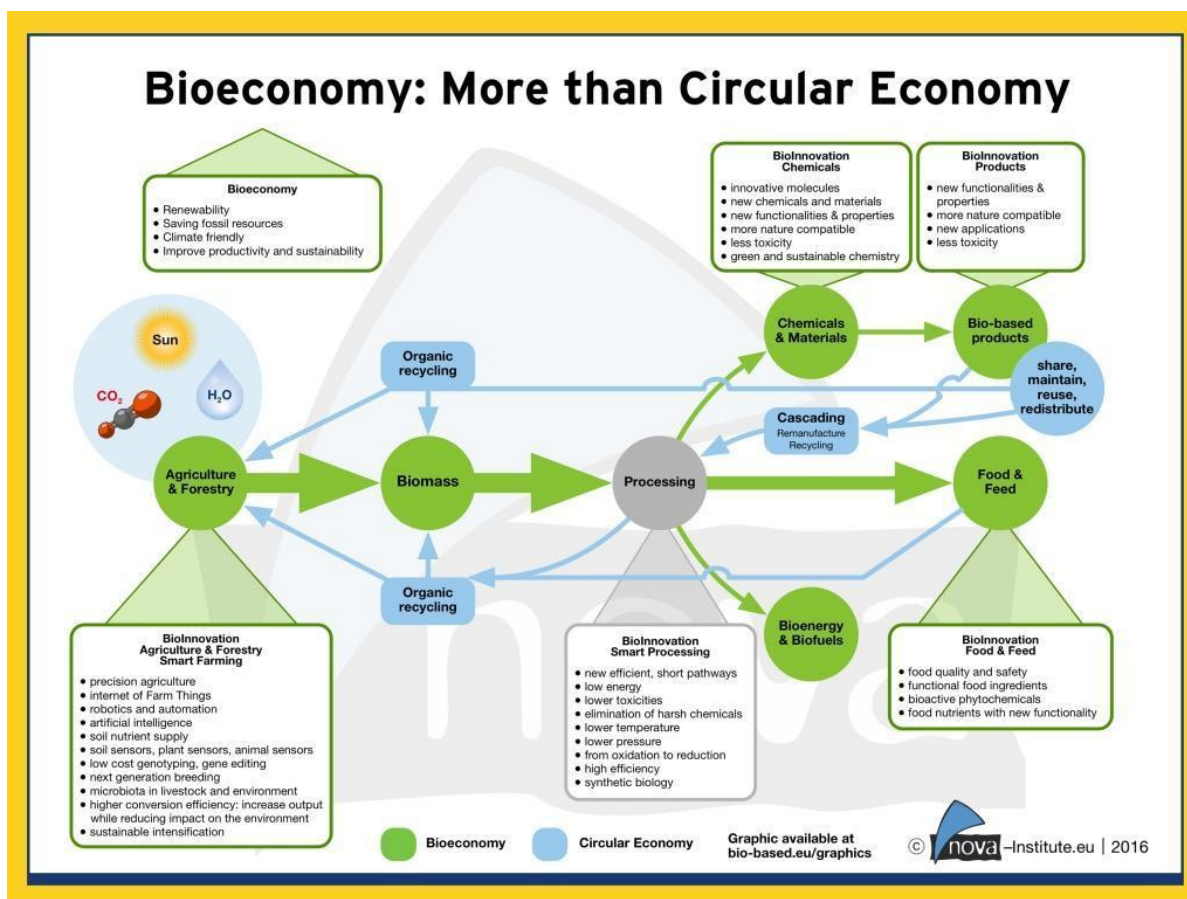


Figure 4.3: Bioeconomy on Land: Beyond Circular Economy – “Agriculture & Forestry” includes all kind of biomass, from agriculture, forestry and marine as well as organic waste streams (nova 2017)

4.4 Contribution of the Bioeconomy to the Circular Economy

Summarising the previous chapters, **the concepts of bioeconomy and circular economy have similar targets and they are partly overlapping to a degree, but neither is fully part of the other nor embedded in the other.**

The bioeconomy should not be considered simply as a part of the circular economy, which does not include certain crucial aspects of the bioeconomy (see chapter 4.3). A sustainable bioeconomy research agenda can significantly contribute to the circular economy, for example in relation eco-efficiency of resources and processes, but it needs additional and specific topics.

