



Report from a series of workshops with the Scenario Exploration System foresight tool

Exploring Foresight Scenarios for the EU Bioeconomy

The European Commission's Knowledge Centre for Bioeconomy

JRC SCIENCE FOR POLICY REPORT

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Abstract

In 2022 and 2023, the European Commission's Knowledge Centre for Bioeconomy organised three workshops to explore bioeconomy foresight scenarios developed in 2020. With the help of a scientific game and foresight tool called the Scenario Exploration System, stakeholders in various bioeconomy sectors were involved in a role-playing exercise involving highly interactive discussions. During the workshops, participants were prompted to develop forward-looking and strategic thinking about the bioeconomy. In particular, they were invited to reflect on aspects such as the role of different actors in leveraging the unique features of the bioeconomy and its contribution to the European Green Deal, a bioeconomy that is inclusive of left-behind regions and how to engage citizens in adopting lifestyles that contribute to a sustainable and just green transition.

The analysis of the dynamics and discussions during the workshops revealed that the assembled bioeconomy stakeholders consider collaboration among bioeconomy actors as instrumental for success, taking into account the importance of different perspectives and of shared but clear responsibilities. Moreover, some actions proved to be more effective than others in promoting regional and rural development. The exemplary actions were found to be collaboration, funding, knowledge sharing and communication, actions with a regional and rural focus and inclusive actions to reach left-behind societal groups. Regarding sustainable lifestyles, it was observed that consumers need to be included in the decision-making process, as they can influence the demand for sustainable and low-carbon products. The findings from the workshops have been used as a basis to formulate policy implications that could contribute to the policy debate on the bioeconomy.

Foreword

The European Green Deal has advanced over the past 4 years, with an increasing rate of related policies. The EU bioeconomy has a unique role in enabling its implementation.

This report summarises the European Commission's Knowledge Centre for Bioeconomy foresight study, which involved 100 stakeholders using the bioeconomy edition of the Scenario Exploration System, a scientific role-play game and foresight tool. The evidence from this study has been used to formulate the following set of recommendations for future bioeconomy policies:

- establish a consistent, stable and coherent policy framework across the bioeconomy sectors and administrative levels (national, regional, local);
- promote cross-stakeholder collaboration by coordinating stakeholders' efforts regarding incentives and enabling solutions;
- design inclusive and revitalising actions with a regional and rural focus, making the most of local resources;
- invest in learning and development opportunities for all involved stakeholders, and collaborative research and facilities;
- unlock investments to scale up bio-based markets and develop new ones;
- engage citizens in decision-making to increase trust and participation;
- implement strategies to increase awareness and education and to share best practices;
- foster intergenerational interaction and cooperation.

With the upcoming revision of the EU bioeconomy strategy, as requested by the Council in its conclusions of 25 April 2023, we hope that these recommendations and the collaborative participatory spirit they reflect will constitute a positive contribution.

Let's keep in mind the old proverb 'If you want to go fast, go alone. If you want to go far, go together.' For a full transition towards climate neutrality, we will need to go far.



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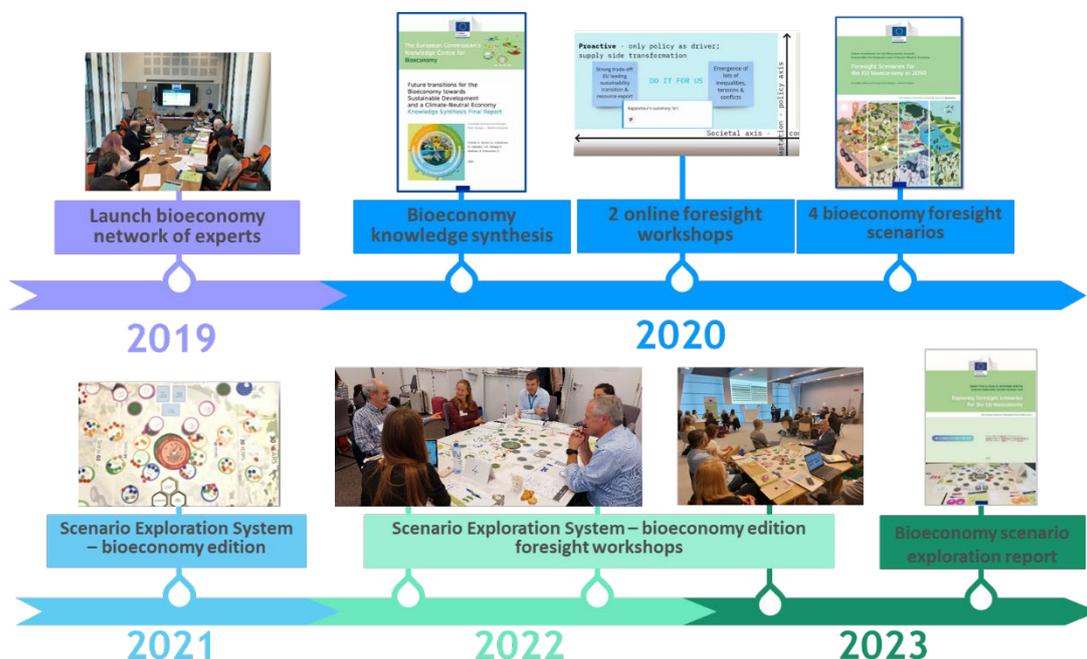
Executive summary

Strategic foresight looks into possible future developments that could shape our world. Since 2020, the Commission has been promoting strategic foresight as an essential tool to support future-informed policymaking. Several foresight exercises have taken place in different domains, including the bioeconomy. The Commission's 2020 strategic foresight report, in particular, mentions the potential of a sustainable bioeconomy to transform Europe's agricultural and industrial base and create new jobs, while enhancing our natural resources and ecosystems.

In this context, in 2019 the Knowledge Centre for Bioeconomy (KCB) initiated a foresight exercise to analyse how the EU bioeconomy could evolve by 2050.

As illustrated in the figure below, a network of experts from different policy domains, civil society, industry and academia was established. The group built four alternative scenarios for the EU bioeconomy in 2050, based on the multiple drivers that could affect its future developments and their interplay, and depending on specific boundary conditions.

Timeline of the KCB bioeconomy foresight exercise



In the second phase, the four scenarios were explored. A number of bioeconomy stakeholders were invited to a series of workshops, in which a scientific board game called Scenario Exploration System (SES) was used, adapted to the bioeconomy by the KCB coordination team. Stakeholders represented in the games included primary producers, business representatives, policymakers, consumer associations, complemented by 'public voices' representing the public opinion. This report describes the outcomes and findings of this second phase.

The objectives of the bioeconomy SES workshops were (i) to stimulate key stakeholders to develop forward-looking and strategic reflections about the various aspects of the bioeconomy and (ii) to observe the dynamics of the groups of participants in order to inform the bioeconomy policy debate regarding actions and perspectives captured from the discussions.

In total, 100 people participated in the workshops from all around Europe. They were selected from various professional domains, including primary production sectors, business and industry, consumer associations and policymaking. They had very different backgrounds and represented a broad variety of competences and different generations and perspectives. During the game sessions, the participants each played a specific role and took action in response to scenario events in a specific time horizon (10, 20 or 30 years from now). The authors of this report have analysed the observed dynamics and stated perceptions of the participants, and synthesised conclusions on a variety of topics, such as the importance of collaboration and the role of the different stakeholders in the achievement of a sustainable bioeconomy or the actions that could best promote regional and rural development, supporting left-behind actors. From these reflections, relevant policy implications have been derived and policy recommendations created.

The analysis of the dynamics and discussions during the workshops revealed that the assembled stakeholders consider collaboration among the bioeconomy actors as a key enabler, taking into account different perspectives and shared but clear responsibilities with the same climate neutrality goals. Each actor is responsible for their part in the transition process, and collaboration can be fostered by providing incentives and creating opportunities for interaction. Moreover, some actions were identified as being more effective in promoting regional and rural development than others. The most effective actions were considered to be collaboration, funding, knowledge sharing and communication, actions with a regional and rural focus and inclusive actions to reach left-behind societal groups. Regarding sustainable lifestyles, it was observed that consumers need to be included in the decision-making process, as they can significantly influence the demand for sustainable and low-carbon products. These findings from the workshops have been used as a basis to formulate the policy recommendations summarised in the figure below.

Recommendations for policymakers – summary



This foresight exercise contributes to the Commission’s efforts to streamline and embed strategic foresight into European Commission and Member State policymaking. In relation to the bioeconomy domain, further foresight exercises have been developed within the Commission and beyond, and the outcomes of some of these are in line with the findings described in this report, which will be part of the KCB’s contribution to the discussions on the next EU bioeconomy strategy during 2024.

1. Introduction

In December 2019, the European Commission's Knowledge Centre for Bioeconomy (KCB) ⁽¹⁾, coordinated by the Joint Research Centre (JRC), in collaboration with the Directorate-General (DG) for Research and Innovation, established an ad hoc network of experts to contribute to the forward-looking analysis of the transition towards a sustainable, clean and resource-efficient bioeconomy. The network focused on climate neutrality and sustainable development.

Seven experts from within this network reviewed and synthesised existing knowledge on the bioeconomy (Fritsche et al., 2020) and identified gaps, trends and bottlenecks with regard to key aspects ⁽²⁾. Building upon this work, the experts contributed to a foresight exercise, organised in collaboration with the European Commission Competence Centre on Foresight ⁽³⁾, with the participation of additional specialists, working on topics relevant to the bioeconomy policy domain, from within and outside Commission services. The foresight phase resulted in the development of four scenarios detailing how the EU bioeconomy could evolve by 2050 (as the long-term time horizon). The corresponding foresight report was published in 2021 (Fritsche et al., 2021).

The following question was addressed.

How can the EU bioeconomy best contribute to specific UN sustainable development goals and to the transition towards a climate-neutral economy by 2050?

Based on these four foresight scenarios, the JRC, in collaboration with DG Research and Innovation, developed a bioeconomy edition of a scientific role-play game and foresight tool designed by the European Commission's Competence Centre on Foresight. The purpose was to engage experts and stakeholders in systemic thinking with a long-term perspective and to explore possible futures considering specific issues and themes. The use of this serious game, called the Scenario Exploration System (SES), enables the involvement of large groups of experts and non-experts in collaborative and participatory foresight, giving them the opportunity to adopt the roles of different stakeholders, who have to pursue their long-term objectives within predefined future scenarios. They interact with each other, can utilise their limited resources depending on the explored scenario and are subject to foreseen and unforeseen events. These 'explorers' are followed by a participant who takes on the role of providing the public voice, with their own bias, who judges the actions of the explorers.

The bioeconomy edition of the SES has been used in a series of three workshops in 2022 and 2023, with the specific objective of facilitating and strengthening forward-looking strategic and systemic reflections among key stakeholders of the European bioeconomy. The outcomes and the lessons learned from these three workshops, summarised in the present report, can serve as a starting point for discussing policy implications of the identified scenarios.

This report is organised as follows. Section 1 serves to set the context and to briefly introduce the four bioeconomy foresight scenarios developed in 2020. Section 2 describes the SES tool and how the workshop sessions were organised, including a brief methodological note on the limitations of the approach. Sections 3 and 4 summarise the outcomes of the workshops by scenario and by role, while Section 5 concludes by analysing the reflections gathered from participants and formulating possible policy implications.

⁽¹⁾ <https://knowledge4policy.ec.europa.eu/bioeconomy>.

