



# DIGICIRC

WP2 – INVOLVE: Generating the DigiCirc Ecosystem

## **D2.6: Circular Innovation Priorities: Bioeconomy**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873468.

## D2.6: Circular Innovation Priorities: Bioeconomy

### Document Information

Grant Agreement Number	873468	Acronym	DigiCirc	
Full Title	European cluster-led accelerator for digitisation of the circular economy across key emerging sectors			
Start Date	1 <sup>st</sup> May 2020	Duration	32 months	
Project URL	<a href="https://digicirc.eu/">https://digicirc.eu/</a>			
Deliverable	D2.6: Circular Innovation Priorities: Bioeconomy			
Work Package	WP 2 - INVOLVE: Generating the DigiCirc Ecosystem			
Date of Delivery	Contractual	31/06/2021	Actual	03/08/2021
Nature	Report	Dissemination Level	Public	
Lead Beneficiary	DPO			
Responsible Author	Hannu Salmela, DPO			
Contributions from	ICA, Arthur’s Legal, DRAXIS, Cap Digital			

### Document History

Version	Issue Date	Stage	Description	Contributor
1.0	19/07/2021	Draft	1 <sup>st</sup> draft for internal review	CTN, ICA, Arthur's Legal, DRAXIS Cap Digital
2.0	30/07/2021	Final	Final version	
3.0	30/07/2021	Final	Final version	CAP
4.0	03/08/2021	Final	Final version submitted	CAP

### Disclaimer

Any dissemination of results reflects only the author's view and the European Commission is not responsible for any use that may be made of the information it contains.

### Copyright message

© DigiCirc Consortium, 2020

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both. Reproduction is authorised provided the source is acknowledged.

## Table of Contents

1 Introduction.....	5
1.1 DigiCirc at a glance .....	5
1.2 Purpose of this document.....	5
2 Bioeconomy.....	5
3 Methodology.....	8
3.1 Methodology description.....	8
3.2 Target Groups .....	9
4 Outcomes of the different activities .....	10
4.1 Desk Research.....	10
Technology watch.....	10
Market trends .....	13
Regulatory landscape .....	18
4.2 Cluster Engagement campaign .....	25
4.3 Market Consultation.....	26
4.5 Clusters meeting – BioE Clusters Advisory board. ....	27
5 Bioeconomy Challenges.....	29
5.1 Results analysis overview .....	29
5.2 Challenges definition .....	34
6 References.....	37
Annexes .....	39
Annex 1: BioE domain Questionnaire for Clusters .....	39
Annex 2: Bioeconomy Market Consultation questionnaire.....	44
Annex 3 : Market consultation questionnaire results.....	47
Annex 4: Cluster meeting BioE challenges discussion .....	50

## List of Figures

Figure 1: Application of digitization to the concept of bioeconomy.....	11
Figure 2: Objectives of the 2018 EU Bioeconomy Strategy and the main criteria to monitor its effectiveness. ....	23
Figure 3: Graph from cluster engagement questionnaire. Sectors related to BioE where Clusters were involved.....	25

## List of Tables

Table 1: Pharmaceuticals challenges by technology.....	34
Table 2: Textiles and wearing apparel by technology.....	34
Table 3: Packaging challenges by technology.....	34
Table 4: Building materials and construction challenges by technology .....	35
Table 5: Other forest products challenges by technology .....	35
Table 6: Electronics and electrical products challenges by technology.....	35

## **D2.6: Circular Innovation Priorities: Bioeconomy**

Table 7: Biomass energy and biofuels challenges by technology.....	35
Table 8: Machinery and equipment challenges by technology .....	36
Table 9: Motor vehicles and components challenges by technology .....	36

## List of Acronyms

Acronym	Designation
CE	Circular Economy
LE	Linear Economy
BioE	Bioeconomy
SME	Small and Medium-sized Enterprise
ECCP	European Cluster Collaboration Platform
ICT	Information and Communication Technologies
EC	European Commission
IoT	Internet of things
AI	Artificial Intelligence
GIS	Geographic Information System

# 1 Introduction

## 1.1 DigiCirc at a glance

DigiCirc's ambition is to build a European ecosystem to enable the digital transformation of the Circular Economy (CE) in three specific sectors (circular cities, blue economy and bioeconomy). To do so, the DigiCirc project supports European SMEs by funding and accelerating their digital innovations in these emerging sectors.

## 1.2 Purpose of this document

This report is designed to present the consultation process and the outcomes from the engagement campaign for Bioeconomy (BioE). The document is divided into three parts:

- The first section describes the methodology implemented, during the engagement campaign during 4 months from March 2021, including the target groups reached and key figures.
- The second section outlines the outcomes of the different activities led in the engagement campaign: results of the desk research on domain priorities, technology, market trends and regulatory landscape, and the results of the consultation (questionnaire, cluster meeting and DigiCirc partner meeting).
- The last part presents the DigiCirc priorities in the domain of BioE (challenges & sectors).

# 2 Bioeconomy

Global challenges like climate change and land and ecosystem degradation force us to seek more sustainable ways of producing and consuming materials. In 2012, the European Commission launched a communication entitled *Innovating for sustainable growth: a bioeconomy for Europe*. **The communication defines the bioeconomy as the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy.** Shifting from non-renewable resources to biomaterials is an important innovation aspect of the circular economy agenda.

According to Finnish Innovation Fund Sitra, the bioeconomy is a strategy used by society to combat urgent problems, such as climate change, increasing competition for natural resources and rural and regional development. The bioeconomy should be viewed as a new economic and social order that will challenge most of our existing practices and structures. The need to achieve sustainability constitutes a strong incentive to modernize our technologies and industries. The future bioeconomy is both global and local. When local solutions are developed, a foundation is being laid for global solutions which may have significant export potential and consequently affect the national economy.

It is estimated that the bioeconomy contributes to almost 9% of the EU-27 labor force and 4.7% of the EU-27 GDP. The bioeconomy will play an integral role in spurring on the EU recovery from the COVID-19 crisis by aligning the economy with the biosphere. **The bioeconomy will thus improve resilience and competitiveness, providing long-term systemic solutions, and ensuring a just transition.**

The bioeconomy contributes to the European Green Deal in many ways. Carbon sequestration in soil, blue carbon and forests and its storage in harvested wood products, together with material substitution of fossil-based products can generate significant carbon savings. Unavoidable biowaste can be converted into energy. Circular use of biomass promotes resource efficiency and stimulates the production of high added-value products from side and waste streams, and at the same time, it reduces the amount of landfilled waste.

Digitalisation is integral to the development of the bioeconomy. This may have disruptive effects, but it may also contribute to the sustainability of bioeconomy industries. By contribution of renewable material like wood there has

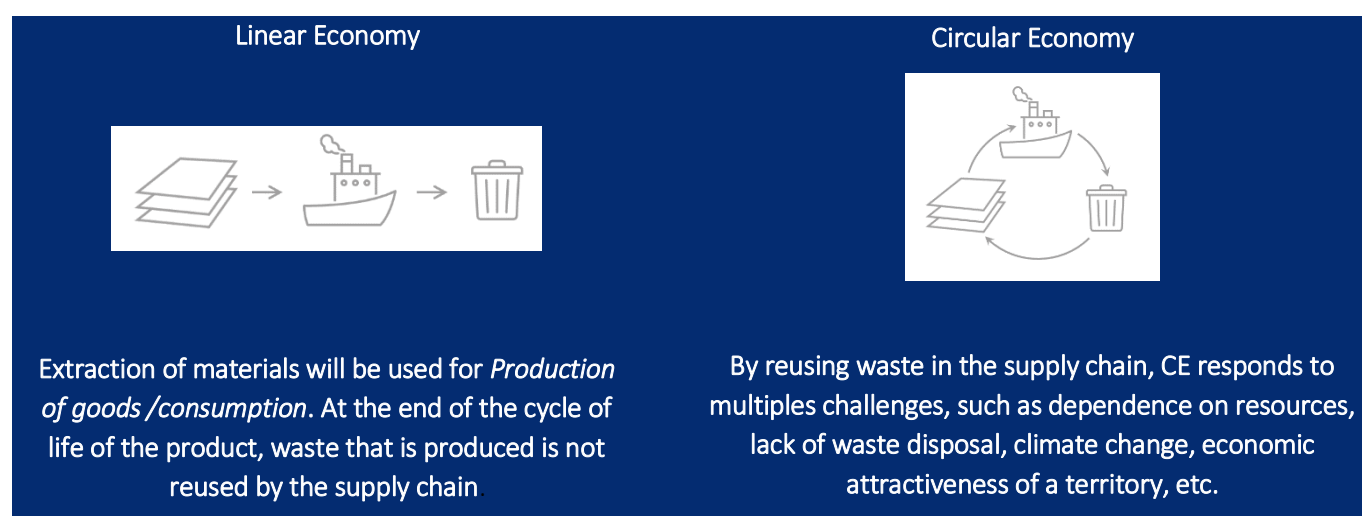
## D2.6: Circular Innovation Priorities: Bioeconomy

emerged disruptive innovations that have started to modernise conservative construction industry and improve its profitability. Research into the effects of digitalisation on the bioeconomy suggests that digitalisation is fostering transparency across value chains and helps to monitor the compliance with given rules and standards. From a rural development perspective, increased use of digital technologies is expected to play a role in attracting a younger generation to farming and rural business start-ups. Digitalisation changes the path for diversifying traditional bioeconomy sectors and is transforming the bioeconomy into an increasingly multi and interdisciplinary skilled sector.

The circular economy (CE) is becoming a familiar and understandable concept to the world, as shown by the European Commission (EC). A new [Circular Economy Action Plan](#)<sup>[1]</sup> was adopted in the framework of the [European Green Deal](#)<sup>[2]</sup> to introduce legislative and non-legislative measures to enable sustainable development. In this light, CE is engaging Europe towards a more sustainable future involving a large spectrum of actors (Members States, local authorities, citizens, productors, suppliers, innovators...) in the economic transformation with a positive environmental and societal impact.

To understand the transition, CE is often defined in contrast to the linear economy (LE). LE includes a supply chain in three main steps: extraction of materials, production of goods/consumption and waste production. In CE, products or materials considered as waste in LE can become a resource anew and so create a circular-shaped supply chain.

This could be illustrated with these following pictograms:



The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity.

<sup>1</sup> European Commission. (2020). Circular economy action plan. European Commission, March, 28.  
<https://doi.org/10.2775/855540>

<sup>2</sup> The European Green Deal, available at: [https://ec.europa.eu/info/sites/info/files/european-green-deal-communication\\_en.pdf](https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf)

## **D2.6: Circular Innovation Priorities: Bioeconomy**

Supporting healthy ecosystems is a European priority. The bioeconomy can contribute to restoring ecosystems, for instance achieving plastic-free seas and oceans. The European Environmental Agency already advises that bio-based, biodegradable materials, alternative to plastics, should be used where the risk of dispersion into the ecosystem is high, such as lubricants, materials subject to wear and tear, and disposable products.

Furthermore, a sustainable bioeconomy will contribute to the Sustainable Development Goals target of achieving land degradation neutrality by 2030 and to the ambition of restoring at least 15% of degraded ecosystems by 2020.

The bioeconomy is a central element to the functioning and success of the EU economy. The deployment of a sustainable European bioeconomy would lead to the creation of jobs, particularly in coastal and rural areas through the growing participation of primary producers in their local bioeconomies. In the bio-based industries one million new jobs could be created by 2030, according to industry estimates. The strong and fast-growing start-up ecosystem in the biotechnology sector will play a leading role in realising this potential.

A sustainable European bioeconomy supports the modernisation and strengthening of the EU industrial base through the creation of new value chains and greener, more cost-effective industrial processes.

A sustainable European bioeconomy is necessary to build a carbon neutral future in line with the Climate objectives of the Paris Agreement. For instance, in the construction sector engineered wood offers great environmental benefits as well as excellent economic opportunities. Studies show that the average impact of building with 1 ton of wood instead of 1 ton of concrete could lead to an average reduction of 2.1 tons of carbon dioxide emissions over the complete life cycle of the product (including use and disposal). A sustainable bioeconomy is also essential to the reduction of emissions in the European Energy sector. Bioenergy, currently the EU's largest renewable energy source, is expected to remain a key component of the energy mix in 2030 and contribute to meet the EU renewable energy targets of 20% in 2020 and of at least 32% in 2030.<sup>11</sup> Sustainable primary production on land and sea underpins the overall sustainability of the bioeconomy and will provide 'negative emissions' or carbon sinks, in line with the commitments of the Paris Agreement.

Responsible production and consumption and climate action will also need to be in the focus of Bioeconomy's development.

The Circular Economy Action Plan previously mentioned, which is one of the main pillars of the European Green Deal, envisions that a circular economy can strengthen the EU's industrial base and foster business creation and entrepreneurship among SMEs. The Plan aims at making sustainable products the norm in the EU while also focusing on sectors where the potential of circularity is high. One of DigiCirc main goals is to raise awareness among innovative companies and local authorities about circular Bioeconomy benefits, to contribute to collective approaches towards more circular activities, and open new business opportunities. To do so, DigiCirc will bring together a large and synergistic group of companies, public authorities, research groups, and corporates and to create an open innovation ecosystem for the CE.