The circular economy is not complete without the bioeconomy. The huge organic side and waste streams from agriculture, forestry, fishery, food & feed and organic process waste can only be integrated in the circular economy with a Bioeconomy Strategy. Natural cycles in the bioeconomy (e.g. the nutrient cycles) can strongly contribute to the circular economy, whilst artificial nutrient supplements act against circularity. New knowledge-based processes, (such as biotechnology, algae or insects for food and feed), new applications and new links between bioeconomy and other industrial sectors are needed.

The bioeconomy can contribute in several ways to the circular economy, including:

- Utilisation of organic side and waste streams from agriculture, forestry, fishery, aquaculture, food & feed and organic process waste;
- Biodegradable products being returned to the organic and nutrient cycles;
- Successful cascading of paper, other wood products, natural fibres textiles and many more;
- Innovative additives from oleo-chemicals enhancing recyclability of other materials;
- Once the critical volume of new, bio-based polymers is reached: collection and recycling of bioplastics will become economically viable and attractive;
- Utilisation of plant waste as feed for aquaculture;

- Linking different industrial sectors (food industries & chemical industry).

European Projects and Investment

In recent years, some new trends became visible. These include new value chains in the bioeconomy and circular economy. These are found in both food & feed, forest and marine industries, for example linking food & feed side-streams to chemicals.

Food industry companies are valorising their biogenic waste / side streams. This can be economically very attractive, but the huge potential had not been recognised previously. The companies are first attracted by the circular economy and then become part of the bioeconomy, by activating additional biomass and feedstock for the chemical and other industries. Examples are the side streams of the milk, cheese and alcohol (beer, wine, spirits) industry to produce organic acids and bio-based plastics; side-streams of olive and orange juice industry, which can be used for the extraction of high value organic components; proteins and fatty acids from the seafood processing industry.

The forest industry would allow a highly efficient side-stream utilisation and cascading due to its well-developed infrastructure and experiences in cascading for paper. However, the barriers from the bioenergy and biofuels policy need to be overcome (non-level playing field for energy and material use), which only supports an energetic use of biomass and not a cascading use⁵⁴. Side-streams of the pulp and paper industries can also be better valorised than it was usual in the past, while boards and panels from construction could also be more intensively re-used.

Insects, bacteria and fungi can transform food waste or agricultural/forest side-streams to food/feed or chemicals. Hence, bioeconomy processes are able to reintegrate materials 'lost' to the circular economy.

One example is SME innovation project UPCYCLING THE OCEANS project is to produce and sell fabrics and clothes made from marine plastic litter, by recycling and industrial methods to convert these plastics into high properties textiles. European seas contain many tons of waste, mainly plastic (around 400 kg per km²). This plastic litter has a very negative impact in the marine environment, affecting the food chain and potentially triggering endocrine and/or carcinogenic processes.

The circular economy brings different industrial sectors together, linking their flows. The knowledge-based bioeconomy can support this with special bio-based processes, such as biotechnology and extraction, and organic recycling to utilise material flows, which could not be used with traditional processes. Thus, the circular economy can inspire companies to utilise new options and bioeconomy technologies – and vice versa.