⁽²⁾ The key aspects are (i) the sustainability of current and future biomass supplies; (ii) the contribution of the bioeconomy to climate change adaptation and mitigation; (iii) the impact of dietary changes on sustainability of food systems and on planetary health; (iv) the sustainability of bioenergy supply, considering biomass demand for other uses; (v) the design and implementation of strategies limiting food losses and waste to contribute to a sustainable and circular economy.

⁽³⁾ <https://knowledge4policy.ec.europa.eu/foresight>.

1.1. Context and background

Strategic foresight aims to go beyond policies that react to specific events or contingencies, and give more consideration to the possible future developments that could shape our world. For this reason, since 2020, the Commission has placed significant emphasis on the importance of strategic foresight as a way to embed future-oriented thinking in policymaking. Every year, it prepares a strategic foresight report informing the Commission work programmes and multiannual programming exercises. Strategic foresight in the Commission is conducted through a participative and cross-sectoral foresight process, led by Commission services in consultation with Member States, in discussion with the European Strategy and Policy Analysis System and external stakeholders. Alongside the 2020 strategic foresight report, the Commission launched an EU-wide foresight network, composed of Ministers for the Future ⁽⁴⁾ designated by each Member State at the invitation of Commission Vice-President Šefčovič. They meet informally at least once a year and are supported by a network of senior officials who follow up on the work of the ministers. This network has the aim of building foresight capacity in Member State administrations across the EU. Recently, strategic foresight has also been included as a tool in the Better Regulation Toolbox (as Tool 20 of this toolbox) ⁽⁵⁾ to facilitate its practical use by policymakers in policy impact assessments and evaluations, and in public consultations.

Several European Commission foresight exercises of relevance to the bioeconomy domain have taken place in the last decade or so. These are summarised below to provide the context in which this exercise is placed.

European Commission strategic foresight reports

The Commission's first strategic foresight report, *Charting the Course Towards a More Resilient Europe* (European Commission, 2020), analysed the EU's resilience across four dimensions: social and economic, geopolitical, green and digital. Links to the COVID-19 pandemic were also considered. The report recognised the potential of the bioeconomy to contribute to green growth.

The third strategic foresight report (European Commission, 2022) and related JRC publication (Muench et al., 2022) reflected on the EU's green and digital transitions (also called the 'twin transitions'), focusing on five strategic sectors that emit the most greenhouse gas: energy, transport, industry, construction and agriculture. The contribution of digital technologies to improving the various bioeconomy sectors is considered in this study, in particular digital environmental monitoring systems and smart sustainable farming.

The latest strategic foresight report, published in June 2023, *Sustainability and people's wellbeing at the heart of Europe's open strategic autonomy* (European Commission, 2023), highlights (i) the need for a new economic model, decoupling growth from resource use and shifting to more sustainable production and consumption, (ii) the growing demand for adequate skills for a sustainable future and (iii) the requirement for unprecedented investments to support the sustainability transitions. These are all aspects that emerged independently during the discussions among the workshop participants.

Standing Committee on Agricultural Research foresight exercises

The European Commission's Standing Committee on Agricultural Research includes an independent foresight expert group that developed five foresight exercises between 2007 and 2020 ⁽⁶⁾. In particular, the fourth foresight exercise (DG Research and Innovation and Kovacs, 2015) focused on the challenges of the bioeconomy primary sectors and was taken into account during the development of the four foresight scenarios on the bioeconomy for 2050 by the JRC-led network of experts (Fritsche et al., 2021). The fifth foresight exercise, published in 2020 (DG Research and Innovation, 2020a, 2020b), looked at the resilience and transformation of natural resources and food systems. According to the reports' key conclusions:

R&I is a key enabler of food systems transformation that can take multiple forms. Key to making advances will be the application of a systems approach that cuts across sectors and disciplines and engages multiple actors to deliver co-benefits for health, sustainability, climate and inclusion.

FORENV cycle

In 2017, the European Commission's DG Environment launched the EU foresight system for the systematic identification of emerging environmental issues (FORENV), with the aim of identifying emerging environmental and climate risks, using horizon scanning techniques combining experts' collaboration and desk research.

⁽⁴⁾ https://ec.europa.eu/info/files/ministers-future_en.

⁽⁵⁾ https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation/better-regulation-guidelines-and-toolbox/better-regulation-toolbox_en.

⁽⁶⁾ <https://scar-europe.org/index.php/foresight/documents>.

Particularly relevant for the bioeconomy domain is the 2019–2020 cycle on emerging innovations – economic, business, technological and social – in the green economy of the future (DG Environment et al., 2021). Here, the evolving role of communities, individuals and local actors for a transition to a sustainable economy is particularly highlighted, as are the changes in societal values towards more subjective choices and the circular economy as a new model of production and consumption, reducing resource use and therefore environmental pressure.

Also worth noting are the outcomes of the 2021–2022 annual cycle on emerging environmental issues due to demographic changes in the EU (DG Environment, 2023), which identified five key clusters of change: lifelong learning and skills for the green transition; cities innovating to manage the green transition and demographic change; whether an ageing society can be a green one; demographic change and social and environmental inequalities; and whether there will be a convergence between green, digital and demographic transition agendas. All of these topics were covered during the discussions in the SES workshops.

BIOEAST foresight exercise

Between 2021 and 2022, a foresight exercise (Košir et al., 2021) was conducted by the Central and Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy (BIOEAST) ⁽⁷⁾, covering 11 central and eastern European countries, to support the participating Member States in developing sustainable bioeconomies. The exercise focused on the specific strengths and weaknesses of this macroregion, with the narratives of the four different scenarios being concerned with sustainable natural resources, a sustainable food system, renewable carbon use and decarbonisation pathways, and governance in the context of circular and sustainable pathways. Interestingly, the scenarios highlight the mindset shift that stakeholders need to make. Based on this exercise, the BIOEAST countries have developed a common position on the most relevant areas for which it is important to invest in terms of research and innovation (R & I) in the coming years.

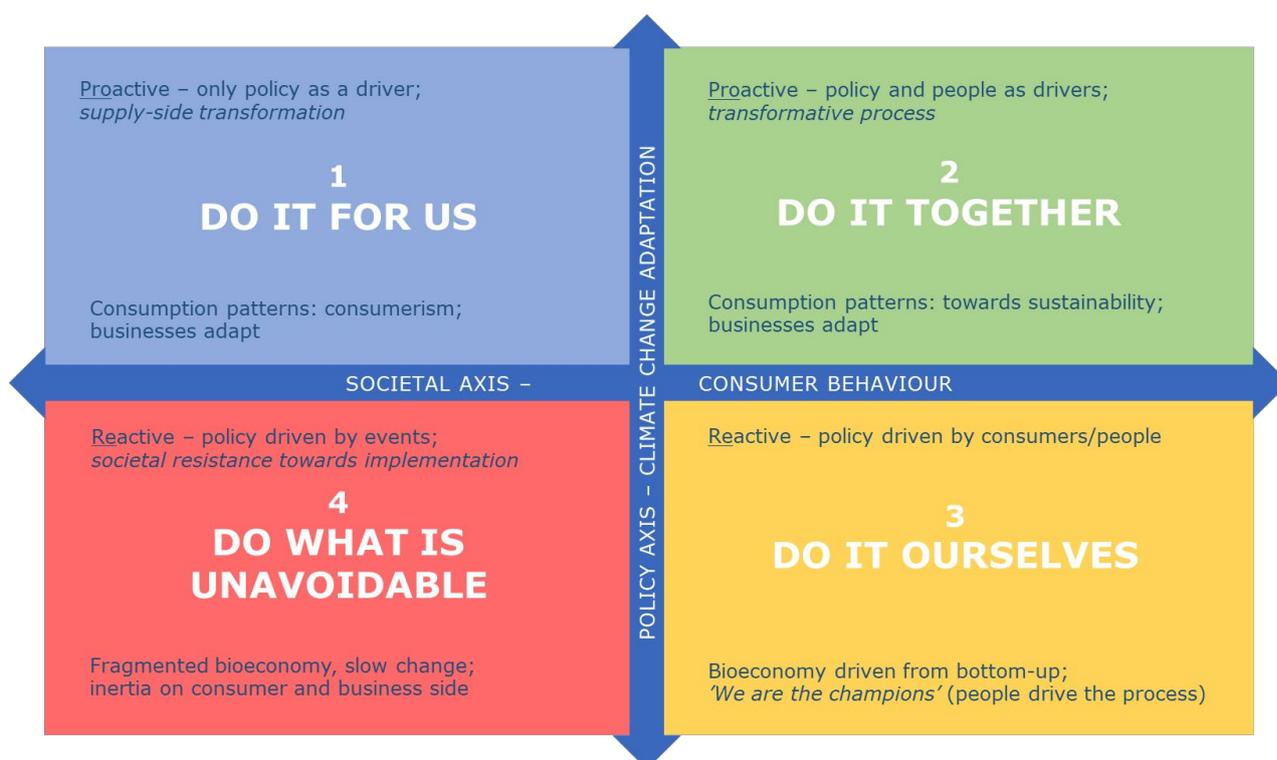
⁽⁷⁾ <https://bioeast.eu/>.

1.2. Four scenarios for the bioeconomy in 2050

In the context of the foresight exercise described in this report, the four bioeconomy foresight scenarios were developed by the network of experts, based on their knowledge synthesis (Fritsche et al., 2020) and on the outputs of three foresight workshops, which took place online in 2020 and involved 49 additional specialists with expertise in EU policy, national and regional administration, research, primary production sectors, industry and community-based organisations.

During the first workshop, drawing on the knowledge synthesis, the experts discussed possible drivers of change for the bioeconomy and identified the two most important and uncertain drivers: (i) the policies in place for adapting to climate change and (ii) the behaviour of consumers and society. Hence, the scenario logic was based on a 2 × 2 matrix with the axes corresponding to these two drivers (policy axis and societal axis) (Figure 1).

Figure 1. Scenario logic



Source: Fritsche et al., 2021.

The vertical axis represents the capacity of the EU political system to implement consistent, coherent and effective policies that are directed towards the achievement of the climate-neutrality goal and the sustainable development goals (SDGs). In the upper half of the axis, there is high implementation capacity, with a proactive political system that anticipates and drives change. In the lower half, the implementation capacity is low, with a political system that acts in reaction to popular calls from society or resulting from political events or crises.

The horizontal axis represents society's attitude towards change, especially related to consumers' lifestyles. On the left, the logic assumes high levels of consumerism and a society that is resistant to change and opposes 'inconvenient' policies, aspiring instead to a status quo. On the right, the logic assumes sustainability and a society that is pushing for change and willing to modify consumption patterns.

The combination of the two axes created the four scenarios shown in the quadrants of Figure 1, which will be described in more detail in Section 3. For a comprehensive description of the scenarios, see Fritsche et al. (2021).

2. Bioeconomy edition of the Scenario Exploration System

The SES is a scientific role-play game and foresight tool developed by the JRC to facilitate the practical use of scenarios from foresight studies. The original motivation behind its development was to create a platform that EU policymakers and other stakeholders could use to explore foresight scenarios in a quick and interactive process that would simplify the application of foresight to policymaking. The tool enables participants to engage in systemic thinking, develop a long-term perspective and consider the vision and strategies of different stakeholders, including policymakers at different governance levels, business and civil society representatives, and the general public. Over recent years, the SES has proved to have a broad range of applications that appeal to diverse audiences across the world, including policymakers, national civil servants, civil society and business representatives, scholars and university students. Several thematic adaptations have been developed inside the JRC and also applied by external partner organisations and independent third parties. The SES is available to any interested party under a Creative Commons licence (CC-BY-SA) that lets users employ it and transform it according to their own needs.