## 3 Methodology

### 3.1 Methodology description

Through several processes of consultation (questionnaires, interviews with experts, cluster meeting, and DigiCirc partners meetings) and by having respondents express and/or voting for sectors/challenges which were listed, was possible to be aware of challenges and sectors that may be considered important regarding to BioE. This also helped to prioritize and get to know the DigiCirc community in the domain of Bioeconomy.

#### 1. Desk research - *Understanding the market trends (March – July 2021)*

The first task was to identify the main domain priorities by sorting out the technology, market trends and regulatory framework through an initial analysis. We called it ‘desk research’. This preliminary work helped us to identify new clusters to engage in DigiCirc ecosystem, priorities for the BioE and structure questionnaires for defining the challenges.

#### 2. Cluster engagement campaign - *Building the DigiCirc Ecosystem (March – July 2021)*

From different sources (ECCP, DigiCirc desk research team, DigiCirc ecosystem...) approx. 70 European clusters related to BioE were identified. An email with a questionnaire was sent to approx. half of them to confirm their interest of being part of DigiCirc ecosystem.

The questionnaire, which was called “Bioeconomy questionnaire for clusters”, had three sections aimed to characterize specific aspects of the clusters (information about the clusters itself, information about members and activities) and the 4th section to gather information about their interest in DigiCirc Bioeconomy thematic areas. For further information about the email and questionnaire refer to Annex 1.

#### 3. Market consultation - *Defining the challenges (June – July 2021)*

In parallel of the Clusters engagement campaign, there was launched an open market consultation through social media platforms (Twitter, LinkedIn) in order to reach a wide range of profiles, sectors, stakeholders, companies, etc. By means of a 5-minute questionnaire, the market consultation helped the project members with the definition of the key BioE challenges. For further information about the questionnaire refer to Annex 2.

The questionnaire focuses on determining the relevance of sectors, technologies in BioE digitalization as well as identifies the challenges to face regarding to BioE sectors digitalization.

#### 4. DigiCirc BioE clusters selection – *(June 2021)*

DPO carried out a selection of partners according to the following criteria: Interest in BioE thematic area, Geographical scope, Cross-sectorial, Responsiveness of clusters.

#### 5. Cluster meeting - *(8<sup>th</sup> July 2021)*

As a result of the cluster engagement campaign and clusters selection, about 20 clusters were invited to participate to the BioE AB cluster meeting online, eight cluster representatives participated in the meeting.

The main goal of the meeting was to discuss and to define the key challenges, sectors and technologies for BioE open call.

Furthermore, during the meeting DigiCirc BioE thematic DigiCirc was introduced as well as the current available digital tool, cluster-cluster synergies related to BioE were established, main interests of each cluster in DigiCirc project were identified and DPO provided information about the BioE market consultation.

### 3.2 Target Groups

We succeeded to reach four target groups for the market consultation by email and meetings.

**Clusters:** Considered to be the gateway to regional ecosystems clusters across Europe, clusters help the DigiCirc consortium to establish the DigiCirc ecosystem. They will reach out their members, in particular SMEs. European Clusters can also support SMEs in the cross-border and cross-sectors activities. To reach relevant clusters interested in BioE, a mailing campaign was performed. In addition, clusters already in contact with the DigiCirc partners were informed about the initiative and invited to join it. For further information about the clusters refer to **0 4.2 Cluster Engagement campaign**.

**Local authorities:** The Circular Economy Centre, the Regional Council of Lapland, City of Kemi, the Lapland University of Applied Sciences, The Arctic Smartness Growth -project. These key actors play a crucial role in the DigiCirc ecosystem. Their expertise in the field of CE must be considered to develop the innovative solutions that can feed into decision-making processing related to a Sustainable Bioeconomy.

**SMEs:** Keystone of DigiCirc ecosystem, they provide technology solutions in the emerging sector as the BioE domain. Following the exchanges, it turns out that many have a strong expertise in CE. Most importantly, a number of them already provide services related to circularity. For instance, some SMEs develop new cycle of life for products, process, or solution in the supply chain. They operate with corporates or/and local authorities on the subjects related to the BioE priorities.

**Competence centers:** During the engagement campaign, we managed to reach the Circular Economy Centre, which is integrated to DPO and also a competence center's cluster Ardeco. These key partners would have the opportunity to support DigiCirc and provide relevant data as their expert insights ultimately feed into decision making.

## 4 Outcomes of the different activities

During the engagement campaign, several activities were implemented: desk research, cluster engagement campaign, market consultation, cluster meeting and DigiCirc's partner meeting. Each activity had a different objective (e.g., identify challenges, reach out cluster...) but, in a whole, all contributed to generate the DigiCirc Ecosystem. In this section, we describe, in the first part, the results of the desk research (Technology Watch, Market Trends, Regulatory landscape), the conclusion of the cluster engagement campaign and the market consultation. The two last parts presents the discussions and votes of clusters invited in the cluster meeting and the final choice of the DigiCirc partners.

### 4.1 Desk Research

The Desk Research team (ICA, [Arthur's Legal](#), [DRAXIS](#)) led by DPO has performed desk research to identify a preliminary longlist of sector priorities as well as to identify market/technology trends and regulatory aspects. These trends are summarized below.

#### Technology watch

The focus of Technology watch was to carry out an initial desk research, in order to define high-level technology domains with existing applications in Bioeconomy, following a similar approach to the desk research performed for the Circular cities thematic area, which is presented in D2.5 and Blue Economy thematic area, presented in D2.7. The identified technology domains are the following six:

- Artificial Intelligence
- Blockchain
- Geographic Information System (GIS) & Spatial Mapping
- Internet of Things & Sensors/Drones
- Big data analytics
- Virtual Reality/Augmented Reality

These six technology domains represent the baseline on which specific applications are built. Either individually or combined with one another, they enable the development of solutions targeted to the bioeconomy domain and foster new and exciting innovations. The digital innovations can assist in the transition from a linear to a circular economy by improving data collection and information exchange, by making products and processes circular or by educating and influencing the public to take part in this effort. More specifically, in the following figure some high-level technological examples and how they relate to Bioeconomy are presented<sup>3</sup>.

#### Smart design to meet needs at all stages of the value chain

Smart design could be used to extend the lifetime of a product or reuse parts of it that can be recycled. Material tracking can provide information on the product's composition, favoring reuse or recycling.

#### National bioeconomy monitoring system based on big data analysis

Such systems could allow the assessment of trends, the identification of new production processes or the calculation of saved emissions using quick real time processing and automatic data flows.

#### New platforms with information on the stock of bio-based materials updated in real time

<sup>3</sup> Leitão, Alexandra, Pintado, Maria Manuela Estevez, Rebelo, Francisco, Ribeiro, Tânia, "Circular and Digital Bioeconomy", 2019

## D2.6: Circular Innovation Priorities: Bioeconomy

Digital marketplaces are very common in many domains and bioeconomy should be no exception. Real-time information for bio-based materials will allow the increase of availability and better tracking of volume and quality.

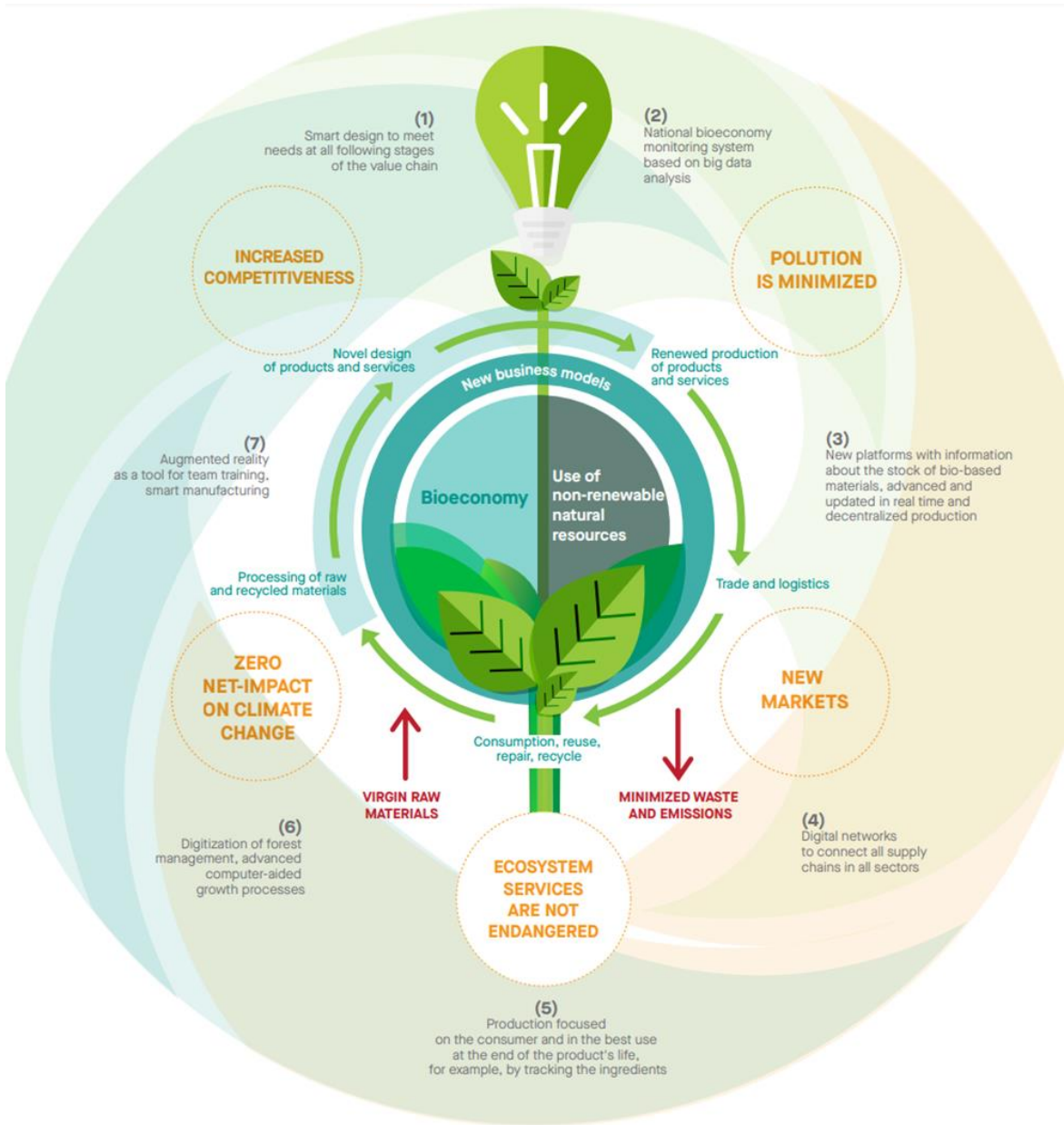


Figure 1: Application of digitization to the concept of bioeconomy

## Digital networks to connect all supply chains in all sectors

Such networks could help in identifying the relations between newly connected sectors and they could cover the demand of one sector with the surplus of another.

Production focused on the consumer and in the best use at the end of a product's life

Smart order systems can lead to a consumer-centric production and they could guide the consumers towards circular use. Through ingredient tracking, complementary materials can be brought together based on the processes followed at the end of their use and their potential after that.

## Digitization of forest management and computer-aided growth processes

Forest growth can be managed according to specific needs and automated processes can make sure each area receives the respective growth input factors and is handled differently. The processes can be programmed

## D2.6: Circular Innovation Priorities: Bioeconomy

accordingly, when the production circumstances change. Harvesting and transport could be automated as well, minimizing the environmental impact.

### Augmented reality for education and training

Virtual and augmented reality will provide interesting and interactive ways to educate staff on machinery or electronics handling, in a virtual environment, saving time and resources <sup>[4]</sup>.

A few applications based on the high-level solutions presented, are mentioned below.

An application of **AI technology** in the **pharmaceuticals** sector are drug repurposing programs, trying to identify and propose new uses for existing drugs with the use of bioinformatics. This approach decreases R&D resources and increases the circularity of existing drugs produced in mass quantities <sup>[5]</sup>. Research also focuses on applications of ICT technology in enhancing sustainable **building construction** and renewable materials by using methods such as building information modeling and technologies like **IoT** to collect sensor data and **big data analytics** for analysis and management <sup>[6]</sup>.

**Forestry** is a domain with many digitalization applications at the moment, the first one being the use of **blockchain** technology. The benefits of blockchain are highly applicable in this sector, aiming for chain transparency and easier management of transactions and contract fulfilment. Origin and material information can be readily available without administrative procedures, even after border crossing <sup>[7]</sup>. Furthermore, it is important to mention the potential role of **GIS** technology in this sector, as it can help locate and design multisectoral bioeconomic clusters in a certain area, meaning interconnected facilities using renewable biological resources. Spatial mapping is an indispensable tool to identify the most suitable location for such a cluster and as a next step, its composition. A possible target of this application is forest management <sup>[8]</sup>. Finally, combinations of trending ICT technologies are examined for **Forestry** and **Biomass crop** pilots, where **big data analytics**, earth observation and **GIS** along with **IoT** are used together to create innovative complex solutions, using massive flows of data from sensors in soil and air and aerial and satellite images <sup>[9]</sup>.