Many such projects have been supported by research projects of the European Commission. Different SC2 and BBI calls from 2014 to 2015 had the contribution of the bioeconomy to the circular economy as a focus. More than 40 projects could be identified that work at least to some extent in the overlap of bioeconomy and circular economy. Main topics were biowaste & side streams utilisation from agriculture, food, wood and fishery, CO₂ utilisation, cascading and resource efficiency. The total EU contribution to those 42 projects is €157 million, representing about 38% of the EU contribution to all SC2 and BBI projects in the period 2014-2016. BBI:

4.5 Limits of Cascading Use and Bio-based Circular Economy

Although cascading use usually increases the efficient use of resources, the direct connection to a reduced release of GHG emission is more complex. Emissions only decrease if those emissions caused by the collection, separation and processing of the bio-waste stream for another bio-based product are lower than the emissions caused by sourcing and producing another bio-based product. However, there is no general rule about this. In some cases, after cascading stage two or three, the additional energy needed for processing etc. cannot justify an additional use. Sometimes even any material use at the first stage is inefficient. In other cases, for example pulp and paper, even long cascades show positive effects. Using renewable energy, including bioenergy, will make more cascading stages justifiable from a GHG footprint perspective.

Moreover, additional limitations exist. Along the cascade, products can accumulate toxic or critical substances, which can serve as barriers for further recycling or even incineration. Nevertheless, it

⁵⁴ Carus, M., Dammer, L., Essel, R. 2015: Quo vadis, cascading use of biomass? (www.bio-based.eu/policy)

is important to keep in mind the overall result must not be the maximisation of cascading as such, but the optimisation of the overall outcome.

The following additional aspects should be kept in mind:

- Energy is needed to produce any type of bio-based product, at whatever stage of the cascade. Given the objective to reduce the use of fossil fuel, this means that renewable energy (including bioenergy) should be preferentially used to produce bio-based products.
- In the future, the demand for feedstock for bio-based products (compound annual growth rate (CAGR) worldwide: 3-4%/year, Europe: 1.5-2%/year) in comparison to bio-based energy (CAGR worldwide: 1%/year, Europa: almost no increase), will grow much faster.
- The cascading principle can only work with good data on biomass flows and a good logistic system connecting the different sectors and if necessary basic economic criteria are met.
- In the case of residues from agriculture or forestry, the bioeconomy should also consider the use / need of such biomass for soil management (i.e. fertility and protection) and/ or animal feed.
- The oceans and seas offer a huge potential for the cascading use in the bioeconomy. These include (only a few of many examples): the use of fisheries discards, algal biorefineries, seaweed farming, the multi-use of marine space in off-shore platforms, zero-waste and circular aquaculture, new products from jellyfish, new pharmaceuticals from marine biodiversity.
- There can be impacts on side stream utilisation from the circular economy / cascading use. Did the side stream not have a previous application? To substitute one utilisation by another can lead to unwanted effects.

In conclusion, **applying the most eco-efficient sequence of the use of biomass depends on the global policy framework, as well as the local circumstances, such as supply and demand and infrastructure.**

5 CONCLUSIONS

The review by the Expert Group found that **significant achievements** were made during the implementation by addressing major societal challenges. Research, development and innovation in FP7 and H2020 have been the basis of much of this progress.

There is strong evidence of **major investments in research, innovation and skills**, through projects portfolios resulting from SC2, SFS, BB and BBI calls.

There is also **significant reinforcement of policy interaction and stakeholder engagement**, for example thorough the stakeholder panel and the stakeholder conferences, as well as national/regional BE strategies.

The **progress in policy implementation and enhancement of markets in the main bioeconomy sectors is clearly demonstrated**, for example the Bio-Based Industries Joint Undertaking (Public-Private Partnership).

An indication of the **magnitude of the impact** is that several Member States have developed or are developing national bioeconomy strategies and action plans. This shows the **potential of the bioeconomy as a unifying agenda**, at the Member State level, the regional level (e.g. through Interreg), the EU level and the global level (e.g. with respect to COP 21 and SDGs).

Research, development and innovation in the bioeconomy is, and will continue to be, an important domain for **international scientific competition and cooperation with 3rd countries world-wide**.

The **EU is the international leader at present in investing in bioeconomy and bio-based industries**. However, continued effort in EU policies and research funding are necessary to support the future development of the bioeconomy as a whole.