The SES tool can be used to pursue the following goals (Bontoux et al., 2020).

- **Forward-looking and strategic reflections.** In this case, the players engage in strategic thinking without necessarily realising it. They are prompted by the game dynamics.
- **Engagement:**
 - with diverse stakeholders to discuss the dimensions of a broad issue in an open and structured way, to try to reach solutions;
 - with a targeted public representing specific groups of stakeholders on a specific issue to elicit ideas for implementation at the policy or industry level;
 - with a specific chain of (local) actors to make them work together better to solve a very practical (but as yet intractable) issue.
- **Education.** The tool can be used to help students develop skills including negotiation, adaptation, futures literacy, communication and emotional intelligence.

The bioeconomy edition of the SES is based on the four scenarios briefly outlined in the previous section.

The primary objective of the workshops described in this report was to **stimulate key stakeholders to develop forward-looking and strategic reflections about the various aspects of the bioeconomy**, through sessions in which all the participants were asked to play a role similar to what they do in their real life.

The secondary objectives of the workshops were to capture the dynamics of the groups participating in the sessions and to report on the actions and perspectives harvested from the discussions to inform the policy debate on the bioeconomy.

The exercise also provided the possibility to test the tool and collect useful feedback on the game dynamics and organisation from the participants (see Annex 1).

2.1. Set-up of the workshops

The bioeconomy edition of the SES was used in a series of three workshops, which took place between autumn 2022 and spring 2023:

- workshop 1 was held in Brussels on 5 October 2022 as a side event of the EU Bioeconomy Conference ⁽⁸⁾, with 49 participants ⁽⁹⁾ from 17 countries (seven tables ⁽¹⁰⁾);
- workshop 2 was held in Brussels on 13 December 2022, with 40 ⁽¹¹⁾ participants from 17 countries (six tables);
- workshop 3 was held in Ispra on 4 May 2023, with 42 participants from central and eastern European countries (contacted through BIOEAST ⁽¹²⁾) (five tables).

⁽⁸⁾ <https://eu-bioeconomy-conference-2022.b2match.io/page-2761>.

⁽⁹⁾ This number is different from the one presented in Annex 3, because some participants did not give consent to publish their name.

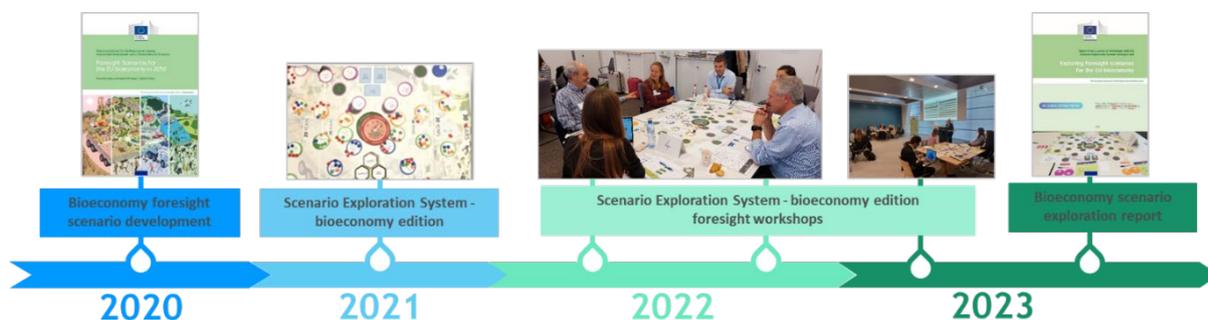
⁽¹⁰⁾ The term 'tables' refers to the small group of participants (sitting at one table) playing the game.

⁽¹¹⁾ This number is different from the one presented in Annex 3, because some participants did not give consent to publish their name.

⁽¹²⁾ <https://bioeast.eu/>.

While the first two workshops focused on the European bioeconomy in its entirety, the third workshop focused on the regional dimension, in particular the central and eastern European region.

Figure 2. Timeline of the KCB bioeconomy foresight exercise



Source: Created by the authors.

During the workshops, participants were asked to simulate their own contribution to the future of the bioeconomy in response to expected drivers and trends, and in relation to the other stakeholders' actions and responses, within the proposed scenarios.

All the sessions were moderated by professional facilitators from the European Commission's Competence Centre on Foresight and from the Academy of Business in Society. The role and the style of the facilitator are very important in explaining the rules of the game clearly, in putting the participants at ease with each other and the new situation they are dealing with, in stimulating the conversation and structuring the discussion, and in helping to remedy difficult situations (e.g. when players are not sure about which actions to choose).

The three events were structured in two parts. The first part was in plenary, with the purposes of informing the participants about the European bioeconomy policy context and the work that led to the development of the four foresight scenarios, and then diving into the rules and dynamics of the board game they would be participating in. In the second part, participants sat at their tables and started playing the game, guided by the facilitators and observed by a journalist, a role adopted by JRC staff or bioeconomy experts (the authors of this report) to capture the dynamics of the discussion in real time.

For each group, the following material was provided for the game:

- a scenario exploration board,
- scenario cards, summarising the scenario name and characteristics,
- scenario detail cards outlining a sequence of events at three time horizons leading to each scenario,
- megatrend cards, presenting strong driving forces that affect all scenarios,
- variable driver cards, describing shorter-term phenomena expected to impact a decade (see Annex 4),
- action cards, which are role-specific cards assigned to each explorer.

At the conclusion of each workshop, the participants were invited to discuss in a debriefing session what they had experienced, through use of the questions outlined in Box 1, and to complete a follow-up survey to provide their written feedback and evaluation of the workshop.

Box 1. Guiding questions to engage participants in strategic reflections

How can different stakeholders help the bioeconomy leverage its unique features and link up all relevant European Green Deal goals and policies?

How can different stakeholders help the bioeconomy reach (current and future) 'left-behind' actors across Europe (farmers, low-growth regions, etc.) and provide them with new prospects?

How can different stakeholders engage all people to contribute to the sustainable and just transformation and develop new sustainable lifestyles?

For the specific rules and material of the game, please see (Borzacchiello et al., 2022).

2.2. Description of the game

Description of the roles and the game

The main roles in the scientific game are played by **four scenario explorers** working and living in the imaginary country of Bioecolandia. They are:

- a **primary producer** (farmer, forest owner, shellfish/seaweed producer, coordinator of a fishers' association, livestock breeder, etc.);
- a **business representative** (agribusiness owner, bio-based product company, wood-processing company, bioenergy plant owner, seafood production company, food-processing company, etc.);
- a **policymaker** in a relevant policy field (agriculture and food systems, innovation and sustainability, climate and environment, transport and energy, rural development, etc.);
- a **consumer association** focused on relevant themes (food, innovative products, forest-based products, energy choices, health issues, circular economy, sustainability education, etc.).

Additionally, there is a **public voice** role, representing the public opinion. The person assigned this role does not take actions but rather judges the actions of the other four stakeholders and serves as a feedback mechanism for the whole game.

The SES sessions are directed by a 'scenario exploration master' (the facilitator mentioned in the previous section), who guides the participants through the game, setting the scene, explaining the specificities of each scenario and stimulating discussions among the participants. The roles are assigned to the participants in advance, so they can familiarise themselves with the role and define their vision and long-term objective(s). The participants have a number of resources (tokens) they can use to give more strength to their actions during the scenario exploration. They explore two of the scenarios, each in three rounds corresponding to different time horizons (10, 20, 30 years), and take actions in turn in response to the scenario events, supported by their available, limited resources.

Once all four scenario explorers have taken action for a particular time horizon, the public voice reacts by assigning tokens to chosen actions according to their judgement about possible impacts. The final score is calculated by multiplying the resources the explorers allocated to each action by the number of tokens assigned by the public voice to support their actions. The scenario exploration master develops a narrative during the rounds and guides the discussion. Everything is recorded in exploration sheets, which are then used as a basis for gathering the outcomes of the workshop, in line with the expected objectives.

How the game unfolded during the workshops

Together, each group explored two opposite future scenarios: 'Do it for us' and 'Do it ourselves' (Scenarios 1 and 3) or 'Do it together' and 'Do what is unavoidable' (Scenarios 2 and 4). In each workshop, multiple groups explored the same set of scenarios to achieve replication.

Each participant was carefully selected following a set of predefined criteria related to:

- specific expertise according to the role to be played;
- geographical origin within the EU (all Member States for workshops 1 and 2, BIOEAST countries for workshop 3);
- gender and age balance.

Table 1. Assignment of roles to tables with specific themes – example from workshop 3

| Table theme (not known by participants) | Role | Role specification | Scenarios explored |
|--|-------------------------|--|---|
| Agriculture | Primary producer | Farmer | Do it for us / do it ourselves |
| | Business representative | Agribusiness owner | |
| | Policymaker | Policy officer – ministry for agriculture and food systems | |
| | Consumer association | Consumer association – focus on food | |
| | Public voice | | |
| | Facilitator | | |
| | Journalist | | |
| Bio-based products | Primary producer | Farmer / livestock owner | Do it together / do what is unavoidable |
| | Business representative | Bio-based product business | |
| | Policymaker | Policy officer – ministry for innovation and sustainability | |
| | Consumer association | Consumer association – focus on innovative products | |
| | Public voice | | |
| | Facilitator | | |
| | Journalist | | |
| Forestry | Primary producer | Forest owner | Do it for us / do it ourselves |
| | Business representative | Wood-processing company | |
| | Policymaker | Policy officer – ministry for climate and environment | |
| | Consumer association | Consumer association – focus on forest-based products | |
| | Public voice | | |
| | Facilitator | | |
| | Journalist | | |
| Food systems | Primary producer | Coordinator of farmers' associations | Do it together / do what is unavoidable |
| | Business representative | Food-processing plant owner | |
| | Policymaker | Policy officer – ministry for health | |
| | Consumer association | Consumer association – focus on food consumption choices | |
| | Public voice | BIOEAST coordinator of Czechia | |
| | Facilitator | | |
| | Journalist | | |
| Fisheries/aquaculture/algae | Primary producer | Seaweed producer | Do it for us / do it ourselves |
| | Business representative | Seafood production company | |
| | Policymaker | Policy officer – ministry for rural development | |
| | Consumer association | Consumer association – focus on novel food and innovative bio-based products | |
| | Public voice | | |
| | Facilitator | | |
| | Journalist | | |

Source: Created by the authors.

Choosing the participants was a long process, during which the KCB team scanned the networks of bioeconomy stakeholders to ensure a balanced, knowledgeable and dynamic set of players at each table. After the selection phase, the invitation process led to adjustments in the composition of the groups, due to limited availability and

last-minute dropouts. Each confirmed attendee was then assigned to a specific table to take part in the SES within a specific group. To facilitate the discussions, participants were grouped according to broad thematic domains relevant to the bioeconomy (bioenergy, bio-based products, agriculture, fisheries, forestry, etc.). However, these themes were communicated only as a hint through the specific description of their role (see Table 1). This decision was made to encourage participants to discuss the bioeconomy as a holistic system, without focusing on a specific domain. Besides, grouping the participants according to similar expertise facilitated the dialogue and the dynamics of the game at the tables during the limited time available.

Before the workshop (typically 1 week in advance), the participants received specific instructions on how to prepare for the role they would be playing. They were asked, in particular, to consider their role and think about various aspects (see Table 2) and to be prepared to briefly present their role in front of their group at the beginning of the exploration. Regarding the public voice, the instructions were slightly different given the particular nature of the role.