**GIS** can be used also to calculate and geo-localize **biomass** residues stemming from various activities, that can be used as a key feedstock for other activities, revealing opportunities for circularity in specific regions <sup>[10]</sup>. The efficiency of biomass supply chains, to be used in bio-based industries, can be increased as well, by integrating **IoT** and other 4.0 technologies <sup>[11]</sup>. **Biofuels** is another sector that can be enhanced, this time with the use of **blockchain** and more specifically a blockchain database for sustainable biofuels. This application will improve data integrity and resolve

---

<sup>4</sup> Antje Klitkou, Joe Bozell, Calliope Panoutsou, Michael Kuhndt, Jaakko Kuusisaari, Jan Peter Beckmann, “Bioeconomy and digitalization”, 2017

<sup>5</sup> Andrii Buvailo, “How Big Pharma Adopts AI To Boost Drug Discovery”, 2018

<sup>6</sup> Research at the InnoRenew CoE. Available in <https://innorenew.eu/research/>

<sup>7</sup> Interreg central Europe, “Chain reactions, thematic brief bioeconomy 2: Blockchains in the bioeconomy”, 2021

<sup>8</sup> Vibeke Nørstebø1&Svein Olav Krøgli2&Misganu Debella-Gilo2&Gerardo A. Perez-Valdes1&Kristin T. Uggen1&Wenche E.

<sup>9</sup> <https://www.neuropublic.gr/en/news-en/the-databio-project-starts-trials-of-26-bioeconomy-pilots/>

<sup>10</sup> Lorie Hamelin, Magdalena Borzęcka, Małgorzata Kozak, Rafał Pudelko, “A spatial approach to bioeconomy: Quantifying the residual biomass potential in the EU-27”, 2019

<sup>11</sup> DataBio. Data-Driven Bioeconomy. Available in <https://ictbiochain.eu/>

transparency issues and it will facilitate business processes and compliance by representing operational processes with technical solutions<sup>[12]</sup>.

### Market trends

The first step of the market trends analysis has been to identify the main sector of the bioeconomy domain. These were divided into three categories: (i) **Novel natural and green materials**; (ii) **Sustainable constructions and structures**, and (iii) **Bioeconomy services**. These three categories of sectors have been selected based on their high potential for developing circular business and circular solutions.

Hereafter, it is included an analysis of the current market trends for the main bioeconomy sectors within the three mention categories: (i) pharmaceuticals, (ii) textiles and wearing apparel, (iii) building materials and construction, (iv) packaging, (v) motor vehicles and components, (vii) other forest products, (viii) electronics and electrical products, (ix) machinery and equipment, (x) biomass energy and biofuels, (xi) food and feed losses and waste for composting purposes

#### BIOECONOMY INDUSTRY TRENDS IN PHARMACEUTICALS

##### Innovative bio-based pharmaceuticals:

- Biopharmaceuticals are large biological molecules, such as proteins, used to treat diseases that cannot easily be addressed by chemical molecules, such as autoimmune diseases or cancer.
- Introduction of blockchain into the production of biopharma is increasingly being discussed.

##### Plant-made pharmaceuticals:

- New innovative agents based on biomass, such as an HIV vaccine from tobacco plants, or carrot cells to treat certain metabolic disorders
- 75% of medicinal plants are used for phytopharmaceuticals and the remainder are used for health food (18%) and cosmetics (7%)

##### Semisynthetic pharmaceuticals:

- Certain pharmaceuticals are produced through semi synthesis with chemicals that means they are generally made by converting starting materials from natural sources into final products via chemical reactions
- Examples of semi-synthetic medicine include the antibiotic, penicillin, and the chemotherapy. Commonly called 'chemo'.

#### BIOECONOMY INDUSTRY TRENDS IN TEXTILES AND WEARING APPAREL

##### Traditional natural fibers

- Natural fibres make up an approximate 41% share in the textiles market, behind synthetic fibres (59%).
- One of the major disadvantages of the largest conventional natural fibre, cotton, is its high water and chemical consumption in the production process. Man-made cellulosic fibres address this issue
- In recent years, technologies have been developed to recycle cotton into viscose fibres

##### Innovative natural and synthetic bio-based fibres

- New natural fibres include jute, flax, and hemp, which primarily serve as technical textiles for industrial use.

---

<sup>12</sup> Roundtable on Sustainable Biomaterials (RSB) and Bioledger, "Blockchain database for sustainable biofuels: A case study", 2020

## **D2.6: Circular Innovation Priorities: Bioeconomy**

- Synthetic spider silk relies on the same proteins as natural silk but is created via fermentation spun into yarns.
- Similarly, protein-based replacements for fur, leather, and wool are being developed.

### **Man-made cellulosic fibres (MMCF)**

- Among natural fibres, man-made cellulosic fibres such as viscose, modal, and lyocell have some of the highest growth rates
- These are made from cellulose found in eucalyptus or beech wood, for example.

## **BIOECONOMY INDUSTRY TRENDS IN BUILDING MATERIALS AND CONSTRUCTION**

### **Increasingly integrate wood-/ bio-based products in structural elements of buildings**

- Bio-based construction materials such as wood are increasingly replacing conventional building materials.
- In 2017, over 60% of all bio-building materials came from forestry.
- Modern wood products, such as laminated veneer lumber (LVL) or cross laminated timber (CLT) can be used to create loadbearing walls from large sheets and allow offsite premanufacturing to increase construction efficiency.

### **Bio-based interior construction**

- The use of biomass-based building materials for interior finishing includes, among others, natural fibres and resins for insulation, lining, and floor coverings.
- Bio-based interior building materials often require less energy in production and through good insulation properties can further reduce building lifetime energy use.

### **Wood fibres and lignin in biocomposites**

- Lignin from biomass waste is used as a plasticizer in concrete production, which reduces water use by 15% as compared to conventional chemical plasticizers.
- Wood cement composites exhibit good bending and shear stiffness and can make use of recycled pulp and solid wood waste.
- Polymer-based biocomposites combine biobased fibres and polymers to form high strength materials.
- Polymers can be conventional, recycled, or biobased.

## **BIOECONOMY INDUSTRY TRENDS IN PACKAGING**

### **Flexible packaging paper (fibre-based)**

- Flexible paper is used for food, tobacco, medical, pharma, cosmetics, and personal care packaging due to its light weight and low production and freight costs.

### **Board-based packaging (fibre-based)**

- Three types of packaging board are currently in use:
  - corrugated board (for example for online trade, food & drink, and industrial products),
  - folding cartons (for example for food or pharma),
  - liquid packaging board (mainly for dairy, fruit drinks, and more recently cosmetics).
- Paper board represents a large share of about 35% in the global packaging market.



### 3D formed fibre

- 3D formed fibre or pulp forming packaging present a promising alternative to fossil fuel-based packaging materials for food, cosmetics, and a wide range of products.
- Formed fibre can be used for the production of most 3D shapes achieved in plastic today
- These wood-based packaging materials are plastic free, biodegradable, renewable, recyclable, and food and hygiene safe.

### Bioplastics in packaging

- Only about 1% of all packaging currently covers bioplastics (such as Bio-PET (Bio-Polyethylene terephthalate) for drinking bottles or Bio-PE (Bio-Polyethylene) for food, cosmetics, and pharma packaging).
- Bio-based polymers are expected to grow at a CAGR (Compound annual growth rate) of 18% until 2021.

## BIOECONOMY INDUSTRY TRENDS IN MOTOR VEHICLES AND COMPONENTS

### Biopolymers for automotive use

- Different types of biopolymers such as PLA (Polylactic acid) and PBS (Polybutylene succinate)
- are used in motor vehicles to replace conventional plastics and even metal car components.
- The global bio-based polymer market in automotive is expected to grow 6% until 2025.

### Natural fibres in motor vehicles

- Various natural fibres are used in innovative automobiles, such as hemp for specific boards and vehicle steel parts, or sisal fibre for floor mats.

### Tires made from dandelion or guayule

- Newer innovations include the ongoing development of tires made from dandelion or guayule.
- Other circular initiatives in tires include using silica derived from rice husk ash as an alternative source for silica, and the use of alternative oils.

## BIOECONOMY INDUSTRY TRENDS IN OTHER FOREST PRODUCTS

### A variety of wood uses

- Material use of wood includes traditional products such as paper, furniture, or care products
- as well as more innovative biomaterials such as microfibrillated cellulose to be used in specialty papers and the use of wood fibres in composite materials.

### End-of-life of forest products

- Wood fibre is a renewable and biodegradable material.
- with a global recycling rate of approximately 60% paper is one of the most recycled materials globally.
- For fibre to reach its full recycling capacity (around seven times), the input of virgin fibre is necessary at each cycle.

### Bio-based chemicals

- Biobased chemicals represent a promising new market for forest products with multiple applications such as bio-based aromas for fragrances and flavours, lubricants, natural fertilizers, or cleaners and solvents.



### BIOECONOMY INDUSTRY TRENDS IN ELECTRONICS AND ELECTRICAL PRODUCTS

#### Bio-based electronics and electrics

- Producers of electronic and electrical products increasingly make use of bio-based materials, mainly biopolymers such as PLA and PBS.
- While PLA is expensive, it has been designed to provide superior properties such as combined shape memory and recyclability.

#### Bio-casings, enclosures, and others

- Applications of biomass-based materials in electronic and electrical products include casings, enclosures, sensors, actuators, optics, shielding, photovoltaics, and displays.
- one major advantage of the use of biopolymers is their lower production temperature

#### Bio-household appliances

- Household appliances such as toasters, coffee machines, electric kettles, and vacuum cleaners based on biopolymers are currently being developed for commercial use.

### BIOECONOMY INDUSTRY TRENDS IN MACHINERY AND EQUIPMENT

#### Novel engineering in biorefineries and biochemical facilities

- Industrial biotechnology produces a wide variety of products in biorefineries and biochemical facilities, ranging from bio-based chemicals and pharmaceuticals to food additives and cosmetic ingredients.
- cultures such as microorganisms and algae, bioreactors produce new types of biomaterials.

#### Biopolymers in engineering

- About 20% of all biopolymers are used in industrial engineering.
- The global biopolymer market for industrial use is expected to increase by 5% per year and is anticipated to reach 445,000 tonnes in 2025.

#### Production of innovative biobased materials

- New developments in injection moulding and related processes have paved the way to produce hybrid bio-based materials.
- the production of bio lubricants, currently only 3% of the overall lubricants market, is increasingly growing.

### BIOECONOMY INDUSTRY TRENDS IN BIOMASS ENERGY AND BIOFUELS

#### Wood as heating material

- Over 50% of all renewable energy is from biomass, out of which the majority originates from wood.
- When discussing wood as an energy source, traditional wood burning in stoves and fires is considered less or not at all sustainable in comparison with modern use, for example in modern heating systems or industrial applications.
- Wood as bioenergy, as well as other types of bioenergy, offer the advantage of generating energy when required.

## **D2.6: Circular Innovation Priorities: Bioeconomy**

### **Biogas from fermentation**

- Biogas plants transform energy crops such as maize, animal manure, and other residuals into methane, often referred to as biogas.
- Organic material waste from this fermentation process can be used as field fertilizers.

### **Biofuels for transportation**

- Biofuels obtained from crops (first generation), residues/agriculture waste (second generation), and algae (third generation) are used in automobiles, ships, and aircrafts.
- Biodiesel is currently the most widely used biofuel type.
- bioethanol and biomethane are other relevant biofuel types.

## **THE BIOECONOMY IN FOOD AND FEED LOSSES AND WASTE FOR COMPOSTING PURPOSES**

### **Composting to feed the soil**

- The transformation of biological waste into fertilizer through composting is a mature technology that is performed for centuries.
- This is not only limited to food and feed waste and loss but can also extend to agricultural waste and other compostable waste, for example suitable paper, cardboard, or cellulose fabrics.

### **Development of new collection methods and services**

- Separation of food and feed waste at the source is critical to ensure a clean feedstock for composting.
- Countries and municipalities are setting up new, distinct collection methods to separate food and feed waste from the general household waste.
- In addition, companies offer composting services to restaurants, cities, or individuals.

### **Innovation to improve composting strategies**

- Companies also innovate in the field of organic or inorganic additives, microbiological variations, and the mitigation of gaseous emissions to improve food waste composting.
- These innovations can decrease the composting time and increase compost quality.

## **POTENTIAL BARRIERS TO SCALING CIRCULAR BIOECONOMY AND SUGGESTED SOLUTIONS**

1. Financial Flows. The initial investments needed for a transformation can be considered too high
2. Technology. The implementation of technology or availability of viable technology may not be sufficient
3. Policy and Regulation. Required public support and regulation may not yet fully be in place and subject to policy adaptations
4. Mindset and Values. Public opinion on bio-based material is often still ambiguous and customers are rarely willing to pay a price premium

### Regulatory landscape

Starting from the main provisions on environment under EU Primary Law, this section focuses on producing an overview of the EU policy instruments pertinent to the area of Bioeconomy. The discussion, also, touches upon the related European regulations adopted in the context of the earlier stated EU policy instruments. The section below aims at setting the policy scene concerning Bioeconomy at EU level rather than producing an exhaustive analysis of all the relevant regulations currently applicable within EU.

Note that the discussion below builds on the associated discussion captured under D2.5 on Circular Innovation Priorities: Circular Cities<sup>[13]</sup> and under D2.7 on Circular Innovation Priorities: Blue Economy<sup>[14]</sup>. It will be, also, complemented by the related content on Bioeconomy to be made available through the Info Portal<sup>[15]</sup> integrated under the project's website.