The bioeconomy and the circular economy are highly complementary and non-exclusive, reinforcing each other's concepts. There is a very interesting synergy and tremendous potential in a synergy of both bioeconomy and the circular economy: **a sustainable, circular bioeconomy**.

There is **enormous potential in the marine bioeconomy**, with algae, sustainable aquaculture and bi-products of the seafood processing industries.

A future or updated Bioeconomy Strategy should built upon (rather than superseding) the existing, interrelated policies and initiatives (e.g. CAP, CFP, Food 2030, etc.), and aim at sustainable production and utilisation of biomass for competing uses in a continuous changing world (Paris Agreement, SDGs)

Considering the above, **the experts conclude that an updated Bioeconomy Strategy and Action Plan is useful, necessary and timely in order to optimise the use of the Bioeconomy in the current socio-economic and geo-political context**.

The main **recommendations on discussing an updated Bioeconomy Strategy and Action Plan** are: A revised Strategy and Action Plan should follow the new **Better Regulation Guidelines** and better specify the logical link between the objectives and the actions (intervention logic). It should also contain a monitoring framework thus allowing a quantitative review to be made.

- **The definition** of Bioeconomy should be specified and clarified with reference to the legitimate diversity of definitions used world-wide. An updated definition would broaden the scope and objectives of the Bioeconomy Strategy, including such concepts as ecosystem services and biodiversity;
- The **objectives** of the Strategy need to be clearly stated and updated;
- The Strategy should include clear **priorities, objectives, intervention logic, key performance indicators and targets** to allow monitoring, assessment and evaluation;
- The Strategy should be discussed with **stakeholders** and their role in implementing the Strategy should be clearly defined.

Synergies, links and actions in the text:

- The synergies with the **sustainable, circular economy** should be specified and developed;
- The **links to other policies and strategies** should be explicit, ensuring policy coherence;
- The Strategy should include **fewer, focused actions** and remove overlaps, replacing these with specified links.

The main **recommendations** on implementation of **an updated Bioeconomy Strategy and Action Plan** are:

- The implementation could benefit from enhanced interactions policy and involvement at the European, regional and national levels.
- The implementation should continue to involve the EU regions and Member States;
- The implementation should reinforce the involvement of the public and private stakeholders and civil society organisations;
- The implementation should improve the access to finance.

Final considerations on the bioeconomy and ecosystems based management of agriculture, fisheries and aquaculture:

The growing needs of the growing population should be met in a sustainable manner that does not damage the ecosystem and ecosystem services, if we are to meet the Sustainable Development Goals. This is not a new concept, Francis Bacon, a 17th Century philosopher expressed it as "*Nature, to be commanded, must be obeyed*". **Ecosystem based management** could reconcile agriculture, fisheries and aquaculture with ecology. While intensive food production and provision is necessary to maintain high levels of productivity, it should also be environmentally friendly and respect the fundamental laws of ecology. **Ecosystem based management** aims to optimise the use and the natural capacities of the agro-ecosystems and aquatic ecosystem, while reducing environmental risks.

Ecosystem based management means working with nature and natural processes to:

- Amplify the ecological functionalities of the agro-ecosystems (photosynthesis, soil fertility, biological control...);
- Amplify the ecological functionalities of the aquatic ecosystems (photosynthesis, biological control, nature-based solutions, nutrient recovery...);
- Maximise synergies between ecological functionalities;
- Use precision agriculture with optimisation with digital innovations (smart delivery, targeted input, less impact on environment);
- Use precision fishing methods (to reduce by-catch, to target the correct size fish, to decrease impact on the environment such as sea-bottom integrity);
- Use biodiversity for increasing resilience of the agro-ecosystems and aquaculture;
- Use bio-inspired innovations (e.g. allelopathy, particularly for sustainable pest management);
- Use bioprocessing to upgrade side streams and wastes.