Table 2. Aspects to consider when preparing the role description

| | Explorers | Public voice |
|---|--|-------------------------------------|
| Aspects to consider when preparing the role description | What is the name of the organisation you represent? | Who are you? |
| | What do you do exactly? | What is your long-term vision? |
| | What goal do you aim to achieve in the next 30 years? Please be as specific as possible. | What are the values that guide you? |
| | What are the values that guide you? Please choose a maximum of three. | |

Moreover, public voices were asked to keep the following aspects in mind when formulating their feedback to the explorers.

- Was the action taken consistent with the role and the long-term objectives of the stakeholder?
- Did they address the situation fully considering the scenario detail card?
- Did they consider the megatrends and variable trends?
- Was their reasoning clear and well explained?
- Were they applying forward (long-term) and systemic thinking?
- Was the action ambitious enough?
- Did their action lead to the development of a sustainable lifestyle?
- Was this action helpful to effectively achieve the objectives of the European Green Deal and contribute to climate neutrality?

The numbers of scenario explorers who took part in each scenario across the 18 tables from the three SES bioeconomy workshops are reported in Table 3. Given the exiguous number of observations, this is not meant to be a statistically significant sample, but it gives valuable insights into how bioeconomy stakeholders might react to different future boundary conditions (represented by the scenarios) and events (represented by the specific scenario details).

Table 3. Number of scenario explorers in each scenario exploration

| Scenario | Policymaker | Consumer association | Primary producer | Business representative |
|---------------------------|-------------|----------------------|------------------|-------------------------|
| 1. Do it for us | 10 | 9 | 8 | 10 |
| 2. Do it together | 8 | 7 | 5 | 8 |
| 3. Do it ourselves | 10 | 9 | 8 | 10 |
| 4. Do what is unavoidable | 8 | 7 | 5 | 8 |
| Total | 36 | 32 | 26 | 36 |

2.3. Methodological note

Before diving into the analysis of the workshops' outcomes, it is important to note that the use of scenario exploration systems (games) is a qualitative exercise to elicit perspectives and perceptions from stakeholders in a safe and informal space. Due to the limited sample size (see Table 3), the exercise does not provide quantitative outcomes, nor was it designed to do so, but it gives concrete and tangible observations about the potential behaviour of actors and stakeholders when confronted with specific conditions and situations. This can help in strategically orienting policymaking.

The selection of participants is very important, and this is not limited to the role they cover in real life (i.e. it is important to select participants who will be keenly aware of the sensitivities and motivations of the role they are assigned); their personality and attitude may influence their behaviour during the exploration. A real-simulation approach (roles closely matching real-life duties) was not always possible due to the lack of available experts. The fact that the primary producer was missing at many tables (because of the constant, high demands of their work) was considered quite typical of primary producers in real life by some players.

In addition, participants, facilitators and organisers remarked on a general bias in participants' values towards sustainability goals and visions. In fact, most participants were linked to the sustainability domain, with relevant background and professional experience. This leaning towards a 'green' attitude characterised most discussions at the various tables and certainly influenced the outcomes of the analysis.

As pointed out by many of the participants who responded to the feedback survey, it is very demanding for the players to simultaneously consider the many elements of the SES, such as their vision, the scenarios, the megatrends and actions to take.

Some differences were observed between the workshop dedicated to the BIOEAST countries and the other two workshops. In the BIOEAST workshop, participants felt more at ease discussing with colleagues from neighbouring countries, as they deal with similar political and societal issues. At some tables, the actions were more localised, aiming to have an impact on a specific region or local community.

In the following section, a summary of each scenario is given and then a description is provided of the more frequent actions chosen by the participants during the exploration in each scenario. This information is visualised in word clouds⁽¹³⁾, with bigger font sizes denoting the most commonly used options. Section 4 provides an analysis considering the behaviour of each role within the dynamics set by the scenario boundary conditions and each role's contribution to the three dimensions of sustainability.

⁽¹³⁾ Created in <http://www.wordclouds.com>.

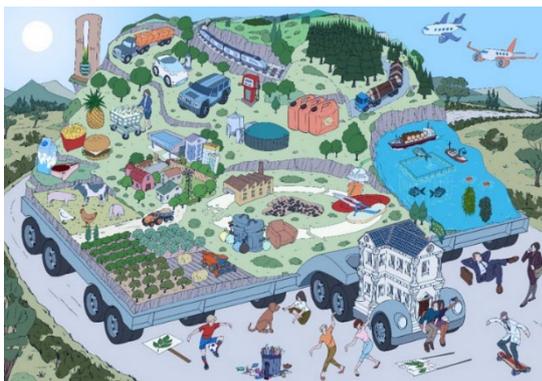
3. Insights from the workshops by scenario

The use of a board game, as a tool to stimulate conversations on the future, as well as the generally informal set-up employed in the workshops, helped to create a safe space for the participants, enabling them to stay relaxed and to be able to share their insights without feeling the need to (overly) defend a position linked to their professional affiliation. Furthermore, the connection between the participants' occupations in real life and their roles in the exploration sessions helped them to make more informed and grounded decisions, to imagine with a certain level of detail what different bioeconomy futures could mean for them and to consider the implications for their interests and priorities. It was possible to observe how various stakeholders would behave under different circumstances, the reasoning behind their actions and how their decisions might influence those of other stakeholders. An intrinsic added value of the SES methodology brought the four main actors (primary producers, policymakers, business representatives and consumer associations) together as a group to debate the necessary actions to address the future challenges of each scenario, with the aim of moving towards sustainable development and a climate-neutral economy.

The following sections are organised by scenario and describe the most common actions and behaviours taken by the participants in their role when confronted with the different scenario details.

3.1. Scenario 1 – do it for us

Figure 3. Scenario 1 – do it for us



Source: Fritsche et al., 2021.

In this scenario, the driving force is policy, which is pulling the landscape of the bioeconomy towards sustainability and climate-neutral goals, through mainly fiscal and regulatory instruments that address the supply systems. However, society resists significant changes in demand away from business as usual. Consumption responds partly to higher prices of goods and services but the pressure of demand on resources remains high.

For this scenario, the three SES bioeconomy workshops (37 participants in total) showed that business representatives and primary producers were generally open to changing their business models to achieve more sustainable production patterns. They felt supported by the measures put in place by the policymakers in line with the European Green Deal objectives, even if these were not reinforced by a change in consumer behaviour.

Figure 4. Policymakers: word cloud of actions in Scenario 1 (do it for us), from the three workshop sessions (ten scenario explorers)



While exploring this scenario, **policymakers** led the transformation: they were very active in supporting green policies, especially in the medium- and long-term horizons, as expected for this scenario. They usually started with information and awareness campaigns on the policies being implemented, launching **consultations** and citizen engagement activities to include and motivate those lagging behind and to promote the inclusion of consumers' access to sustainable products. This was a means to help change habits through a 'soft' strategy. They followed up with stronger actions such as **providing facilities, enforcing** green standards and rules (e.g. stopping industrial plants such as cement plants from running on fossil fuels) or investing in collaborative research at national and international levels, involving several ministries and academia. In some cases, policymakers funded employment and vocational training projects, supporting the

development of **new business** and the **reskilling** of the workforce. Less often, they enforced social security measures to increase living standards and therefore the accessibility of more sustainable products for those on lower incomes. Tracking the progress of the policy initiatives to monitor their implementation and impact was also a common course of action.

Figure 5. Consumers: word cloud of actions in Scenario 1 (do it for us), from the three workshop sessions (nine scenario explorers)



Consumer associations tended to strive for **information campaigns** to have their voices heard, even in the face of aggressive investment and strong policy actions from policymakers. They defended the rights of all consumers, including those with more individualistic behaviour, and resisted the sustainable transition. They highlighted the regulatory burdens and the considerable economic resources necessary to change consumption patterns. At the same time, against the scenario narrative, they were aware of the need to **change habits and consumption patterns**, so they tried to **raise awareness** among the public and to **participate** more actively in the sustainability debate. Their collaboration with other stakeholders increased over time. As expected, this failed to effectively promote sustainable lifestyles among various consumer categories.

Figure 6. Primary producers: word cloud of actions in Scenario 1 (do it for us), from the three workshop sessions (eight scenario explorers)



Primary producers tended to **engage** with other stakeholders, trying to adapt their investments and subsequent production to business and consumer needs. Small-scale primary producers understood the importance of networking and joined forces to look for solutions to common challenges. Despite the scenario trends, primary producers were committed to **promoting and extending innovative practices**, sharing their workforce, establishing a lively economy, engaging with universities and creating practice labs on farms to test new technologies. These actions were supported by **investments**, which were intended to bring not only economic dividends but also social benefits such as making the rural environment attractive to young people and fighting against rural isolation and depopulation. This strategic approach encouraged collaboration from other actors and contributed to social and economic sustainability.

Figure 7. Business: word cloud of actions in Scenario 1 (do it for us), from the three workshop sessions (ten scenario explorers)



Businesses seemed to find suitable conditions to invest in **research and development**, change their business models and expand their production with **new and innovative products** and new value chain processes to capture the growing market for sustainable products/services. On one hand, they wanted to react to negative megatrends such as environmental degradation and climate change. On the other hand, they took advantage of the favourable policy environment, putting in place facilities suitable for supporting industrial development. Business investments were technology-centred, but they were usually accompanied by upskilling and training of **personnel** to fulfil the **changes in business models and technology**. From the beginning (10-year time horizon), they started looking forward and adapted their strategy to longer-term horizons. In general, they did not hesitate to **raise capital** to achieve their ambitious objectives.

Regarding collaboration in Scenario 1, the behaviour varied considerably, depending on different settings and visions. In some cases, there was mutual and supportive cooperation among all the players. In some other cases, especially when their values drove them to consolidate their own profits, the business representatives and primary producers were hesitant to collaborate or support the policymakers' actions, as they were perceived as potentially disruptive of the market.

3.2. Scenario 2 – do it together

Figure 8. Scenario 2 – do it together



Source: Fritsche et al., 2021.

This scenario follows an integrative approach and delivers the most, but it is also the most challenging. Bioeconomy policy must reach out to society and be inclusive of Member States (diversity) and social movements. It also requires a post-2030 ‘new Green Deal’. The bioeconomy is built from the ground (bottom-up) and collaboratively from the top down (through clusters and networking), with the inclusion of partners outside the EU. The political system and society are aligned to achieve the climate-neutrality goal and the SDGs. Businesses quickly adapt and are part of the change. The transformative process includes all actors.

The unambiguous message that emerged from this second scenario (28 participants in total) is that working together offers win-win solutions for environmental, economic and social sustainability alike. Businesses, policymakers and consumers aligned both their objectives and the ways to achieve them, as this scenario offered plenty of scope for collaboration.

Figure 9. Policymakers: word cloud of actions in Scenario 2 (do it together), from the three workshop sessions (eight scenario explorers)



Policymakers engaged and cooperated with other stakeholders. They **adapted** their actions to society’s needs, to enable an efficient transition. They tended to accept the challenge of more responsibility, by launching stakeholder **consultations** to raise awareness about the priorities at stake, developing **monitoring** instruments for the implementation of their policies, gathering data and information on all bioeconomy domains, demonstrating trends and enabling evidence-based policymaking. Moreover, they proposed and **enforced environmental rules** establishing target standards for bio-based materials, making sure that they were respected by the industry. These actions had indirect environmental and social effects regarding sustainability. Overall, policymakers did not push other stakeholders through strong measures, informative actions or incentives, as it was sufficient to follow and facilitate the societal change towards sustainability.