### EU Primary Law

Article 191 – 194 of The Treaty on the Functioning of the European Union (TFEU) requires EU policy to contribute to several objectives including preserving and protecting the quality of the environment and promoting judicious and rational use of natural resources. In addition, the TFEU also requires that Union policy on energy should aim to promote energy efficiency and energy saving and also the development of new and renewable forms of energy.

In this context, the European Regulator has been taking initiatives through policy actions, strategies, regulations and other soft law instruments to support and improve Bioeconomy while also focusing on economic development in the EU. In the context of these initiatives taken, it has been considered that “bioeconomy” covers the production of renewable biological resources, their conversion into food, feed, bio-based products and bio-energy. It, thus, includes waste streams, agriculture, forestry, fisheries, food, pulp and paper production, chemicals, biotechnology and energy<sup>[16]</sup>.

### EU Policy Instruments

As it was discussed in the above-mentioned deliverables i.e., D2.5 Circular Innovation Priorities Circular Cities<sup>[17]</sup> and D2.7 on Circular Innovation Priorities: Blue Economy, the EU has been a front-runner in taking measures and policies to improve environmental quality, which is essential for human health, quality of life as well as the economy. The discussion now focuses on certain instruments adopted at EU level that were considered particularly relevant for the area of Bioeconomy, as well as on certain instruments that are relevant for the scope of DigiCirc as a whole, including for the area of Bioeconomy.

### Background developments

---

<sup>13</sup> D2.5: Circular Innovation Priorities Circular Cities, available at: [https://digidirc.eu/wp-content/uploads/2020/11/D2.5\\_Circular\\_Innovation\\_Priorities\\_V3\\_Final.pdf](https://digidirc.eu/wp-content/uploads/2020/11/D2.5_Circular_Innovation_Priorities_V3_Final.pdf)

<sup>14</sup> This deliverable is currently under review by the European Commission services.

<sup>15</sup> See, also, <https://infoportal.digidirc.eu/>

<sup>16</sup> European Commission. Innovating for sustainable growth: a bioeconomy for Europe. (COM/2012/060 final). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 2012.

<sup>17</sup> D2.5: Circular Innovation Priorities Circular Cities, available at: [https://digidirc.eu/wp-content/uploads/2020/11/D2.5\\_Circular\\_Innovation\\_Priorities\\_V3\\_Final.pdf](https://digidirc.eu/wp-content/uploads/2020/11/D2.5_Circular_Innovation_Priorities_V3_Final.pdf)

## D2.6: Circular Innovation Priorities: Bioeconomy

Already as of 2008, European Commission proposed changes relevant for the area of Bioeconomy, for instance, by taking initiatives within the specific area of European waste legislation<sup>[18]</sup> that would require Member States to collect bio-waste separately from other waste streams whenever possible, while banning the landfilling of waste that has been separately collected. The proposed changes were adopted and several waste management principles were ultimately introduced under EU law along with a “waste hierarchy” that sets out an order of preference for waste management. As of then, European Commission has put forward a series of proposals related to waste such as the recently proposed regulation on the Waste Framework Directive for Batteries and Accumulators<sup>[19]</sup>.

### The EU Bioeconomy Strategy

In the light of the more recent developments, it has been made explicit that the shift to a sustainable Bioeconomy is expected to contribute to the overall objectives and specific initiatives of the **European Green Deal**<sup>[20]</sup> and to the success of many EU policies. In the era of global challenges such as biodiversity loss, growing population, ecosystem degradation, climate change and increasing consumption of resources, the **EU strategy for A Sustainable Bioeconomy for Europe**<sup>[21]</sup>, which also resonates in the European Work Program 2021 to be touched upon below<sup>[22]</sup> aims to further pursue sustainable development within the ecological boundaries of mother earth<sup>[23]</sup>.

In particular, the EU Bioeconomy Strategy<sup>[24]</sup> is operating within existing policy context which is including a variety of sectorial policies such as the New Industrial Strategy for Europe<sup>[25]</sup>, the regulation on the Governance of the Energy Union and Climate Action<sup>[26]</sup> in the context of which bioeconomy is identified as one of the seven strategic building blocks of the EU long-term vision to reach climate-neutrality by 2050, the Common Agricultural Policy

---

<sup>18</sup> Proposal for a directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste. [http://eur-lex.europa.eu/resource.html?uri=cellar:c2b5929d-999e-11e5-b3b7-01aa75ed71a1.0018.02/DOC\\_1&format=PDF](http://eur-lex.europa.eu/resource.html?uri=cellar:c2b5929d-999e-11e5-b3b7-01aa75ed71a1.0018.02/DOC_1&format=PDF).

<sup>19</sup> Proposal for a Regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020, available at: [https://ec.europa.eu/environment/pdf/waste/batteries/Proposal\\_for\\_a\\_Regulation\\_on\\_batteries\\_and\\_waste\\_batteries.pdf](https://ec.europa.eu/environment/pdf/waste/batteries/Proposal_for_a_Regulation_on_batteries_and_waste_batteries.pdf)

<sup>20</sup> European Commission. Communication from the Commission to the European Parliament, The European Council, the Council, the European Economic and Social Committee and the Committee of the Regions The European Green Deal.COM (2019) 640 final. 2019. [https://ec.europa.eu/info/sites/info/files/european-green-deal-communication\\_en.pdf](https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf).

<sup>21</sup> European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment (COM(2018) 673 final) 2018. <https://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52018SC0431&from=EN>

<sup>22</sup> Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Commission Work Programme 2021, available at: [https://ec.europa.eu/info/sites/info/files/2021\\_commission\\_work\\_programme\\_annexes\\_en.pdf](https://ec.europa.eu/info/sites/info/files/2021_commission_work_programme_annexes_en.pdf)

<sup>23</sup> Bell J, Paula L, Dodd T, Németh S, Nanou C, Mega V, et al. EU ambition to build the world's leading bioeconomy—uncertain times demand innovative and sustainable solutions. N Biotechnol 2018;40:25–30. <https://doi.org/10.1016/j.nbt.2017.06.010>.

<sup>24</sup> European Commission. Innovating for sustainable growth: a bioeconomy for Europe. (COM/2012/060 final). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. 2012.

<sup>25</sup> European Commission. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. A New Industrial Strategy for Europe.COM(2020) 102 final. 2020. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:102:FIN>.

<sup>26</sup> Regulation(EU)2018/1000 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC). [https://eurlex.europa.eu/legalcontent/EN/TXT/?toc=OJ:L:2018:328:TOC&uri=uriserv:OJ.L\\_.2018.328.01.0001.01.ENG](https://eurlex.europa.eu/legalcontent/EN/TXT/?toc=OJ:L:2018:328:TOC&uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG)

## D2.6: Circular Innovation Priorities: Bioeconomy

(CAP)<sup>[27]</sup>, the Common Fisheries Policy (CFP)<sup>[28]</sup>, the European strategic long-term vision for a modern, competitive, prosperous and climate neutral economy<sup>[29]</sup>, the EU Biodiversity Strategy<sup>[30]</sup>, Europe's Strategy for research and innovation<sup>[31]</sup>, the European action for sustainability<sup>[32]</sup>, the new Circular Economy Action Plan<sup>[33]</sup> and the EU Trade Policy<sup>[34]</sup>. Furthermore, as it is inferred, Bioeconomy can create an impact on European Industry; in this respect, it is expected that the deployment of innovative solutions for the production of new and sustainable bio-based products will strengthen the European capacity to substitute fossil raw materials in very significant parts of European industry which is in turn in line with the renewed EU Industrial Policy Strategy<sup>[35]</sup>.

In light, also, of the above, the table below summarizes the most relevant policy initiatives taken within the area of Bioeconomy, as well as with respect to related sectors such as the food and nutrition security.

---

<sup>27</sup> European Parliament, Council of the European Union. Regulation (EU) No 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) No 352/78, (EC) No 165/94, (EC) No 2799/98, (EC) No 814/2000, (EC) No 1290/2005 and (EC) No 485/2008. 2017 <http://data.europa.eu/eli/reg/2013/1306/2018-01-01>.

<sup>28</sup> European Parliament, Council of the European Union. Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC vol. L 354/22. 2013. <http://data.europa.eu/eli/reg/2013/1380/2019-08-14>.

<sup>29</sup> European Commission. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the regions and the European Investment Bank. A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. COM(2018) 773 final. 2018. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773>.

<sup>30</sup> European Commission. Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. Our life insurance, our natural capital: an EU biodiversity strategy to 2020. COM(2011) 244 final. 2011. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0244>.

<sup>31</sup> Shaping EU Research and Innovation Policy. [https://ec.europa.eu/info/research-and-innovation/strategy/support-policy-making/shaping-eu-research-and-innovation-policy\\_en](https://ec.europa.eu/info/research-and-innovation/strategy/support-policy-making/shaping-eu-research-and-innovation-policy_en)

<sup>32</sup> European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Next steps for a sustainable European future – European action for sustainability. COM(2016) 739 final. 2016.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0739>

<sup>33</sup> European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new Circular Economy Action Plan For a cleaner and more competitive Europe (COM/2020/98 final). 2020.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN>.

<sup>34</sup> EU Trade Policy. Commission sets course for an open, sustainable and assertive EU trade policy. [https://ec.europa.eu/commission/presscorner/detail/en/ip\\_21\\_644](https://ec.europa.eu/commission/presscorner/detail/en/ip_21_644)

<sup>35</sup> COM(2017)479, Investing in a smart, innovative and sustainable Industry A renewed EU Industrial Policy

Strategy, 13.09.2017. [https://eur-lex.europa.eu/resource.html?uri=cellar:c8b9aac5-9861-11e7-b92d-01aa75ed71a1.0001.02/DOC\\_1&format=PDF](https://eur-lex.europa.eu/resource.html?uri=cellar:c8b9aac5-9861-11e7-b92d-01aa75ed71a1.0001.02/DOC_1&format=PDF)

## D2.6: Circular Innovation Priorities: Bioeconomy

Strategies relevant to the bioeconomy	
Bioeconomy specific	<ul style="list-style-type: none"> <li>➤ Commission communication 'Innovating for sustainable growth: a bioeconomy for Europe' (EC 2012a)</li> </ul>
Sectors mainly supplying biomass	
Agriculture	<ul style="list-style-type: none"> <li>➤ Commission communications: legislative proposals on the common agricultural policy (CAP) beyond 2020 (COM/2018/392 final; COM/2018/393 final; COM/2018/394 final/2)</li> <li>➤ Commission communication 'Thematic Strategy for Soil Protection' (SEC(2006)620)</li> </ul>
Forest-based sector	<ul style="list-style-type: none"> <li>➤ Commission communication 'A new EU forest strategy: for forests and the forest-based sector' (EC 2013a)</li> <li>➤ Commission staff working document 'Multiannual implementation plan of the new EU forest strategy' (EC 2015a)</li> <li>➤ Blueprint for the EU Forest-based Industries (SWD(2013)343)</li> </ul>
Fisheries, aquaculture and algae	<ul style="list-style-type: none"> <li>➤ The Common Fisheries Basic Regulation (EU) No 1380/2013</li> <li>➤ Commission communication 'Blue growth: opportunities for marine and maritime growth' (EC 2012e)</li> <li>➤ Report on the Blue Growth Strategy, Towards more sustainable growth and jobs in the blue economy, SWD (2017) 128 final</li> <li>➤ Commission communication 'Strategic guidelines for the sustainable development of EU aquaculture' (EC 2013e)</li> <li>➤ Joint communication "International ocean governance agenda for the future of our oceans" (EC 2016)</li> </ul>
Waste	<ul style="list-style-type: none"> <li>➤ See cross-cutting policies (below)</li> </ul>
Sectors mainly using biomass	
Food and nutrition security	<ul style="list-style-type: none"> <li>➤ Commission communication 'An EU policy framework to assist developing countries in addressing food security challenges' (EC 2010e)</li> <li>➤ Commission communication 'Increasing the impact of EU development policy: an agenda for change' (EC 2011c)</li> <li>➤ Commission communication 'Enhancing maternal and child nutrition in external assistance: an EU policy framework' (EC 2013b)</li> <li>➤ Commission communication 'The EU approach to resilience: learning from food security crises' (EC 2012c)</li> </ul>
Energy	<ul style="list-style-type: none"> <li>➤ EU Renewable Energy Directive (2009/28/EC)</li> <li>➤ Commission communication 'An energy policy for Europe' (EC 2007a)</li> <li>➤ Commission communication 'A European strategic energy technology plan (SET-plan) — Towards a low carbon future' (EC 2007b)</li> <li>➤ Commission communication 'Limiting global climate change to 2 degrees Celsius — The way ahead for 2020 and beyond' (EC 2007c)</li> <li>➤ Commission communication 'Energy 2020 — A strategy for competitive, sustainable and secure energy' (EC 2010f)</li> </ul>