6 RECOMMENDATIONS FOR THE BIOECONOMY STRATEGY AND ITS ACTION PLAN

The Terms of Reference of the review mention that the Expert Group should:

"identify the causes of delays or unfulfilled expectations, such as insufficient funding, regulatory barriers, technology failure, etc., and provide information on bottlenecks related to possible EU investment (including also biomass and bio-based products flow, demand and supply, as well as highlighting the relevant societal challenges), including identifying needs for new programme, projects, actions and/or refocus of current actions, with a view to arriving at a more focussed Action Plan, with actions concretely linked to key Bioeconomy policy objectives.

The following recommendations address this. In this section, the recommendations are arranged in two sets. The first includes recommendations to support **the optimisation of the Bioeconomy Strategy and Action Plan** in order to deliver in the current context on the most pressing socio-economic challenges affecting the EU, and on the main EU policies and international commitments. It is about an updating of the Strategy and Action Plan to adapt it in an evolving world. The second set of recommendations here are about the concepts and **implementation** of an updated Bioeconomy Strategy and Action Plan.

Optimisation of the Bioeconomy Strategy and Action Plan

The updated Strategy should include clear priorities, targets, indicators and milestones to allow monitoring, assessment and evaluation. An updated Strategy and Action Plan should follow the Better Regulation Guidelines and specify the logical link between the objectives and the actions (intervention logic). It should also contain a monitoring framework thus allowing a quantitative review to be made. The updated Bioeconomy Strategy should contain clear priorities, targets, actions and KPIs (Key Performance Indicators). These were lacking in the previous Strategy and Action Plan, which made the assessment difficult.

The definition of bioeconomy could be clarified (and updated if needed), taking into account the legitimate diversity of various bioeconomies at EU level and world-wide. There should be a clear distinction between a definition of a term (definition of what is the bioeconomy) and the principles underlying a Strategy. There could be references to different terminologies that have been used in different geographical contexts and different times (e.g. 'bioeconomy', 'bio-based economy', 'green growth/economy', 'circular economy', 'nature-based solutions' to societal challenges) and similar principles, to avoid confusion.

The objectives of the Strategy need to be clearly stated and updated. The scope of the objectives could reinforce some of the original underlying principles. These have become even more prominent and relevant in light of the current context, socio-economic needs, both in the EU and globally. Policy priorities still include, achieving food and nutrition security, mitigating climate change, protecting rural livelihoods under climate change challenged agriculture, ensuring rural renaissance and blue growth, energy security, industrial growth and securing carbon sources for material use, natural resources sustainability, etc. There are new relevant trends and policies, such as CFP and CAP reforms, circular economy, SDGs, Paris Climate Agreement, and accelerating changes in a more efficient way.

An updated Bioeconomy Strategy should emphasise health and well-being, for example nutrition, not just focusing on food security.

All three pillars of sustainability (Economic, Environmental, Social) should be recognised. This should be reflected in the goals and actions in the Strategy to maximise synergies between economic and social prosperity with the enhancement of Europe's biological and natural capital and environmental sustainability.

The Strategy should include more focused actions and remove overlaps. The specific actions should ensure optimised collaboration between sectors, policies and stakeholders, and build synergies to achieve overall increased momentum in unlocking the full potentials of the bioeconomy. Fewer but more focused actions are needed linked to major policy (e.g. SDG), including performance indicators and guidance on how to implement the different actions.

The Strategy should be clearly linked to other policies and strategies, ensuring policy coherence. The Strategy needs to specify the link to relevant policies and strategies such as biodiversity, climate action, Common Agricultural Policy, EU Forest Strategy, Research & Innovation, Common Fisheries Policy, sustainable development strategy, regional policy, renewable energy, water management, international ocean governance, etc.. It should consider the recent

and on-going reforms and initiatives such as the CFP reform, the climate-energy policy framework, the creation of a public-private partnership (BBU JU), and take into account new political priorities of the EC (e.g. the Juncker Plan for growth & jobs, smart specialisation, etc.).