Figure 10. Consumers: word cloud of actions in Scenario 2 (do it together), from the three workshop sessions (seven scenario explorers)



Consumer associations behaved positively and actively. They **campaigned** to raise awareness about the importance of biodiversity and sustainable consumption, while defending consumers’ interests against rising prices. These actions led to lower consumption levels and to a shift towards greener products, which enabled more sustainable lifestyles. Interestingly, one action taken by consumers was to ‘advise’ different parts of society to **change their habits** (e.g. eat more healthily, have a balanced diet and include more plant-based proteins). They also helped producers understand the preferences/choices of consumers to help them adapt to the demand. In general, consumers responded to the scenario conditions with soft measures and were mostly vigilant about developments in policy and industry.

Figure 11. Primary producers: word cloud of actions in Scenario 2 (do it together), from the three workshop sessions (five scenario explorers)



Primary producers chose concrete actions, such as **changing and improving common practices** to make their production greener. They decided to make use of their waste streams and orientate towards circular production models. They recognised that, by improving their efficiency, they could increase their **production** levels and **invest** to sell more diversified products to a larger pool of sustainability-oriented clients. A minority of primary producers focused on stakeholder engagement and networking. The aim of these actions was to have a better understanding of civil society demands in terms of food quality and proximity, to meet consumers’ requirements. Together with the availability of sustainable finance, this was a major driver of change.

Figure 12. Business: word cloud of actions in Scenario 2 (do it together), from the three workshop sessions (eight scenario explorers)



The **business** community was keen to **expand**, both geographically and in terms of production output, opening new facilities and developing innovative products. Businesses **raised capital** and **invested in R & I** or business diversification to overcome major challenges such as waste reuse and critical materials supply. While these actions contributed mostly to the economic and social dimensions of sustainability, in many cases, such as the development of new products with a lower environmental footprint, they also contributed to the environmental dimension. Particularly impressive was the business community’s reactivity and adaptability to actively seek collaboration.

In this scenario, the effort to achieve the sustainability targets was well balanced among the different actors, who were fairly aligned in both their vision and their actions. Collaboration was in general mutual, targeting common objectives and amplifying sustainability in multiple dimensions. More diverse collaboration patterns were observed in the situations in which all four players (including the primary producer) were present.

Figure 15. Consumers: word cloud of actions in Scenario 3 (do it ourselves), from the three workshop sessions (nine scenario explorers)



Consumer associations had an active role in the exploration of this scenario. They **raised awareness** using different means, including social media and door-to-door campaigns. They provided consumers with general advice on low-impact habits, and even went into more detail through specialist advice on environmental resource protection and sustainable consumption patterns. In some cases, they organised courses, set up competence centres and facilitated dialogue to inform and motivate citizens in relation to sustainability. In general, they tried to reinforce the active role of consumers and society in the decision-making process to compensate for the lack of active policies and created momentum for **strategic change**. Consumer associations shared and discussed their needs and problems with policymakers, primary producers and businesses – that is, they **interfaced with stakeholders** to manage conflicting demands and tensions due to

limited available finance. They supported the other roles, in particular to find a common ground with policymakers and to help the other stakeholders foster local bioeconomies. This contributed to both the environmental and the social dimensions of sustainability, although in some cases indirectly.

Figure 16. Primary producers: word cloud of actions of in Scenario 3 (do it ourselves), from the three workshop sessions (eight scenario explorers)



Given the extreme weather events, and the important role of local communities, **primary producers** tended to **change practices** and business models, develop commercial activities and **expand and diversify their production** to address new demand. They produced new varieties as alternatives to traditional ones, **invested** in new emergent activities and diversified their business streams to bring additional services to society (e.g. creating local school farms for children). This strategic approach to improve education and training was seen as promising, so the farming community looked for other groups in Europe to join forces and extend the model. The aim of such **engagement** activities was to gain support from a society that is more and more conscious of the need to **change consumption patterns** towards sustainability. In this sense, these actions supported both the economic and the social dimensions of sustainability.

Figure 17. Business: word cloud of actions in Scenario 3 (do it ourselves), from the three workshop sessions (ten scenario explorers)



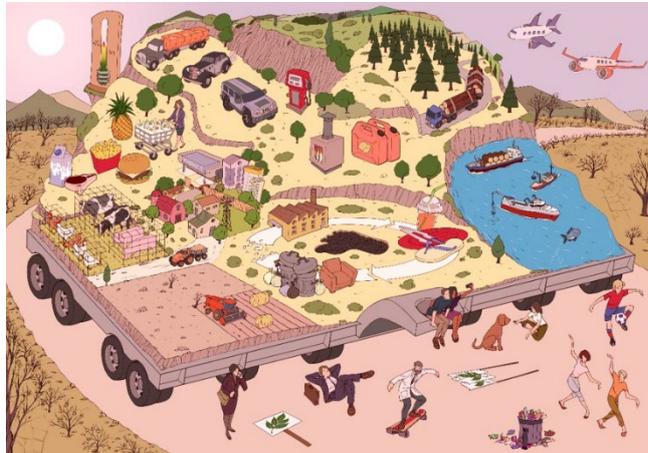
Businesses tended to take a proactive role, **investing in research and development** and setting up new **facilities** to achieve more sustainable, circular, efficient and inclusive processes. In this scenario narrative, consumption patterns were changing and businesses tried to address the increasing demand for bio-based sustainable products by making use of non-traditional methods of communication and **campaigning** (social media, influencers, etc.) for their marketing strategies. Such trends allowed businesses to raise capital and **expand production** to the bio-based sectors. In addition, they tried to cope with the lack of support from government by lobbying and **engaging with stakeholders** to achieve a common vision and advertise their sustainability efforts. They believed that this public pressure would also drive policy and investments and contribute to the economic and social dimensions of sustainability. Unfortunately, when a suitable policy framework

was missing, the stakeholders struggled to invest and adapt their business models, with high risks and low returns.

In terms of collaboration, there was a tendency among primary producers and businesses to leverage consumer demand for their own interests (which included profit, but as a result of the nature of the roles chosen, also sustainability in general). In addition, primary producers and businesses supported each other in terms of investment, shared vision and value chains, to compensate for the lack of action from government.

3.4. Scenario 4 – do what is unavoidable

Figure 18. Scenario 4 – do what is unavoidable



Source: Fritsche et al., 2021.

This scenario is the most unfavourable, but may well be the most realistic, given the trends over the last three decades. A ‘middle-through’ logic of short-sighted, uncoordinated and non-integrated policies across levels, themes and sectors will cause significant pain and losses. Lifestyles do not change significantly from business-as-usual patterns. The political system is not able to implement/enforce proactive policies, nor does it support them, instead limiting itself to adopting – with some delay – measures in reaction to crises.

Actions and behaviours in this scenario were characterised by disharmony, disorientation and attention being paid to the shorter-term interests. Each stakeholder was heading in a different direction and fighting for their own interests, and nobody obtained their desired results.

In the exploration of this scenario, there was an initial proactive attitude from the players (28 participants in total) to try to understand why the situation was so negative, through consultation and engagement with various stakeholders. In the first time horizon (10 years) in particular, there was a general tendency to react to the adverse situation with investment, innovation and continued production. In a low-margin environment, the focus was on resource efficiency, profitability and marginal improvements. These actions generally contributed more to the economic and social dimensions of sustainability, tending to provoke a shift in sustainable lifestyles without contributing to the climate-neutrality targets directly.

Figure 19. Policymakers: word cloud of actions in Scenario 4 (do what is unavoidable), from the three workshop sessions (eight scenario explorers)



Since the Green Deal goals seem out of reach in this scenario, policymakers intervened, **setting new rules** and minimum requirements to adapt consumer behaviours and consumption patterns to the harsh climate change reality. They could not do anything other than **change current practices**, which had failed to prevent huge environmental damage (crisis management). More concretely, they **provided facilities** to encourage researchers and market players to find new green solutions to satisfy the basic needs of citizens. In addition, they tried to **consult** and reach out to stakeholders to manage conflicting demands and interests. They also tried to monitor the impact of all these measures, but it seemed too little and too late. The measures influenced the social and economic dimensions of sustainability but failed to promote sustainable lifestyles or contribute to climate-neutrality targets. In some cases, if the society was definitely not engaged in a green

transition mindset, policymakers did not feel much pressure to put in place green policies.

Figure 20. Consumers: word cloud of actions in Scenario 4 (do what is unavoidable), from the three workshop sessions (seven scenario explorers)



Consumer associations either adopted a defensive approach to **protect their constituency's** interests or tried to **change strategy** in response to the dramatic events unfolding. In the latter case, they consulted experts to understand the impact of dietary shifts and changes in consumption on the escalating climate change crisis and tried to build bridges with other stakeholders to better reach citizens and convince them that **changing habits** was very important and could not be delayed, in the interest of **resource protection**. Consumer associations could also encourage people to produce their own food to address the reduction of primary production, which was not mitigated by any political action. In general, the associations' level of **commitment and participation** increased over time and as climate change revealed its true nature and harmful impacts.

Figure 21. Primary producers: word cloud of actions in Scenario 4 (do what is unavoidable), from the three workshop sessions (five scenario explorers)



Primary producers were keen to react to this unfavourable scenario: they did not hesitate to **invest** significant economic resources to cope with challenges related to climate change, especially at the 30-year time horizon, when the environmental, social and economic damage was very clear. Their actions depended on their long-term values. If they were profit-driven, they could start with mixed (conventional and organic) production and then convert it into fully **conventional production**, to survive and ultimately expand and scale up (supported by technology), without searching for any collaboration. The more sustainability-oriented producers strove to produce accordingly, changing common practices to improve waste management. Despite the difficult boundary conditions, they **engaged** with other primary producers and business actors, such as foresters and farmers at the local level.

Figure 22. Business: word cloud of actions in Scenario 4 (do what is unavoidable), from the three workshop sessions (eight scenario explorers)



Sustainability-oriented **businesses lobbied** national governments to put in place some actions to reduce disharmony and work together to find win-win solutions. They also campaigned and highlighted the importance of their social role – keeping jobs in the regions – both for lobbying and for marketing purposes. Businesses tried to **adjust their supply chains and business models** to increase cooperation and efficiency in order to distribute risks and overcome the legislative fragmentation. In some cases, despite the unfavourable trends, they **invested** in research and development and cultivated **sustainable manufacturing** practices. Indeed, the dramatic evolution of this scenario pushed businesses to find creative solutions and to exploit all their resources to be able to cope with the environmental, social and economic challenges the whole society was facing.

In this scenario, even when certain businesses, policymakers and consumer associations appeared to be aligned in their objectives, everyone tended to head in a different direction to achieve them. Scope for collaboration (support for each other's actions) was therefore limited and stakeholders often ended up in a counterproductive 'blame and shame' game.

4. Insights from the workshops by role

4.1. Actions by role versus scenario narratives

As explained in Section 2, each scenario explorer could explore two contrasting scenario couples, either Scenarios 1 and 3 or Scenarios 2 and 4 (see Figure 1 to recall the scenario details). Therefore, an analysis could be performed to see whether the same participants playing the same role, but confronted with different scenario contexts, would consistently choose similar types of actions.