28 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC024452011DC0244>



## D2.6: Circular Innovation Priorities: Bioeconomy

	<ul style="list-style-type: none"> <li>➤ Commission communication 'Energy roadmap 2050' (EC 2011d)</li> <li>➤ Commission communication 'A policy framework for climate and energy in the period from 2020 to 2030' (EC 2014a)</li> <li>➤ Commission communication: 'Accelerating Europe's transition to a low-carbon economy' (EC 2016k)</li> <li>➤ Clean Energy Package (2016)</li> <li>➤ Commission communication 'The role of waste-to-energy in the circular economy', (EC 2017a)</li> </ul>
<b>Bio-based industries</b>	<ul style="list-style-type: none"> <li>➤ Commission communication 'A lead market initiative for Europe' (EC 2007d)</li> <li>➤ Commission communication 'Preparing for our future: developing a common strategy for key enabling technologies in the EU' (EC 2009)</li> <li>➤ Commission communication: 'A stronger European industry for growth and economic recovery' (EC 2012d)</li> <li>➤ Commission communication 'For a European industrial renaissance' (EC 2014f)</li> <li>➤ Future strategy on plastics use, reuse and recycling (EC 2016l)</li> </ul>
<b>Cross-cutting policies relevant for the bioeconomy</b>	
<b>Environmental protection and Climate Change</b>	<ul style="list-style-type: none"> <li>➤ EU Action Plan for Nature, People and the Environment (COM(2017)0198 final)</li> <li>➤ EU Biodiversity Strategy (COM/2011/0244 final)</li> <li>➤ EU Strategy on adaptation to climate change (COM/2013/0216 final)</li> </ul>
<b>Circular economy — Waste</b>	<ul style="list-style-type: none"> <li>➤ Commission communication 'Towards a circular economy: a zero waste programme for Europe' (EC 2014e)</li> <li>➤ Commission communication 'Closing the loop — An EU action plan for the circular economy' (EC 2015b)</li> <li>➤ Commission communication 'The role of waste-to-energy in the circular economy' (EC 2017a)</li> <li>➤ Future strategy on plastics use, reuse and recycling (EC 2016l)</li> <li>➤ Waste package 2018</li> <li>➤ Fertiliser Regulation (Regulation (EC) No 2003/2003)</li> <li>➤ A European Strategy for Plastics in a Circular Economy (EC 2018)</li> </ul>
<b>Regional policies — Smart specialisation</b>	<ul style="list-style-type: none"> <li>➤ Commission communication 'Regional policy contributing to smart growth in Europe 2020' (EC 2010g)</li> <li>➤ Commission communication 'Strengthening Innovation in Europe's Regions: Strategies for resilient, inclusive and sustainable growth (EC 2017)</li> </ul>
<b>Research and innovation</b>	<ul style="list-style-type: none"> <li>➤ Commission communication 'Europe 2020 flagship initiative — Innovation union' (EC 2010a)</li> </ul>
<b>Industrial policy</b>	<ul style="list-style-type: none"> <li>➤ Commission Communication 'Investing in a smart, innovative and sustainable Industry- A renewed EU Industrial Policy Strategy' (COM/2017/0479 final)</li> </ul>

Table 1: EU policies relevant for the bioeconomy

Overall, the **Bioeconomy Strategy** aims at accelerating deployment of a sustainable European Bioeconomy and has set out **five (5) goals**, namely, **to ensure food and nutrition security, to manage natural resources sustainably, to reduce dependencies on non-renewable resources, to limit and adapt to climate change and to strengthen European competitiveness and create jobs**. In order to support the said objectives in relation to policy priorities, the strategy proposes three main action areas: 1) to strengthen and scale-up the bio-based sectors, unlock investments and markets 2) to deploy local bioeconomies rapidly across Europe; and 3) to understand the ecological boundaries of the bioeconomy. Initiatives and efforts pursuant to the Bioeconomy Strategy also accelerate the EU's contribution towards the UN Sustainable Development Goals as can be seen in the Figure below.

## D2.6: Circular Innovation Priorities: Bioeconomy

EU Strategy Objective	Normative criteria	Related SDGs
1. Ensuring food and nutrition security	<ul style="list-style-type: none"> <li>- Food security and nutrition are supported</li> <li>- Sustainable trade of biomass for food uses is promoted</li> </ul>	    
2. Managing natural resources sustainably	<ul style="list-style-type: none"> <li>- Ecosystem condition and biodiversity are maintained or enhanced</li> <li>- Primary production sectors are managed sustainably</li> <li>- Ecosystem services contribution to human well-being is maintained or enhanced without deteriorating ecosystem condition and/or biodiversity</li> </ul>	    
3. Reducing dependence on non-renewable, unsustainable resources, whether sourced domestically or from abroad	<ul style="list-style-type: none"> <li>- Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain are improved</li> <li>- Food loss and waste are prevented or minimised and, when unavoidable, its biomass is reused or recycled</li> <li>- Sustainable production and consumption of biomass and bio-based products (within EU) are promoted. Consumption patterns of bioeconomy goods match sustainable supply levels of biomass</li> <li>- Bioeconomy should promote sustainable trade of biomass for non-food uses</li> <li>- Sustainability of urban centres is enhanced</li> </ul>	         
4. Mitigating and adapting to climate change	<ul style="list-style-type: none"> <li>- Climate change mitigation and adaptation are pursued</li> <li>- The sustainability of urban centres is enhanced</li> </ul>	 
5. Strengthening European competitiveness and creating jobs	<ul style="list-style-type: none"> <li>- Economic development is fostered</li> <li>- Inclusive economic growth is strengthened</li> <li>- Resilience of the rural, coastal and urban economy is enhanced</li> <li>- Existing knowledge is adequately valued and proven sound technologies are fostered</li> <li>- Knowledge generation and innovation are promoted</li> <li>- Demand and supply-side market mechanisms of food and non-food goods are enhanced</li> </ul>	     

Figure 2: Objectives of the 2018 EU Bioeconomy Strategy and the main criteria to monitor its effectiveness.

The mapping to SDGs is carried out by comparing key components/criteria of the EU Bioeconomy framework to the UN SDG targets identified.

### EU Green Deal

The Green Deal, announced in December 2019 aims at turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all. Moreover, it aims to boost the efficient use of resources by moving to a clean, circular economy. The Green Deal acknowledges the importance of a sustainable product policy in reducing waste to a large extent. The Green Deal suggests that in cases where wastage is unavoidable, economic value must be recovered and its impact on the environment should be avoided or minimized. The Green Deal also supports the “Farm to Fork” strategy as a means to strengthen efforts towards climate change and to protect and preserve the environment.

### EU Circular Economy Action Plan

The Circular Economy Action Plan<sup>[36]</sup> which is one of the main pillars of the European Green Deal envisions that a circular economy can strengthen the EU’s industrial base and foster business creation and entrepreneurship among SMEs. The Plan aims at making sustainable products the norm in the EU while also focusing on sectors where the potential of circularity is high. In addition, the Plan also states that the Commission will ensure circularity in industry as envisioned by the European Industrial Strategy by supporting the sustainable and circular bio-based sector through the implementation of the Bioeconomy Action Plan. Moving away from the “take-make-use-dispose” approach taken by manufacturers of products, the Plan aims at encouraging product durability and usability and to also increase recycled content in products.

<sup>36</sup> Circular Economy Action Plan, available at: [https://ec.europa.eu/environment/circular-economy/pdf/new\\_circular\\_economy\\_action\\_plan.pdf](https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf)



## D2.6: Circular Innovation Priorities: Bioeconomy

### European Commission Work Programme 2021<sup>[37]</sup>

In October 2020, the European Commission launched its new 2021 Work Programme. Guided by the Sustainable Development Goals and the Paris Agreement, the Work Programme seeks to deliver change across six political priorities. Focus areas include accelerating the transition towards a greener society, making Europe fit for the digital age, rebuilding the economy whilst ensuring no one is left behind in Europe's recovery, and strengthening partnerships, aid programmes, healthcare, and European democratic values. The main pillars of the green and digital transition reflect the values and objectives of DigiCirc, indicating the relevance of this framework for the project.

The section above touched upon the policy directions within EU regarding Bioeconomy that it is intended, among other, to lead in the future to concrete legislative proposals and possibly to new laws. Depending, also, on the exact type of the exact legislative instrument to be proposed (e.g. Directive, Regulation) Member States will have a crucial role to play with respect to the actual implementation and enforcement.

---

<sup>37</sup> Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Commission Work Programme 2021, available at: [https://ec.europa.eu/info/sites/info/files/2021\\_commission\\_work\\_programme\\_annexes\\_en.pdf](https://ec.europa.eu/info/sites/info/files/2021_commission_work_programme_annexes_en.pdf)

## 4.2 Cluster Engagement campaign

With the support of the European clusters and umbrella organisations active in BioE and ICT domains, DigiCirc can reach out actors in the clusters across Europe. Cluster organisations and networks act in the role of “node” and can interact with their members and the DigiCirc consortium. To be connected to clusters, we considered to build off existing relationships and previous links as well conducted a complementary desk research on the European Cluster Collaboration Platform (ECCP).

Finally, clusters related to BioE were approached. An email with a questionnaire was sent to 40 clusters to gather the following information:

- Cluster basic information about their composition (number and type of members), activities and target sectors to find synergies with the DigiCirc BioE and BioE thematic areas.
- Information about their particular interest in DigiCirc project and their main activities related to the BioE thematic area.

### 7. Sector

Energy and biofuels	6
Building materials and constru...	2
Environment	5
Food, feed	2
ICT	2
Services	3
Creativity	2
Tourism	1
Transport	1
Design	2
Pharmaceuticals & Health	0
Industrial production	6
Textiles and wearing apparels	2
Muu	1

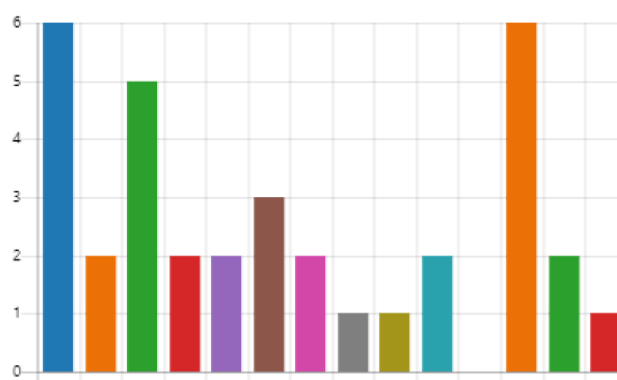


Figure 3: Graph from cluster engagement questionnaire. Sectors related to BioE where Clusters were involved

### Clusters for Bioeconomy that joined the DigiCirc Ecosystem:

- Arctic Design Cluster, Finland
- Baltic Eco-Energy Cluster, Poland
- Business Joensuu, Finland
- Arctic Industry and Circular Economy cluster, Finland
- Arctic Smart Rural Community, Finland
- Arctic Development Environments
- Circular Bioeconomy Cluster South-West Ireland
- Lombardy Energy Cleantech Cluster, Italy
- Paper Province, Sweden

## 4.3 Market Consultation

### Market consultation overview

To consult the market stakeholders on the BioE, an online questionnaire was created and spread out across the DigiCirc communication channels, DPO ecosystem and social media (by email and by contacting by phone). The questionnaire can be divided into 3 parts:

- Part 1: regarding the type of impact expected after the digitalization of the BioE (Question 4).
- Part 2: aims to understand the relevance of sectors and technology in BioE digitalization, relevance of digitalization application in BioE (Question 5 to 7).
- Part 3: specifies the key challenges to face for BioE digitalization (Question 8).

The online questionnaire was opened from June to July (2021).

Refer to Annex 2 for further information about the BioE market consultation.

### Main conclusions

Consultation results are discussed below. To have a good understanding, the conclusions will be divided into 3 parts following the same division that in the previous section “Market consultation overview”. Graphs and statistics can be consulted in Annex 3 as well:

- Part 1: Results show that BioE development impacts shall be mostly environmental, with lower relevance in societal and economical. Only small differences between the three aforementioned categories.
- Part 2: According to the results, all of the sectors are relevant or very relevant in BioE digitalization, only Machinery and equipment seems to be the least relevant sector. In technologies for BioE digitalization, Big Data Analytics and IoT & Sensors and Drones are the most relevant while Virtual Reality/Augmented Reality are the least relevant technology. About the relevance of digitalisation applications, results show that Turning waste into resources (e.g., centralized waste, remanufacturing) and Circular use (e.g., applications for sharing and renting) are the most relevant, however all the digitalisation applications are considered to be relevant.
- Part 3: Regarding the challenges for BioE digitalization, 7 answers can be found. These are listed in Annex 3, and they will help DigiCirc experts to define the main BioE challenges.

## 4.5 Clusters meeting – BioE Clusters Advisory board.

Finally, 8 clusters were invited to join for BioE clusters meeting:

1. Paper Province, Sweden
2. TECOS, Slovenian Tool and Die Development Centre, Slovenia
3. LE2C Lombardy Energy Cleantech Cluster, Italy
4. Circular Bioeconomy Cluster South-West Ireland
5. BEEC Cluster, Poland
6. Arctic Industry and Circular Economy Cluster, Finland
7. Finnish Cleantech Cluster, Finland
8. Business Joensuu, Finland

They were selected according to the following criteria: geographical scope, wide representation of all sub-sectors within the Bioeconomy, “Excellence” base on cluster labelling, etc.

The aim of the meeting was to determine the key challenges to face by BioE sectors related to digitalization. This feedback will contribute to define the DigiCirc BioE open calls.