A systematic assessment and mapping of all relevant policy sectors should ensure coherence and build synergies. For example, the Strategy should include an objective that contributes new knowledge and new technologies to the UN sustainable development goals. Bioeconomy and circular economy are necessary tools to reach SDGs, climate change mitigation and adaptation, by combining the increase of well-being, rural livelihood and human development and at the same time proportionally reduce resource-use and environmental degradation.

The synergies with the sustainable, circular economy should be further developed. A new, ambitious, Circular Bioeconomy Strategy that brings together the bioeconomy and the circular economy (see previous chapter) is needed. The intersection of bio and circular economy should be increased and developed. As an example, recycling of nutrients links the bio-based and mineral sectors. In the future, as some fossil minerals like phosphorus become scarce, effective nutrient recovery and recycling is crucial. Valorisation of waste and side streams becomes crucial. The growing collaboration of the food-processing and the forestry industry with e.g. the chemical industry to valorise side streams should be further developed. The use of Municipal Solid Waste to produce and recover some chemicals should also be stimulated.

Improve the implementation of the (updated) Bioeconomy Strategy and Action Plan

The implementation needs reinforced coordination within the EC. While the Strategy and Action Plan were jointly produced by several EC services, involving more DG's in an active way should facilitate the implementation of the Strategy. These should include DG RTD, DG AGRI, DG GROW, DG ENV, DG MARE, DG REGIO, DG ENER, DG CLIMA, DG DEVCO and the JRC. Ensuring a high-profile 'patronage' for the bioeconomy in the EU by a group of key Commissioners (as it was the case by the original Communication) and Members of the European Parliament (MEPs) would also be an advantage. Bioeconomy and the Bioeconomy Strategy was mentioned in several reports and opinions in the European Parliament recently (e.g. in opinions about sustainable agriculture, forest strategy, sustainability, (bio)-waste, jobs and growth, renewable energy, circular economy, and the European Funds for Strategic Investments or EFSI).

New measures for centralised and coordinated data collection are needed, enabling a direct connection between the Strategy and the results of publicly funded policies and projects.

The EU regions and Member States should be further involved in the development and implementation of the revised Bioeconomy Strategy. The Committee of the Regions (CoR) has shown a strong interest towards the Bioeconomy Strategy since its adoption. An Opinion on the bioeconomy was recently published by the CoR⁵⁵ and several collaborative activities took place between the CoR and Commission services on this matter⁵⁶.

Regions are indeed playing an increasingly important role in the further development of the bioeconomy in Europe as they can support the establishment of (regional) innovative value chains. They are also best situated to identify the available feedstock sources in their regions, which can stimulate the biobased economy. Finally, regions can play a crucial role in attracting investments by using the European Structural and Investment Funds (ESIF) or the European Agricultural Fund for Rural Development (EAFRD), creating jobs and growth – while maintaining the natural and human capital - and additional opportunities for the primary production sectors.

The updated Bioeconomy Strategy should involve the public and private stakeholders in the development and implementation of the Bioeconomy Strategy. Public and private stakeholders should work hand in hand. For example, despite the environmental and social benefits that bio-based products can bring, customers and end-users are not necessarily aware of how they differ from fossil carbon based products or of the value proposition offered by these products. Targeted information campaigns to customers and end-users can help develop the market. However, to ensure maximum impact, public understanding should first be ascertained to identify the gaps to be addressed.