Policymakers' actions

In Scenario 1 (do it for us), the policymaker is expected to be proactive and lead the sustainability efforts, choosing actions which tend to have a specific transformative effect (change procedure, change practice, develop safety measures, etc.), and to communicate (through information campaigns, interfaces with stakeholders, etc.). In Scenario 3 (do it ourselves), characterised by more sustainable consumption patterns adopted by the society, it seems that the tendency is rather to get information about the actions of the other roles and monitor what is happening. In Scenario 2 (do it together), the policymaker, probably supported by a general positive trend, tended to have less proactive actions and rather monitored and supported (through investments) what was already happening. In Scenario 4 (do what is unavoidable), their tendency to contest the boundary conditions by enforcing new rules, investing in transformative actions and communicating the importance of sustainable behaviour was more evident.

Consumer associations' actions

Consumer associations reacted to the boundary conditions of Scenario 1 (do it for us) by trying to convince consumers and society to change behaviours towards sustainability, even if the scenario details presented an opposite tendency. Interestingly, in Scenario 3 (do it ourselves), they maintained more or less the same actions as in Scenario 1 (raising awareness, interfacing, providing advice, consulting) – even though in theory the scenario characteristics presented a consumer behaviour already oriented towards sustainable consumption – as a way of enforcing sustainable behaviours. In Scenario 2 (do it together), characterised by a general positive transformation towards sustainability, consumer associations preferred campaigning, raising awareness and advising towards sustainability, thus consolidating the tendency to consume less and change habits and supporting the scenario dynamics. In Scenario 4 (do what is unavoidable), they tended to promote behavioural change, consult society and defend their members/constituents from the looming threats of climate change and general unsustainable consumption patterns.

Primary producers' actions

In Scenario 1 (do it for us) primary producers tended to expand and modernise their production systems while engaging with authorities and other stakeholders. These actions were most probably triggered by the supportive policy context typical of this scenario. In Scenario 3 (do it ourselves), primary producers reduced this tendency and chose a series of actions oriented to changing activities, practices and production processes in response to consumer demands towards more sustainably produced and healthy products. The same tendency to invest and expand could be observed in the actions of primary producers exploring Scenario 2 (do it together), supported not only by institutional investments but also by general sustainable consumption patterns. These types of actions were dropped in Scenario 4 (do what is unavoidable), where primary producers instead were inclined to conserve the status quo and to engage with other stakeholders to try to address the difficult boundary conditions together.

Business representatives' actions

For business representatives exploring Scenarios 1 and 3, there was no clear difference or marked trend in the chosen actions. In general, they tended to invest in and develop new products or manufacturing processes regardless of the scenario, probably as a way of finding their market niche and/or securing their business streams in an unstable (regulatory and societal) framework. However, for Scenario 2 (do it together), there was a much clearer trend towards investing and expanding (probably thanks to the favourable boundary conditions, as in the case of the primary producers). This was reduced in Scenario 4 (do what is unavoidable), in which the business representatives preferred actions related to communicating and interfacing with other stakeholders and oriented towards a change in business models.

4.2. Sustainability dimensions

The different scenarios have different ways of contributing to sustainable development and a climate-neutral economy, with Scenario 2 (do it together) being the most favourable one thanks to the proactive policymaking and the collaboration of policymakers with civil society, consumers and businesses.

In every scenario, the actions of each stakeholder can contribute to the three dimensions of sustainability – economic, environmental and social – and to the SDGs ⁽¹⁴⁾ to different extents. The sustainability dimensions are interrelated, meaning that one influences the others, in a positive or negative way, depending on the scenario settings and the choices of the actors.

Policy-makers' actions

For the policymakers, providing facilities to make things possible can have an impact on all the sustainability dimensions. For example, the environmental schemes contribute primarily to environmental sustainability (SDGs 14 and 15), but they also have an impact on the economic dimension, with the opening of new markets (SDG 8). Moreover, improving farmers' livelihoods also contributes to the social dimension, reducing poverty and combatting inequalities (SDGs 1 and 10).

More generally, the action of consulting and talking to stakeholders and experts to understand their point of view is important to find solutions together, involving both consumers and producers. The action can provide the knowledge and skills needed to promote sustainable development (SDG targets 4.7 and 12.8). This action would also produce secondary effects on the other dimensions, including multistakeholder partnerships that contribute to strengthening the means of implementation (SDG 17).

Consumer associations' actions

On the side of the consumers, campaigns to raise awareness, for example about the need to move towards a zero-waste society, will support sustainable development education (SDG target 4.7), improve citizens' engagement and promote new, more sustainable lifestyles (SDG target 12.8).

In addition, the action of protecting resources will contribute more specifically to the environmental dimension of sustainability (SDGs 6, 12, 14 and 15).

Primary producers' actions

Primary producers changing their waste practices, moving towards a zero-waste society, will reduce the adverse environmental impact of cities (SDG target 11.6) and will reduce waste being released into the air, water and soil (SDG targets 12.4 and 12.5), with positive impacts on human health (SDG 3) and the environment (SDGs 14 and 15). This will contribute directly to the climate-neutrality targets and will also promote sustainable lifestyles, especially when associated with an awareness-raising campaign for consumers.

The investment of money to increase employment in rural areas by primary producers will have a positive impact on the economic dimension of sustainability, supporting employment and productive activities (SDG targets 8.2 and 8.5). In addition, adopting new technologies and ideas for agroecology will foster R & I (SDG target 9.5) and skills for employment (SDG target 4.4) and will support sustainable agriculture and food production (SDG target 2.4), with cascading positive effects for the environment and people.

Business representatives' actions

The actions of businesses support mainly the economic dimension, for example when they change business model or raise capital to support expansion or development.

There could also be impacts on the environmental side, for example if they improve manufacturing to make processes more efficient, cleaner and less resource intensive. In this way, businesses also address the issues of resource scarcity and climate change (SDGs 12 and 13).

In general, improving infrastructures and changing logistics, to adapt to the new environmental constraints, would promote sustainable industrialisation (SDG 9), reinforce the efficient use of natural resources (SDG target 12.2) and improve resource efficiency in production and decouple economic growth from environmental degradation (SDG target 8.4).

⁽¹⁴⁾ <https://www.undp.org/sustainable-development-goals>.

4.3. The role of the public voice

The role of the public voice in this series of workshops was assigned to the EU Bioeconomy Youth Ambassadors, appointed in summer 2022 by DG Research and Innovation ⁽¹⁵⁾. As explained in Section 2, the public voice acts as the public opinion, judging the actions of the players, by considering their collaborative attitudes, and giving scores. This role is not designed as a neutral one though, as the public voice takes into account its own fundamental values and long-term objectives. The youth ambassadors were very creative and proactive in defining themselves in the imaginary country of Bioecolandia. Examples include a young professional working in the biotech industry, a family-oriented person grounded in values of truth, honesty and fairness, a climate activist, a local newspaper journalist, a conservative elderly people's association, a student union representative, a non-governmental organisation against food waste, a social media and science influencer, an editor of a newspaper for the general public, a young person eager to ensure a liveable future for their generation and a member of a family running a fossil-based business.

A review of the reactions of the public voices across the three workshop sessions (18 tables) did not reveal common key trends in their behaviour in the same scenarios, as explained for the other roles in this section. This is probably because this role is more open to interpretation and thus highly dependent on the specific identity of the explorer. Two main categories were identified: the public voices aligning to the scenario explored, considering themselves as the voice of the general public and following the main narrative of the scenario, and those resisting the common scenario narrative, trying to guide the other players towards their own values and objectives instead.

All stakeholders needed to make a shared effort to influence the public voice, so that it had a positive opinion of their actions and collaboration habits. Indeed, the reaction of the public voice, giving appreciation and preference to the actions of the stakeholders, influenced the behaviour and choices of the players. This proved more difficult when the public voice represented a specific niche in society (e.g. an elderly people's association, a post-truth journalist), with less flexibility and openness to compromise.

⁽¹⁵⁾ https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/meet-our-bioeconomy-youth-ambassadors-2022-08-04_en.

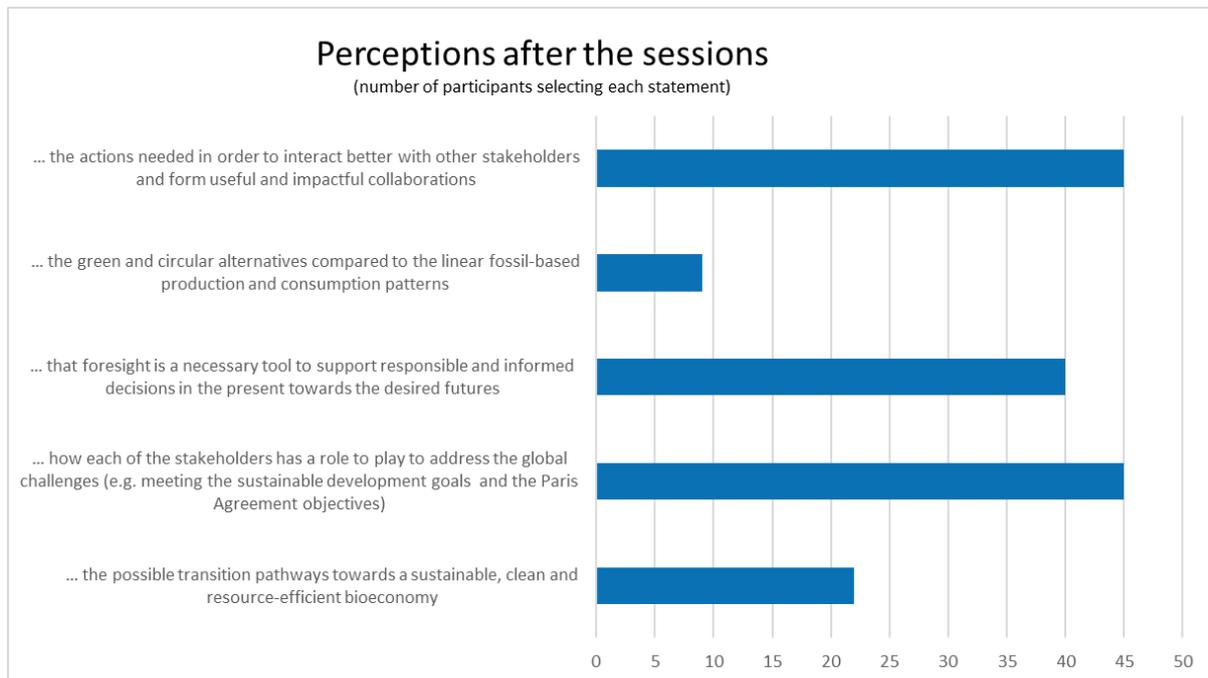
5. Conclusions

5.1. Analysis of feedback from participants

After each workshop, participants provided written feedback via a survey. One part of the survey focused on the event organisation (see Annex 1), while the other part explored specific issues discussed during the debriefing sessions. The plenary session in the last workshop enriched the discussion and collection of outcomes and proved to be an excellent means of gathering collective reflections on the exercise.

The SES bioeconomy workshops' main objective was to engage the participants in systemic reflection. They allowed key stakeholders to look at the bioeconomy with an open mind and a forward-looking perspective. This was achieved through a simulation of the participants' own contribution to the future of the bioeconomy in response to expected drivers and trends, and concerning the contribution of the other players, within the proposed scenarios. Therefore, participants were invited to share their impressions of these aspects after the experience. The cumulative feedback shown in Figure 23 shows that most participants perceived that, after playing the game, they were more aware of the actions needed to interact and collaborate with other stakeholders, of the role of foresight in informing policy and of the importance of considering the perspectives of each actor to address climate-related challenges.