### Meeting overview

The aforementioned eight clusters, plus three DigiCirc partners ([Cap Digital](#) and [Marine Technology Centre \(CTN\)](#) and inspiring Culture Association ICA) and two external experts of bioeconomy participated in the Cluster Advisory Board meeting. During this online meeting the following activities took place:

- **Introduction:** Brief introduction to the meeting and main goals.
- **General Information:** DPO presented an overview of the DigiCirc project
- Discussion on the key Bioeconomy Challenges: Clusters were invited to participate in an online workshop to help DigiCirc project members to identify the key BioE challenges related to digitalization. To do so, two questionnaires were sent to all attendees (*1. Cluster meeting 08072021: Defining the Challenges in Bioeconomy. Open discussion workshop; 2. Bioeconomy: Definition of Challenges. Section 2. Relevant use cases for Circular Bioeconomy*)
- **Next steps:** Clusters were informed about the following steps: final Key BioE challenges approval, launch of the open call for BioE, actions are planned, main focus is on the Bioeconomy Open Call.

## D2.6: Circular Innovation Priorities: Bioeconomy

Microsoft Teams

Recording has started. This meeting is being recorded. By joining, you are giving consent for this meeting to be recorded. [Privacy po...](#) Dismiss

Participants

Invite someone or dial a number

Share invite

In this meeting (17) Mute all

Shaping the DigiCirc Ecosystem

### ACCELERATION Programme: Designed for You, SME!

Phase	Duration	Consortia	Funding per Consortium	Expected outputs
Phase 1	4 weeks	15 consortia	5k€ per consortium	Business plan, First PoC
Phase 2	7 weeks	15 consortia	15k€ per consortium	Updated Business plan, Prototype/MVP validated in a simulated environment
DemoDay + 6 months	6 months	5 winning consortia	100k€ per consortia	Business development success, Prototype/MVP validated in a real environment

TRL 4-5

TRL 5-6

TRL 6-7

TRL 8

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873468.

Type here to search

08/07/2021

## 5 Bioeconomy Challenges

### 5.1 Results analysis overview

After the Desk Research, Market Consultation and Cluster meeting discussion and questionnaire's results, the Bioeconomy key challenges should focus on:

**Impacts:** Environmental, Economical and Societal impacts.

**Sectors:**

The following sectors were considered to be the most relevant:

- Pharmaceuticals,
- Textiles and wearing apparel,
- Building materials and construction,
- Packaging,
- Other forest products,
- Electronics and electrical products,
- Biomass energy and biofuels and
- Food and feed losses and waste for composting purposes.

The least relevant were Machinery and equipment and Motor vehicles and components.

All sectors were at least somewhat relevant. Challenges for all sectors will be considered.

**Digital technologies:** IoT & Sensors, Drones was the technology which was already the most integrated into the work according to the answers (Bioeconomy domain Questionnaire for Clusters). Virtual Reality / Augmented Reality was seen as the trending digital technology which should be applied in work. IoT & Sensors, Drones was seen to have the most impact in the digitalization of the bioeconomy (Bioeconomy Market Consultation questionnaire + Cluster meeting 08072021 Defining the Challenges in Bio-economy Open discussion workshop).

**Specific applications:**

The following specific applications: circular use, turning waste into resources.

Also, GIS, Eco-design, 3D modelling, footprint neutral activities, and traceability were considered as relevant applications.

This approach means a wide range of challenges to consider. We have focused on the key challenges in our approach.

Relevancy of the sectors is defined based on the received answers to the questionnaire for the clusters after the cluster meeting. The grading of the technologies for each sector is based on a scale of 0-5. Score of 0 is considered **not relevant**, 1 to 4 is considered as **relevant**, score of 5 or more is considered as **very relevant**. Relevancy score is based on Relevant and Very relevant votes. Relevant vote is 1 point and Very relevant vote is 2 points.

To define the most specific challenges or key challenges for DigiCirc BioE open calls, additional data related to sector, technology and use case had to be considered to allow expert to have additional criteria to select the most promising ones. Use cases were established by the DigiCirc BioE Desk research. The AB clusters and desk research experts will evaluate each case according to their relevance in BioE digitalization to achieve CE.

- Pharmaceuticals

Artificial Intelligence

Relevancy score: 1

Virtual Reality / Augmented Reality

Relevancy score: 0

## D2.6: Circular Innovation Priorities: Bioeconomy

### Blockchain

Relevancy score: 6

### GIS & Spatial Mapping

Relevancy score: 3

### IoT & Sensors, Drones

Relevancy score: 0

### Big Data Analytics

Relevancy score: 7

- Textiles and wearing apparel

### Artificial Intelligence

Relevancy score: 3

### Virtual Reality / Augmented Reality

Relevancy score: 4

### Blockchain

Relevancy score: 2

### GIS & Spatial Mapping

Relevancy score: 3

### IoT & Sensors, Drones

Relevancy score: 0

### Big Data Analytics

Relevancy score: 2

- Building materials and construction

### Artificial Intelligence

Relevancy score: 5

### Virtual Reality / Augmented Reality

Relevancy score: 6

### Blockchain

Relevancy score: 3

### GIS & Spatial Mapping

Relevancy score: 5

### IoT & Sensors, Drones

Relevancy score: 3

### Big Data Analytics

Relevancy score: 7

- Packaging

## D2.6: Circular Innovation Priorities: Bioeconomy

Artificial Intelligence

Relevancy score: 4

Virtual Reality / Augmented Reality

Relevancy score: 7

Blockchain

Relevancy score: 2

GIS & Spatial Mapping

Relevancy score: 3

IoT & Sensors, Drones

Relevancy score: 4

Big Data Analytics

Relevancy score: 5

- Motor vehicles and components

Artificial Intelligence

Relevancy score: 5

Virtual Reality / Augmented Reality

Relevancy score: 5

Blockchain

Relevancy score: 1

GIS & Spatial Mapping

Relevancy score: 0

IoT & Sensors, Drones

Relevancy score: 4

Big Data Analytics

Relevancy score: 7

- Other forest products

Artificial Intelligence

Relevancy score: 2

Virtual Reality / Augmented Reality

Relevancy score: 3

Blockchain

Relevancy score: 3

GIS & Spatial Mapping

Relevancy score: 5

IoT & Sensors, Drones

Relevancy score: 5



## D2.6: Circular Innovation Priorities: Bioeconomy

### Big Data Analytics

Relevancy score: 4

- Electronics and electrical products

### Artificial Intelligence

Relevancy score: 5

### Virtual Reality / Augmented Reality

Relevancy score: 5

### Blockchain

Relevancy score: 1

### GIS & Spatial Mapping

Relevancy score: 2

### IoT & Sensors, Drones

Relevancy score: 4

### Big Data Analytics

Relevancy score: 6

- Machinery and equipment

### Artificial Intelligence

Relevancy score: 5

### Virtual Reality / Augmented Reality

Relevancy score: 6

### Blockchain

Relevancy score: 3

### GIS & Spatial Mapping

Relevancy score: 3

### IoT & Sensors, Drones

Relevancy score: 6

### Big Data Analytics

Relevancy score: 5

- Biomass energy and biofuels

### Artificial Intelligence

Relevancy score: 2

### Virtual Reality / Augmented Reality

Relevancy score: 1

### Blockchain

Relevancy score: 2



## D2.6: Circular Innovation Priorities: Bioeconomy

GIS & Spatial Mapping

Relevancy score: 6

IoT & Sensors, Drones

Relevancy score: 4

Big Data Analytics

Relevancy score: 3

- Food and feed losses and waste for composting purposes

Artificial Intelligence

Relevancy score: 4

Virtual Reality / Augmented Reality

Relevancy score: 1

Blockchain

Relevancy score: 3

GIS & Spatial Mapping

Relevancy score: 4

IoT & Sensors, Drones

Relevancy score: 3

Big Data Analytics

Relevancy score: 4

## 5.2 Challenges definition

A summary of all the information analyzed in section 5.1 Results analysis overview is presented below.

Challenges will be defined for each sector; these will be broad with specific use cases as examples and will consider the most relevant technologies to achieve circular economy through digitalization.

One very relevant example of a technological solution is presented below for each sector.

Digitalization expected impacts through the open calls will be mostly environmental, economic and societal (in that order of preference).

The BioE challenges are presented in the following tables:

### #1 Challenge: Pharmaceuticals

Develop products and services based on digital technologies and up-to-date information to increase sustainability, circularity, and effectiveness in the pharmaceutical sector by facing the significant needs and challenges of this sector.

Table 1: Pharmaceuticals challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts (ordered by relevance)
Big Data	Analytics to support drug development, efficient clinical trials and research and development. Also enables traceability data analysis.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

### #2 Challenge: Textiles and wearing apparel & packaging

Create solutions, products and services to promote circularity and sustainability for textiles and wearing apparel & packaging, by utilizing digitalization or digital technologies by offering innovative options and by increasing consumer awareness about sustainability.

Table 2: Textiles and wearing apparel by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts (ordered by relevance)
Virtual reality and Augmented reality	Virtual Reality or/and Augmented Technology solutions could convey reliable apparel product information in terms of fit, size, and product performance	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

Table 3: Packaging challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts (ordered by relevance)
Virtual reality and Augmented reality	Visualizing new packaging products and other aspects of the production chain.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

## D2.6: Circular Innovation Priorities: Bioeconomy

### #3 Challenge: Building materials and construction & other forest products

Create solutions, products, tools, and services to increase efficiency, sustainability and circularity in building materials and construction & other forest products applying digitalization and digital technologies

Table 4: Building materials and construction challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts (ordered by relevance)
Big Data	Digital logistics platform, testing new materials and research and development.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

Table 5: Other forest products challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts
GIS & Spatial Mapping & IoT & Sensors, Drones	GIS & spatial mapping for historical analysis, stand inventory, soil types, changing weather patterns, and land-use practices. Drones for monitoring plant health, performing inspections, and improving safety	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

### #4 Challenge: Electronics and electrical products

Develop solutions to improve the effectiveness of digital technologies in the sector of electronics and electrical products, increasing and optimizing circularity and sustainability.

Table 6: Electronics and electrical products challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts
Big Data	Optimizing work processes, utilizing environmental data, improving forest management.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

### #5 Challenge: Biomass energy and biofuels & food and feed losses and waste for composting purpose

Create solutions based on digital technologies to address sustainability challenges in biomass energy and biofuels & food and feed losses and waste for composting purposes in matters of fuel sustainability and circularity.

Table 7: Biomass energy and biofuels challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts
GIS & Spatial Mapping	Smart farming practices and utilizing waste with the help of GIS.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

## D2.6: Circular Innovation Priorities: Bioeconomy

### #6 Challenge: Machinery and equipment & Motor vehicles and components

Solutions, products and services based on digital technologies to make machinery and equipment & motor vehicles and components more effective, sustainable, and circular.

Table 8: Machinery and equipment challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts
Virtual Reality / Augmented Reality & IoT & Sensors, Drones	Remote support, design reviews, training and education, marketing and research and development.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

Table 9: Motor vehicles and components challenges by technology

Digital Tech/Tools	Sub-challenges/examples for open calls topics	Expected Impacts
Big Data	To manufacture the analytics value chain, analyzing customers, marketing and global supply.	1. ENVIRONMENTAL 2. ECONOMICAL 3. SOCIETAL

## 6 References

- Synced. 2019. "AI Provides Solutions for the Japanese Fishing Industry". Available at: <https://medium.com/syncedreview/ai-provides-solutions-for-the-japanese-fishing-industry-9865cc15cc2f>
- Rolf Hansen, E. 2020. "Prospective Study on Global Blue Economy Industrial, Investment and Technological Trends"
- Alltech. 2017. "8 digital technologies disrupting aquaculture". Available at: <https://www.alltech.com/blog/8-digital-technologies-disrupting-aquaculture>
- Blaha, F. Katafono, K. 2020. "Blockchain application in sea food value chains". Available at: <http://www.fao.org/3/ca8751en/CA8751EN.pdf>
- Gimpel, A. Stelzenmüller, V. Töpsch, S. Galparsoro, I. Gubbins, M. Miller, D. Murillas, A. Murray, A.G. Pınarbaşı, K. Roca, G. Watret, R. 2018. "A GIS-based tool for an integrated assessment of spatial planning trade-offs with aquaculture". Science of The Total Environment, Volume 627. Available at: <https://www.sciencedirect.com/science/article/pii/S0048969718301554>
- Global Fishing Watch. Available at: <https://globalfishingwatch.org/>
- Lima, R. Boogaard, F. C. De Graaf, R. 2020. "Innovative Water Quality and Ecology Monitoring Using Underwater Unmanned Vehicles: Field Applications, Challenges and Feedback from Water Managers". Available at: [https://www.researchgate.net/publication/340882094\\_Innovative\\_Water\\_Quality\\_and\\_Ecology\\_Monitoring\\_Using\\_Underwater\\_Unmanned\\_Vehicles\\_Field\\_Applications\\_Challenges\\_and\\_Feedback\\_from\\_Water\\_Managers](https://www.researchgate.net/publication/340882094_Innovative_Water_Quality_and_Ecology_Monitoring_Using_Underwater_Unmanned_Vehicles_Field_Applications_Challenges_and_Feedback_from_Water_Managers)
- Sightbit. "AI-Augmented Lifeguarding". Available at: <https://sightbit.com/>
- Sharma, N. Blumenstein, M. 2018. "SharkSpotter combines AI and drone technology to spot sharks and aid swimmers on Australian beaches". Available at: <https://theconversation.com/sharkspotter-combines-ai-and-drone-technology-to-spot-sharks-and-aid-swimmers-on-australian-beaches-92667>
- Gidley, S. 2017. "Virtual reality: Tourism firms use VR to attract visitors". Available at: <https://www.bbc.com/news/uk-wales-41635746>
- Cameron, N. 2016. "Tourism Australia uses virtual reality and 360-degree views in latest campaign". Available at: <https://www.cmo.com.au/article/592861/tourism-australia-uses-virtual-reality-360-degree-views-latest-campaign/>
- Alves, L. 2019. "New Virtual Reality Project Shows Threat of Sea Level Rise in Coastal Communities". Available at: <https://miamibeatimes.com/politics/new-virtual-reality-project-shows-threat-of-sea-level-rise-in-coastal-communities/>
- Fraser, C. Bernatchez, P. Dugas, S. 2017. "Development of a GIS coastal land-use planning tool for coastal erosion adaptation based on the exposure of buildings and infrastructure to coastal erosion, Québec, Canada". Available at: <https://www.tandfonline.com/doi/full/10.1080/19475705.2017.1294114>
- National Oceanic and Atmospheric Administration. 2019. "Robots probe ocean depths in mission to fine-tune hurricane forecasts". Available at: <https://www.noaa.gov/stories/robots-probe-ocean-depths-in-mission-to-fine-tune-hurricane-forecasts>
- Ideaforge. 2019. "Using Drones in Port Operations is The Move World Commerce Needs". Available at: <https://www.ideaforge.co.in/blog/drones-in-port-operations/>
- Raines, C. "Location Intelligence for Ports". Available at: <https://storymaps.arcgis.com/stories/09f876480ffb49bbb3c0dcd7176f98df>
- [Georgiou, M. 2019. "THE ROLE OF AI TECHNOLOGY IN IMPROVING THE RENEWABLE ENERGY SECTOR". Available at: <https://www.imaginnovation.net/blog/artificial-intelligence-in-renewable-energy/>