⁵⁵ Opinion of the European Committee of the Regions – The local and regional dimension of bioeconomy and the role of regions and cities - CDR 44/2017

<http://cor.europa.eu/en/activities/opinions/pages/opinion-factsheet.aspx?OpinionNumber=CDR%2044/2017>

⁵⁶ see references in the SC2 H2020 interim evaluation

The updated Bioeconomy Strategy should develop actions to improve the access to finance

Support for start-up companies, tax reliefs, subsidies, grants and loans are all important to develop a sustainable and competitive bioeconomy. With regards to access to finance, a recent study by the European Investment Bank⁵⁷ under InnovFin advisory indicated amongst its main findings that:

- Regulation and market and demand framework conditions are perceived as the most important drivers and incentives but also present the biggest risks and challenges for both bio-based industries and blue economy project promoters as well as financial market participants to invest in the bioeconomy (EIB study, p. 3);
- Project promoters identified that main funding gaps exist in (i) bio-based Industries projects scaling up from pilot to demonstration projects and (ii) particularly in bio-based Industries, moving from demonstration to flagship/first-of-a-kind and industrial-scale projects (EIB study, p. 4);
- Financial market participants are attracted by the growth potential of the bioeconomy, but due to its high perceived risks and information asymmetries identify the same two funding gaps as the project promoters (EIB study, p. 5);
- Existing public financial instruments are utilised but their catalytic impact could be further enhanced (EIB study, p. 6).

Indeed, in the past, not many dedicated funds existed. Today a variety of different instruments can be accessed including Horizon2020 and the Bio-Based Industries Joint Undertaking (BBI JU), European Structural and Investment Funds (ESIF) including the European Agricultural Fund for Rural Development (EAFRD), InnovFin, the European Fund for Strategic Investments (EFSI), and the European Investment Bank (EIB) for loans and guarantees. However, access and effectiveness remain a critical issue. Synergies are sought between different EU funds, but the funding scene is fragmented, sometimes overlapping, sometimes mutually exclusive, with different procedures across institutions, regions, organisations making the whole application experience very lengthy and complex. It will therefore be critical for the EU, governments, regions and other funding organisations to put these theoretical synergies into practice to make investing in Europe a seamless process.

There is a need to reinforce awareness about instruments such as InnovFin and the European Fund for Strategic Investments (EFSI), which can match the funding needs of certain bioeconomy related investment projects that are less risky than the usual bioeconomy projects.

A distinct European BioEconomy Strategic Investment Fund (EBESIF) or thematic investment platform, that would pool together several sources of financing (e.g. from the EU, private investors, the European Investment Bank, and other possible sources), would help to attract private investment for R&I to the bioeconomy and to leverage the EU contribution (e.g. via the BBI JU) to this fund. Further links between the investment fund and the Circular Economy Finance Support Platform⁵⁸ could be explored.

And finally, a web-based tool could help identify available funding and whether the applicant does qualify with the eligibility conditions of such mechanism. The system could also provide the needed links and resources to apply directly to the funding mechanism.

These recommendations have also been proposed by the EIB study⁵⁹ as well as the Bio-Tic project⁶⁰.

⁵⁷ EIB, Study on Access-to-Finance - Conditions for Investments in Bio-Based Industries and the Blue Economy, June 2017) http://www.eib.org/attachments/pj/access_to_finance_study_on_bioeconomy_en.pdf

⁵⁸ http://europa.eu/rapid/press-release_IP-17-104_en.htm

⁵⁹ http://www.eib.org/attachments/pj/access_to_finance_study_on_bioeconomy_en.pdf

⁶⁰ <http://www.industrialbiotech-europe.eu/new/wp-content/uploads/2015/09/Non-technological-Roadmap.pdf>

7 LIST OF ANNEXES

Annex 1	Detailed Assessment of the Action Plan
Annex 2	List of Indicators and Scores used for the Assessment
Annex 3	Terms of Reference
Annex 4	Glossary of Terms

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This report, authored by an interdisciplinary group of expert, presents a review of the 2012 EU Bioeconomy Strategy and its Action Plan. The review is not a formal evaluation but presents a partly-quantitative and qualitative assessment of the implementation of the 2012 EU Bioeconomy Strategy and its Action Plan. The expert group concludes that significant achievements were made, especially through Research and Innovation actions. However, for an optimised delivery in the current policy context, there is a need to update the Strategy and its Action Plan, with clear objectives, targets, indicators and monitoring.

Studies and reports