Figure 23. Feedback on the question related to the objectives of the workshops (responses from 100 participants in the three SES bioeconomy workshops)



Both in the debriefing sessions and in the written survey, the explorers were asked four specific questions based on the issues raised by the progress report on the bioeconomy strategy (DG Research and Innovation, 2022). These questions were agreed at the outset by the KCB team (JRC and DG Research and Innovation).

1. How can collaboration between primary producers / businesses / consumers / policymakers better achieve a sustainable bioeconomy?

The general feedback highlighted the importance of collaboration, with five main aspects.

- **Collaboration is essential due to the complexity of the bioeconomy.** It helps to identify solutions that are win-win for all stakeholders faster and more efficiently under changing conditions. It is important to fully understand the positive and negative impacts of different behaviours, decisions, resources used, production systems and regulations along the value chain. Co-creation and sharing of solutions are key –

if these do not exist, the transition will be hindered by resistance from the left-behind stakeholders. On the other hand, when collaboration takes too long to achieve, new policy instruments have an important role to play to engage all stakeholders proactively and with a cooperative mindset.

- **Consumers should play an important role in decision-making.** The active collaboration of consumers with other actors can provide public buy-in, and the bioeconomy can be implemented at the citizen level. The sensitive aspect of people's social and economic status was also touched upon: those who are left behind and struggle for survival might not consider sustainability as a priority.
- **Different perspectives with the same goal should be taken into account.** The different points of view should be duly considered, and different objectives clearly defined. Mutual understanding is key, and it is fundamental to make sure that producers' decisions and policymaking are working in the same direction and are purpose-driven, responding to consumer demand and to the needs of the wider society. Collaboration can increase impacts if actions are geared towards the same subjects (e.g. consumers) or can help to address trade-offs and levels of disparities.
- **Each actor is responsible for their part in the transition process.** It is very important for businesses and primary producers to collaborate in order to have a stronger voice. Policymakers should lead, listen, coordinate and provide incentives and solutions. Primary producers have a critical role in the value chain. Consumers should be socially responsible and recognise their role in influencing sustainable production, but, on the other hand, primary producers and businesses should listen to consumer needs. This can trigger a virtuous cycle in which sustainable behaviour by one actor influences the others and, in turn, promotes collaborative schemes.
- **Collaboration can be fostered by providing incentives and creating opportunities for interaction** and open dialogue involving the exchange of information, knowledge, perceptions and best practices, to increase the level of awareness and understanding, cross-sectoral integration and coordination, leading by example, trust and transparency and clear communication about where investments will be most effective.

2. What role do the primary producers, consumers, businesses and policymakers play in the deployment of a sustainable bioeconomy? Do you think all the stakeholders are equally committed to contributing to the scenario and addressing its challenges, reaching towards a sustainable bioeconomy? What was your specific role in this process?

The following recurring issues were highlighted for this question.

- **Sharing of responsibility.** Participants' perceptions of responsibility varied. Some felt that all players were contributing equally, while others felt that some were not committed to the same extent. However, most participants agreed that everyone should share responsibility for achieving a sustainable bioeconomy, even in the face of adverse scenario conditions. Many differences occurred depending on the specific scenario at stake. For example, in the 'Do it for us' scenario, policymakers usually had a stronger role than in the other scenarios. However, for some respondents this did not correspond to a real-life situation. In general, communication among the stakeholders should be improved to encourage mutual understanding and acceptance of their different drivers, especially in the event of unexpected developments.
- **Policymakers are seen, in general, as playing a driving and 'enabling' role.** They shape the boundaries within which other stakeholders act, and encourage the expression of needs to find multipurpose solutions, while considering possible trade-offs and compensation. In addition, they try to demonstrate which economic activity deserves public support, paying attention to market signals. It is interesting that, when policymaking is weak, the other three players are forced to collaborate more effectively.
- **Primary producers are seen as essential producers of primary goods** who work 'on the ground' to make tangible products. They have their own strategic goals and they need to be supported through investments, as they have an important stake in moving towards a more sustainable bioeconomy to protect their future (e.g. soil health, biodiversity). Yet, they are sometimes perceived as being 'left behind'. They have a lot of value to offer but they require more support from the consumers.
- **Businesses are driven by profitability and are seen as reacting to the demand to ensure their existence.** However, they are increasingly looking for responsible business models, investing in R & I to

improve products and aligning their interests with societal needs. These tendencies could be encouraged through dedicated public funding.

- **Consumers are seen as responsible for creating demand.** Depending on the scenario, they may push for sustainability in the interests of society and enable the actions of other actors, especially business and policymakers, or they may lack commitment and need awareness and education campaigns to understand the benefits of a sustainable bioeconomy.
- **The public voice is seen as a role with oversight of the actions put in place by the other roles,** reacting to the change of context with actions that protect people and citizens.
- **Both primary producers and businesses felt the need to be more involved in harmonising methodologies** for assessing environmental and socioeconomic sustainability (together with EU institutions). They also need to invest more in improved R & I facilities and processes.
- **Some experts noted that each stakeholder has its own objective and timeframe for implementation** (long term for policymakers and consumers, short term for businesses and primary producers). They share the same scenario and are affected by the same trends, so they will collaborate at least to overcome the challenges of these. The sustainable bioeconomy will be supported only if the stakeholders see that they have an interest in it and will benefit from it. In this process, the society plays a crucial role, as pointed out in the previous section.

3. Which set of actions best promotes regional and rural development and can reach left-behind actors?

Five main categories of action were highlighted by the workshop participants.

- **Collaboration.** Cooperation and interaction among all stakeholders are important. In particular, there is a need to put in place partnerships, especially between the primary sector and industry. Policymakers can promote collaborative models so that everyone gets a similar say, to support the sharing of ideas and visions, to overcome the reasons why actors do not / cannot / will not engage and to empower the different actors, including citizens, through cooperation.
- **Funding.** Financial support is required for investments that aim to reinforce the bioeconomy. In addition, there should be an enabling framework for the stakeholders, and information should be provided on where to get funds. Company growth and/or new business and employment opportunities should be promoted.
- **Knowledge sharing and communication.** It is important to reach out to, consult and inform all actors in order to boost engagement, and to raise awareness among consumers. The best way to promote regional and rural development is to reach as many people as possible, through events, marketing and media coverage of local success stories. Actions can also include supporting education on sustainable initiatives for children; knowledge transfer and vocational training for workers to repurpose their skills to keep pace with the innovation and transition; and helping industry and consumers together to better trust primary producers, including through information provision.
- **Regional and rural focus.** Actions in this area should make the most of local resources; reactivating local value chains (or creating new ones); strengthening the resilience of local territories; funding and replicating small-scale biorefining facilities in rural and coastal areas; improving logistics for feedstock supply circulation in rural regions; using life cycle assessment methodologies, including regional boundaries that might be different to wider planetary boundaries; investing in sustainable business in regional and rural areas to increase employment, and, in parallel, investing in education and relevant skills; and providing financial and political support to rural companies.
- **Inclusivity.** Involving rural, regional and left-behind actors and helping them to derive greater benefit from the bioeconomy is essential. This can be done through adopting inclusive business models; systematically including groups from less-developed regions that make a unique contribution to the bioeconomy (not ad hoc support); promoting demographic movements focused on rural areas; exploring less-developed sectors; exchanging programmes; reinforcing the role of ecosystem facilitators to assess and listen; involving/empowering all voices to enable the stakeholders to be game changers by providing knowledge, tools and platforms; and attracting more women into the sector.

4. How do the dynamics in the different scenarios influence the behaviour of the various types of stakeholders?

All respondents agreed that the dynamics of the scenario had an impact on the actions of the players.

- **The impact of the scenario dynamics was more evident on the actions of certain roles, such as consumers and policymakers**, who naturally drive the scenario. Collaboration continued despite the changing scenarios, but players were often forced to explain the rationale behind their actions.
- **The more positive scenarios allowed all actors to reinforce their agendas and visions and achieve shared goals more effectively.** Also, greater flexibility of actors to address certain trends and to collaborate was evident. The negative scenario forced stakeholders to be more reactionary and dynamic, still defending their positions. At one table, the atmosphere was so negative that it blocked action and everybody blamed each other, while actors wanting to make a change got frustrated. Interestingly, at another table the negative scenario produced more innovation.
- **Interestingly, as put by one respondent, stakeholders 'bond' over common challenges** – if their underlying values converge – but there are difficulties in understanding how actions put in place can influence scenario assumptions; thus, the scenario's narrative leads to path dependencies, and stakeholders become stuck in the given situation.

5.2. Emerging policy implications

This section presents possible policy implications deriving from the analysis described in Section 5.1 and also points to previous EU foresight initiatives in which similar issues and implications were found (see Section 1.1).

During the workshops and the subsequent analysis, a mutual influence between actors emerged clearly (in both the impact of actions and the reactions among actors), emphasised by the highly interactive nature of the scenario explorations.

Policymaking shapes the boundaries and plays a key driving and enabling role in the future of the bioeconomy. A coherent policy framework is essential for a holistic approach to the bioeconomy. Indeed, considering the collaborative approach envisaged by most participants and the idea of having a common perspective with the same goal, this concept extends to the collaboration and consistency requested at the policy level in the first place. **A consistent, stable and coherent policy framework could enable stakeholders along the same value chain and across the whole bioeconomy sector to cooperate, look for synergies and eventually adopt win-win business and behavioural strategies.** Similar conclusions are reached in the JRC study as part of the preparation for the third European Commission strategic foresight report on the twin green and digital transitions (Muench et al., 2022) ⁽¹⁶⁾ and in the fifth Standing Committee on Agricultural Research foresight exercise ⁽¹⁷⁾ (DG Research and Innovation, 2020a, 2020b).

Cross-stakeholder collaboration and understanding is essential for achieving both common (societal) and individual (stakeholder) goals, regardless of the scenario and circumstances. It can amplify positive impacts, such as the identification of win-win outcomes, and help address trade-offs and disparities. The bioeconomy is a complex and interconnected system. Sectors and actors (and biomass resources and value chains) are so interconnected and interlinked that considering the perspectives, interests and goals of each bioeconomy agent/sector/stakeholder is necessary to achieve the global sustainability targets. Therefore, bioeconomy policies and strategies are more likely to be successfully implemented if tools and measures are put in place to enable and facilitate intragovernmental and stakeholder collaboration, dialogue and mutual understanding, and co-creation and knowledge sharing (such as dedicated funding and the creation of platforms, clusters, partnerships, cross-sectoral bodies, etc.). Policymakers can play a leading role, listen, coordinate and provide incentives, means and solutions for cross-stakeholder collaboration, especially among farmers (e.g. cooperatives), regional and local authorities and other key bioeconomy actors in rural areas, and civil society.

Economic development should not leave people behind. This exercise has shown that, if actors feel that they are marginalised or not supported, their resistance to sustainability transitions increases. To drive change with all actors proactively engaged, it is essential to put them in a position in which their resistance is lowered and they feel empowered and enabled to act. This reiterates the importance of collaborative and participatory approaches, involving a plurality of actors. **Inclusive and revitalising actions with a regional and rural focus, for example by making the most of local resources and creating new and innovative business opportunities or reactivating local value chains, are key** (see also DG Research and Innovation, 2020, p. 68).

Policymakers are called on to consult and listen to the stakeholders' needs but also to effectively and efficiently communicate the expected impacts of their decisions and actions on the society. This would encourage stakeholders to participate in the development of stimulating policies that might impact their lifestyles. The communication should be clear and reach the target audiences with the appropriate tone and language, taking into consideration the regional differences across Europe.