## D2.6: Circular Innovation Priorities: Bioeconomy

- “The ELEMENT Project”. Available at: <https://element-project.eu/>
- Energy Web. 2020. “Ocean Protocol, Energy Web Announce Collaboration to Unlock IoT Energy Data, Boost Distributed Energy Resource Optimization”. Available at: <https://medium.com/energy-web-insights/ocean-protocol-energy-web-announce-collaboration-to-unlock-iot-energy-data-boost-distributed-77597e2cb57a>
- OEdigital. 2020. “HP to Help Carnegie Develop AI-Tech for Wave Energy Project”. Available at: <https://www.oedigital.com/news/483579-hp-to-help-carnegie-develop-ai-tech-for-wave-energy-project>
- Tara Expeditions Foundation. 2018. “Ocean Miner, a new system to generate Bitcoins and finance Ocean research”. Available at: <https://oceans.taraexpeditions.org/en/ocean-miner-systeme-inedit/>
- MAPLINE. 2017. “The Growing Role of GIS for Renewable Energy” Available at: <https://mapline.com/role-gis-renewable-energy/>
- Bigdataocean. “Exploiting Oceans of Data for Maritime Apps”. Available at: <https://www.bigdataocean.eu/>
- Love, A. 2020. “AI in shipping: areas to watch in 2020”. Available at: <https://www.ship-technology.com/features/ai-in-shipping/>
- [Gallucci, M. 2019. “Shipping industry takes a page from bitcoin to clean up its act”. Available at: <https://grist.org/article/shipping-industry-takes-a-page-from-bitcoin-to-clean-up-its-act/>
- Elsener, R. “A VR training solution to operate and maintain ship engines”. Available at: <https://www.man-es.com/discover/a-vr-training-solution-to-operate-and-maintain-ship-engines>
- Eonreality. 2020. “Understanding Renewable Energy with AR and VR”. Available at: <https://eonreality.com/understanding-renewable-energy-with-ar-and-vr/>

# Annexes

## Annex 1: BioE domain Questionnaire for Clusters

*Note: \*Mandatory answers*

**1. Name of your cluster\***

**2. Name of cluster organisation (legal entity).\***

**3. Your name \***

**4. E-mail address \***

**5. Country \***

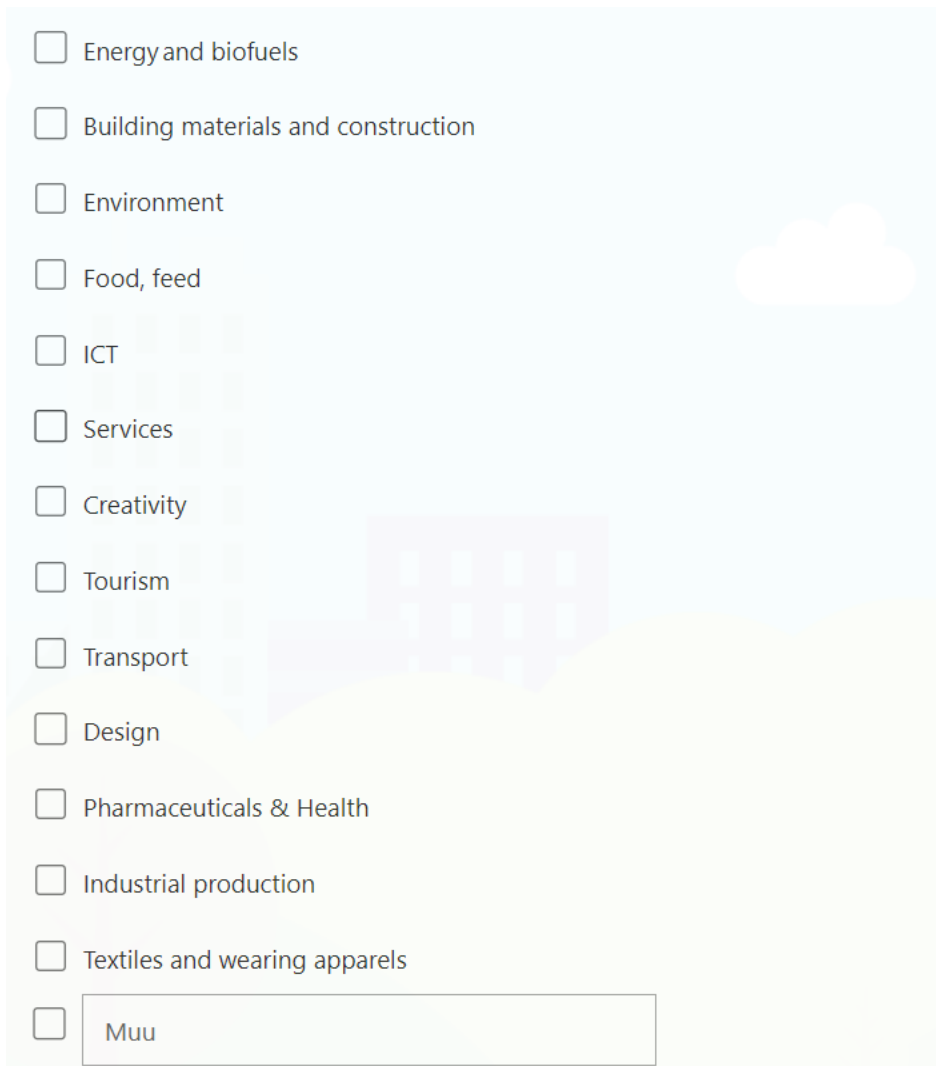
**6. Size of the cluster \***

- ☐ Less than 50 members
- ☐ 50-100 members
- ☐ 100-150 members
- ☐ 150+ members

**7. Sector**



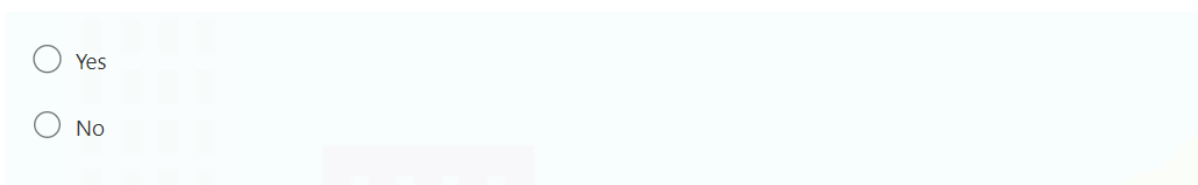
## D2.6: Circular Innovation Priorities: Bioeconomy



- ☐ Energy and biofuels
- ☐ Building materials and construction
- ☐ Environment
- ☐ Food, feed
- ☐ ICT
- ☐ Services
- ☐ Creativity
- ☐ Tourism
- ☐ Transport
- ☐ Design
- ☐ Pharmaceuticals & Health
- ☐ Industrial production
- ☐ Textiles and wearing apparels
- ☐

Muu

### 8. Does your cluster organisation work with sustainability?



☐ Yes

☐ No

### 9. If yes, choose from the followings. Multiple choices allowed.

## D2.6: Circular Innovation Priorities: Bioeconomy

- ☐ Reusing and recycling critical raw materials
- ☐ Novel natural and green materials
- ☐ Sustainable constructions and structures
- ☐ Bioeconomy services
- ☐ Green business models
- ☐ In other UN Sustainable Development goals

### 10. Has the Covid-crisis affected your cluster organisation services?

- ☐ Yes
- ☐ No

### 11. If yes, how? (Multiple choices).

- ☐ Digitalisation
- ☐ Community building (internal networking)
- ☐ Location branding
- ☐ Research, development and innovation
- ☐ Business development
- ☐ Development of human resources
- ☐ Development of entrepreneurship
- ☐ Support policy development
- ☐ Internationalisation

### 12. How do the companies of your cluster reuse materials?

(Written answer)

**13. Does any company in your cluster recycle critical raw materials?**

☐ Yes

☐ No

☐ Maybe

**14. Are there any companies in your cluster, that substitute non-renewable materials?**

☐ Yes

☐ No

**15. Which of the following trending digital technologies have you already integrated in your work?**

☐ Artificial Intelligence

☐ Big data analytics

☐ Internet of Things (Sensors, Drones)

☐ GIS & Spatial Mapping

☐ Blockchain

☐ 5G

☐ Virtual Reality/Augmented Reality

**16. Which of the following trending digital technologies do you think should be applied in your domain of work?**

## D2.6: Circular Innovation Priorities: Bioeconomy

- ☐ Artificial Intelligence
- ☐ Big data analytics
- ☐ Internet of Things (Sensors, Drones)
- ☐ GIS & Spatial Mapping
- ☐ Blockchain
- ☐ 5G
- ☐ Virtual Reality/Augmented Reality

## Annex 2: Bioeconomy Market Consultation questionnaire

### Introduction

This questionnaire is part of the DigiCirc H2020 project (This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873468)

Help Us define the Challenges for the Digitalisation of the Circular Bioeconomy!

DigiCirc (<https://digidirc.eu/>) is an H2020 INNOSUP project that aims to boost the circular economy using digital tools by supporting innovative #SMEs in the development and marketing of solutions based on circular value chains through 3 acceleration programs on the following themes: "Circular cities", "Blue Economy" and "Bioeconomy".

The #CircularEconomy considers the entire life cycle of a product from its production, through its consumption, to the management of the waste produced. It responds to multiple challenges such as dependence on increasingly scarce resources, lack of waste disposal, the resilience of an ecosystem and its economic attractiveness, etc.

In relation with #CircularEconomy, #Bioeconomy provides solutions for creating growth based on renewable natural resources and for building a climate-friendly future.

How to reduce that impact through digital technologies and Circular Economy? In order to define the current challenges of #Bioeconomy that will be included in the call for projects, we would like to collect the opinions of the different key actors of the market (local authorities, companies, population, etc.) with the next questionnaire.

**1.Name \***

**2.Company \***

**3.Position \***

**4.What impacts should be considered during the development of the Bioeconomy? (Last option "Other")**

- ☐ Societal
- ☐ Environmental
- ☐ Economic
- ☐ Muu

**5. In your opinion, which sectors can promote the development of Bioeconomy through digitalization?**

## D2.6: Circular Innovation Priorities: Bioeconomy

	Not relevant	Low relevance	Relevant	Very relevant
Pharmaceuticals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Textiles and wearing apparel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Building materials and construction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Packaging	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Motor vehicles and components	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other forest products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronics and electrical products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Machinery and equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biomass energy and biofuels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Food and feed losses and waste for composting purposes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 6. In your opinion, do the following technologies have impact in the digitalization of the Bioeconomy?

	Not relevant	Low relevance	Relevant	Very relevant
Artificial Intelligence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Virtual Reality / Augmented Reality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blockchain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
GIS & Spatial Mapping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
IoT & Sensors, Drones	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Big Data Analytics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 7. In your opinion, what relevance do the following digitalization applications have in Bioeconomy? \*

## D2.6: Circular Innovation Priorities: Bioeconomy

	Not relevant	Low relevance	Relevant	Very relevant
Eco-Design (EcoDesign Tools are simplified LCA software tools)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Turning waste into resources (e.g. centralized waste, remanufacturing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Circular use (e.g. applications for sharing or renting)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pollution detection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Traceability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Footprint neutral activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 8. What do you think should be the challenges to be tackled in those sectors regarding the digitalization of the Bioeconomy?

7 answers collected:

- Lack of knowledge, awareness of opportunities and abilities
- Difficulty in getting an approval from authorities
- Affordability of bioeconomy products
- To break barriers between sectors and detecting synergies
- The need to be proactive and aligned with stakeholders
- Digitalization enables building a traceable value chain
- Lack of testing platforms

### 9. If you want us to keep you updated on DigiCirc's latest news, please insert your e-mail address here:

(Optional open answer)



## Annex 3 : Market consultation questionnaire results

## Questionnaire results balance

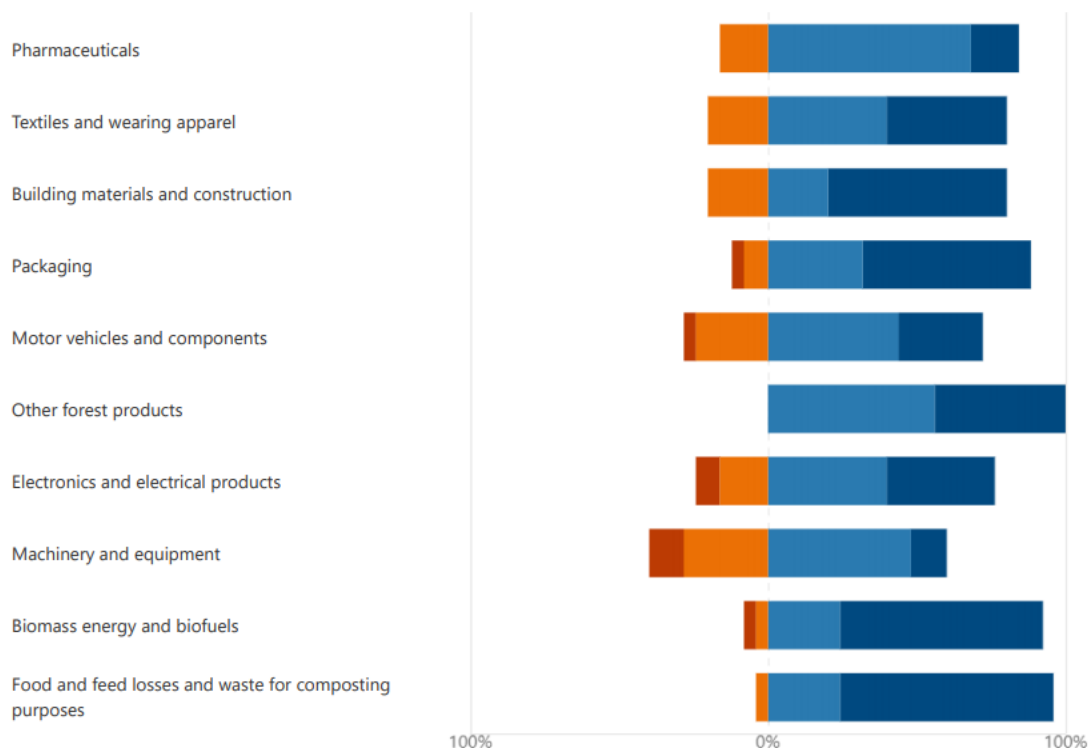
4. What impacts should be considered during the development of the Bioeconomy? (Last option "Other")

<span style="color: blue;">●</span> Societal	17
<span style="color: orange;">●</span> Environmental	25
<span style="color: green;">●</span> Economic	21
<span style="color: red;">●</span> Muu	3



5. In your opinion, which sectors can promote the development of Bioeconomy through digitalization?

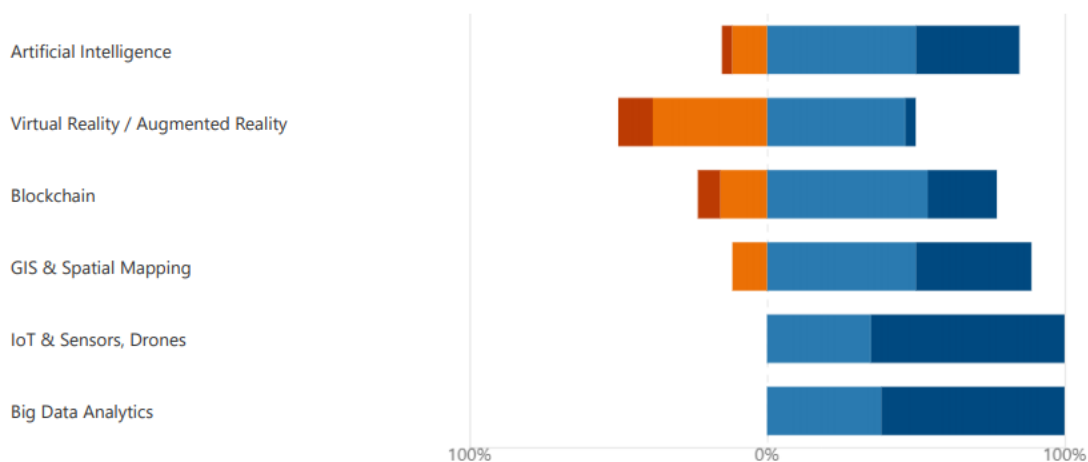
■ Not relevant ■ Low relevance ■ Relevant ■ Very relevant



## D2.6: Circular Innovation Priorities: Bioeconomy

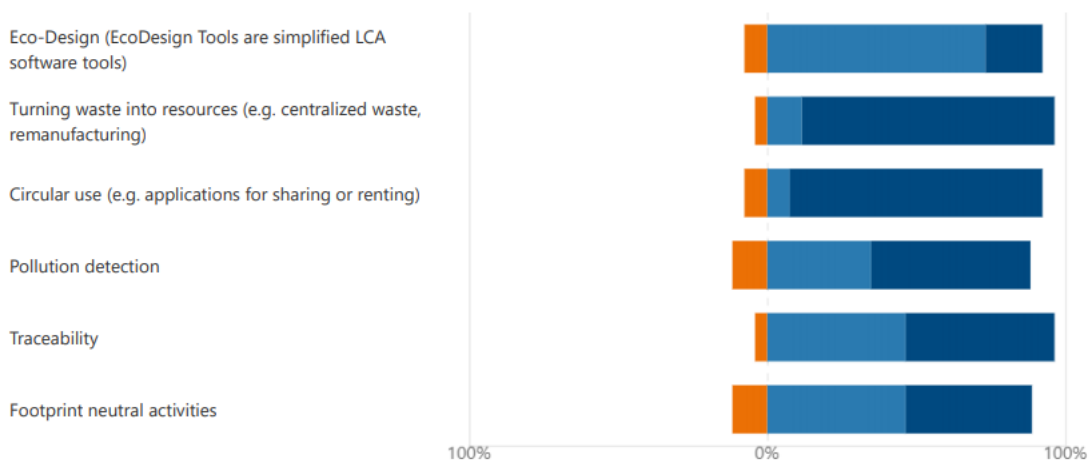
6. In your opinion, do the following technologies have impact in the digitalization of the Bioeconomy?

■ Not relevant ■ Low relevance ■ Relevant ■ Very relevant



7. In your opinion, what relevance do the following digitalization applications have in Bioeconomy?

■ Not relevant ■ Low relevance ■ Relevant ■ Very relevant



8. What do you think should be the challenges to be tackled in those sectors regarding the digitalization of the Bioeconomy?

1	anonymou s	digital ecosystem to manage reusable packaging
2	anonymou s	- In building sector and industrial sectors, break barriers between sectors detecting synergies. - Detect possible interactions between buildings and their natural direct environment - Substitute chemical sourced materials by bio sourced resources in materials

## D2.6: Circular Innovation Priorities: Bioeconomy

3	anonymou s	.
4	anonymou s	- Map the most urgent issues per critical area to have a pipeline which includes the prioritization of digitalization activities; at the same time have a consistent plan of complementary applications and technologies - Proceed with an agile approach, monitoring and readapting the pipeline as much as possible - Improve the current digital divide, both globally and even more in the Italian scenario, we need proactive and aligned stakeholders, engaged in the digitalization process of the Bioeconomy - Match the top down model, as defined by EU entities, with specific countries' priorities and key capabilities (considering technology, main assets, natural resources, human competences)
5	anonymou s	Affordable price to boost adoption rate of Bioeconomy products
6	anonymou s	Ruokahävikin vähentäminen (Reducing the amount of food waste)
7	anonymou s	Especially consumers and SMEs might have problems to use digital solutions. "Lack of knowhow and lack of awareness"
8	anonymou s	Lots of needs/opportunities in digitization of the Bioeconomy. Still there seems not to be wide understanding / vision of those opportunities.
9	anonymou s	Authority approvals
10	anonymou s	Better awareness of the possibilities of digitalisation in bioeconomy.
11	anonymou s	Standardized metrics to determine increase/decrease of emissions and impact. E.g., very hard currently to compare ecological merits of two different solutions. Then also standardized platforms and API to exchange data.
12	anonymou s	Circular use of natural products i.e., slurry of pigs and cows. Extracting ammonia from slurry during stripping process and enable re-use of ammonia and slurry for the fields. Reducing number of artificial fertilizers and supporting nature's own natural resources.
13	anonymou s	To add more skilled interdisciplinary workforce who can easily adopt new technologies/technology platforms to bioeconomy sectors. Integrating engineering design with biotechnology.
14	anonymou s	More discussion between science and engineering, lack of testing platforms.
15	anonymou s	Digitalization enables building a traceable value chain.
16	anonymou s	Availability and showcasing of appropriate and potential digital tools also for SMEs + success stories, examples and spreading the tools and methods through benchmarking.

## Annex 4: Cluster meeting BioE challenges discussion

**Key challenges (based on the Market consultation questionnaire and the cluster meeting discussions)**

Financial Flows. The initial investments needed for a transformation can be considered too high

Affordability of bioeconomy products

Scaling up: market connections (are they developing the right product / in line with needs), a key challenge. Also funding of course to scale up / also what it looks like through collaboration.

The same goes for pricing: it is not smart when we build a business out of waste, price ends up higher than material.

Balance between economic, social & environmental is good

Other part: real cost to start projects in terms of real structure = too high. Lots of stakeholders complaining that the initial investment does not cover the cost & time gap needed to make it happen. It is a matter of balance. Investment too high. Lack of knowledge in there.

How to accelerate "born global" Start Ups using our international networks...

Technology. The implementation of technology or availability of viable technology may not be sufficient

How to utilize digitalization to solve challenges caused by climate change in timber supply and forestry

How to develop ecosystem for industrial wood construction

How to build up resource-efficient industrial ecosystems linked to wood processing -

Digitalization enables building a traceable value chain

Lack of testing platforms

Material use efficiency should be considered already at the production design stage

Policy and Regulation. Required public support and regulation may not yet fully be in place and subject to policy adaptations

## D2.6: Circular Innovation Priorities: Bioeconomy

Difficulty in getting an approval from authorities

Permits and challenges in relation to new innovations

Mindset and Values. Public opinion on bio-based material is often still ambiguous and customers are rarely willing to pay a price premium

Lack of knowledge, awareness of opportunities and abilities

Lack of knowledge to achieve bioeconomy project – members working on biomethanisation, liquid bioethanol, etc. and lack full access to tech and other partners and lack of funding (subsidizing) to cover investment gap (high costs to cover/support)

Communication as well: how do we describe / ensure we speak of bioeconomy within a circular context and zero-carbon context

Funding is always a challenge but also the information flow, getting new information on latest developments and getting the knowledge into the company but also having the right personnel to incorporate the new knowledge into production (HR to implement); lack of time to deal with these new technologies

Awareness despite of potential. Projects on-going and hope to grow these projects and companies to generate bioeconomy. Journey to get onto and need to promote such projects. Second, we are so busy, this makes it even more difficult to contribute to projects that can support such development.

We also need a shift in thinking: new products, not circulating old ones. Innovation and advancing state of the art is needed.

Are we talking the same language? Skills of bioexperts and digital experts for instance: there is a gap between the two. Digital experts are not crop experts. Skills upgrade is required in that respect. Combining skills and bridging people with different languages. Combining skills is even more important than simply upgrading existing ones

Lack of interconnectivity. Mindset issues: some companies (major global companies) that can be advanced in that respect while SMEs may not see the opportunity. Change avoidance as we have been doing well traditionally. No incentive to change and transform. Digitization is a tool to achieve a necessary transformation. Surprising result: valuable traceability while low rank of blockchain/DLT.

Super important to raise awareness on the benefits of the digital tech: give concrete access to the real benefits of the tech and what it can do for SMEs to achieve bioeconomy. Key. Example of Blockchain. Lots of SMEs do not really know the real benefits of these tech.

## **D2.6: Circular Innovation Priorities: Bioeconomy**

Disruptive innovation: mindset-related. Aiming for higher productivity, with the example of the construction industry (modular timber building in factories). CLT & applications that can be produced. Why is it so difficult to make the construction industry understand how important it is for it to implement digitization within the sector.

To break barriers between sectors and detecting synergies

Struggling with: narrow-minded entrepreneurs and multi-disciplinarity. We see the need for collaboration across domains.

Breaking the barriers between "silos" is an important challenge and positive angle for solving is to transfer good practices between areas of industries." (Sharing information/knowledge between different sectors to promote co-operation).



End of Document



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873468.