Communication emerged as a key enabler of a shared transition, facilitating cooperation and synergies among stakeholders. This was supported by the substantial number of (soft) actions related to informing, campaigning, consulting, participating, raising awareness, etc. undertaken across scenarios and time horizons by all the explorers/roles. Thus, **strategies to increase awareness, education and understanding of the bioeconomy, its potential and impacts, to share best practices and to demonstrate the benefits of promising bio-based solutions should accompany future policy initiatives at all levels.** The importance of involving younger generations in a fruitful exchange with more experienced actors was also highlighted by the exercise. The discussions were rich and dynamic, partly because of the participation of various generations

⁽¹⁶⁾ 'Regulations should be consistent in the long-term across different government levels and regions to have a stable framework that facilitates cooperation and innovation while avoiding unnecessary complexity.'

⁽¹⁷⁾ 'Governments must also act, with more coherent policies, support to promising innovations and networks, better cost accounting and investment, and more information from production to consumption to better trace supply routes.'

with different values and priorities but, nevertheless, all open to mutual learning. In this respect it is worth recalling that, according to the FORENV report on emerging environmental issues due to demographic changes in the EU (European Commission, 2023), the younger generations are projected to become more conscious of sustainability issues as adults and seniors, thus pointing to more sustainable lifestyles among future generations.

Policymakers have a significant role in creating learning and development opportunities at various levels, not only for young generations, but also for experienced stakeholders who must build additional capacity for innovative products and methods to guarantee sustainability. This is true for the different categories of actors (see also DG Research and Innovation, 2020), as observed during the scenario exploration exercises. Moreover, **intergenerational interaction and cooperation should be considered when designing and implementing the abovementioned initiatives to facilitate cross-stakeholder collaboration.**

Primary producers, businesses, consumer associations and policymakers are key stakeholders for the future of the bioeconomy. Their actions, interactions and collaboration can make a difference in all possible scenarios, regardless of the underlying important trends and megatrends. Each actor has a responsibility in the transition process.

Primary producers need support through investments to enable the digitalisation and the adoption of efficient and environment-friendly technologies. This evolution is essential for their survival, especially for the smaller producers, and to keep a relevant stake in moving towards a more sustainable bioeconomy. We may consider the extent to which primary producers have an impact on, but are also impacted by, soil health and biodiversity levels. Yet, they are perceived by some as 'left behind' in general. They have a lot of value to offer but require more support from the consumers. Shorter and local-based value chains, reliable certification systems and a higher level of consumption awareness may contribute to empowering primary producers and to ensuring that they have a relevant role in the transition to a sustainable bioeconomy.

Businesses could adopt business models designed and managed not only to seek economic feasibility but also to establish social and environmental responsibility while improving products and services through R & I.

Increasing investments in R & I, in innovative and sustainable production practices and in product development is key to achieve both sustainability goals and the medium- and long-term goals of primary producers and businesses. Besides, actions to raise capital and to provide facilities are also common strategies for these two categories of stakeholders to thrive and adjust to additional (or new) demand and/or market conditions. Thus, **policies aiming to unlock investments to scale up and develop new bio-based markets are also crucial for primary producers and businesses to succeed, regardless of the scenario in place.**

Consumers are driving the demand for sustainable, but also non-sustainable, products. At the same time, they influence the actions of the other stakeholders (mainly primary producers and businesses) to adapt to such demand. **For the transition towards a sustainable bioeconomy, consumers need to be empowered and encouraged to participate in decision-making** (see Cagnin et al., 2021). Thus, measures to enable clear, transparent and trustable information and communication campaigns and education programmes are important in driving bioeconomy actors (and society at large) towards sustainability. Similarly, **the monitoring of policies and their levels of implementation and impact is crucial to ensure acceptance and follow-up by citizens.**

These reflections can be summarised in eight recommendations outlined in Figure 24.

The need to establish coherent policies, to support regional and rural development, to invest in education and awareness raising, to promote sustainable lifestyles, and engage citizens in the decision-making process are the most important takeaways of this exercise, to be considered by policy makers when dealing with future bioeconomy strategic developments.

Figure 24. Recommendations for policymakers – summary



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Abbreviations

| | |
|---------|---|
| BIOEAST | Central and Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy |
| DG | Directorate-General |
| FORENV | EU foresight system for the systematic identification of emerging environmental issues |
| JRC | Joint Research Centre |
| KCB | Knowledge Centre for Bioeconomy |
| R & I | research and innovation |
| SDG | sustainable development goal |
| SES | Scenario Exploration System |

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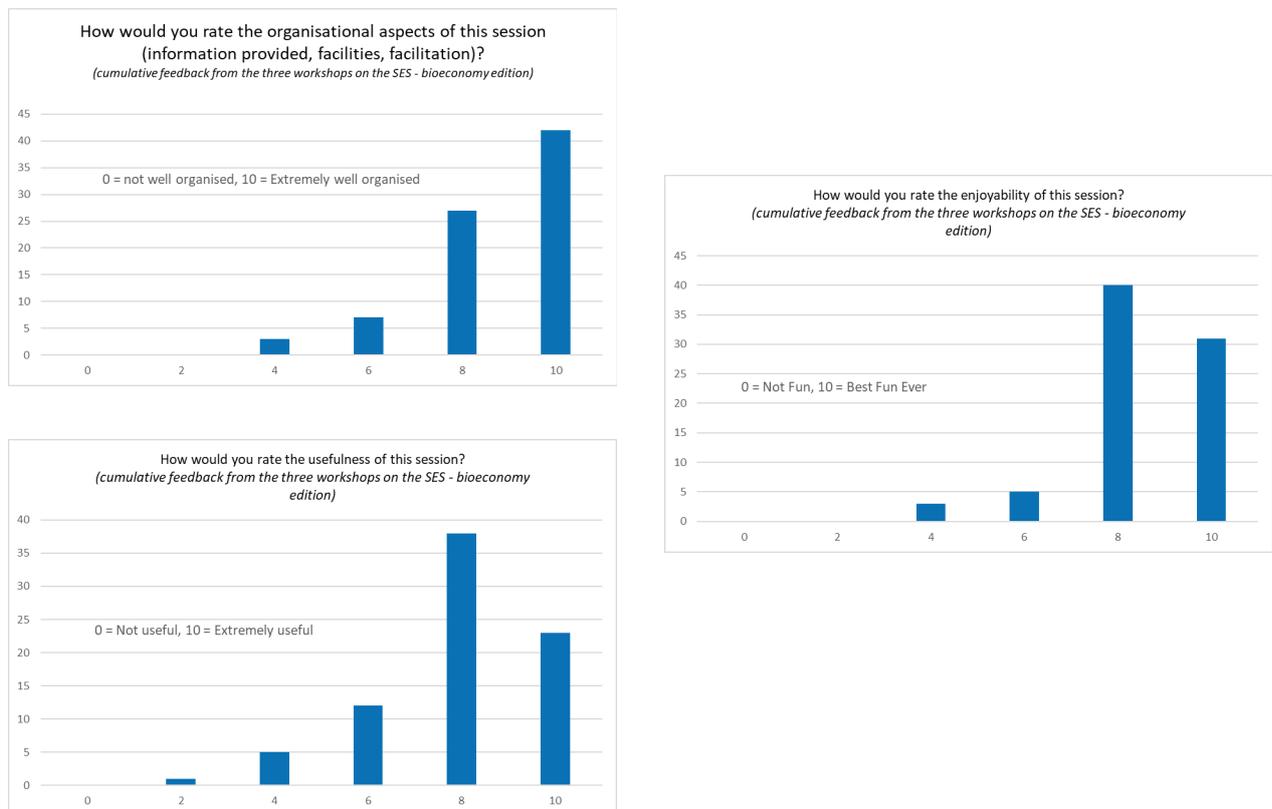
Annexes

Annex 1. Participants' feedback on workshop organisation

The participants were in general very satisfied with the organisational aspects of the workshops, as can be seen in **Error! Reference source not found.** Many participants gave positive written feedback, and some provided suggestions for improvement. This feedback could be used for improving and adapting the facilitation and the organisation of future SES sessions in any domain, not only for the bioeconomy version.

Among the positive aspects, participants indicated that the game was simple to play, especially after the first (warm-up) round. They also considered the workshops a useful and educational experience, to be repeated with policymakers of different domains. The exercise also provided an opportunity for some to step outside their own sectoral domain and consider the approaches and perspectives of other stakeholders working in different bioeconomy domains.

Participants' feedback on workshop organisation



The rest of the feedback related mainly to time management, roles, format and logistics, as described below.

Time

Some participants found the sessions very dense and suggested increasing the game duration to allow participants to better understand the rules and the roles in the game, to become familiar with the actions and to have some time for discussion across the tables. This approach was subsequently implemented in the third workshop. It was also suggested that reflection time should be limited using a timer or stopwatch, but this aspect was not implemented because it might have hampered the spontaneity of the interventions. Many participants suggested sending information about the game rules and the role preparation well in advance, so that they could spend more time discussing the actions rather than understanding the game on the spot. This was implemented in the last two workshops.

Roles

Many participants suggested that the explorers' roles should closely match their real-life roles (jobs/affiliations). Some perceived that explorers who were not playing their real selves were deviating from reality and had a less 'efficient' behaviour during the game. By design, the SES bioeconomy workshops were intended to be a simulation game (i.e. with players' roles matching their real-life role), but it was not always possible to find the right people. As a result, the roles had to be adapted in some cases.

Some participants proposed narrowing down the conversation topic at the tables, considering only a specific sector of the bioeconomy (bioenergy, bio-based chemicals, etc.), on the grounds that the bioeconomy is too broad to be tackled as a whole. In fact, as explained in Section 3.1, the explorers at the tables were chosen according to a cluster of specific themes to facilitate the discussions among people working in the same sectors, across the value chain. However, these themes were intentionally not communicated to the players, to facilitate the collection of their perspectives regarding the bioeconomy as a whole.

Another common comment was related to the fact that most players had chosen values oriented towards sustainability. This created a sort of bias in the conversations, as at many tables there was no opposing view (e.g. on actions driven exclusively by personal or economic interest). However, the suggestion to have participants take a more balanced/representative role, possibly opposing the sustainability paradigm, is difficult to address, as the players had full freedom to choose their vision and long-term values for a better game experience.

Format

Many respondents pointed out that an online format could enable the collection of more input from participants. However, previous experiences, both among the Competence Centre on Foresight team and of the Academy of Business in Society, revealed that the human-physical exchange is very important for this kind of interactive exercise. Furthermore, the physical presence format, including break times, offered an important networking opportunity for bioeconomy stakeholders.

The scenario details proved difficult to grasp quickly for the explorers, who sometimes struggled to respond promptly to the situations with appropriate and coherent actions. It was hard to take into consideration many elements at the same time – the drivers, megatrends, scenario context, scenario details and possible implications – before making a rational decision on a possible action. A working solution would be to provide the players with a list of scenario details in advance, together with the game instructions, so that they have the time to think about the events that might influence their actions. Some also suggested including visual aids for the players, to improve the understanding of the scenarios and make the experience more efficient.

After the first workshop, some participants suggested starting from the exploration of negative scenarios to think more deeply about the steps in the other scenarios. This was successfully implemented in workshops 2 and 3.

Some pointed out that there was no clear link between the actions taken and the evolution of the situation, which seemed to unfold independently of the actions. This is a common perception when playing the game and when confronted with different scenarios. In reality, the players have their own vision and values and should stick to them regardless of the contextual situation described by the scenarios. The scenarios represent possible futures that evolve following specific trends, despite the individual behaviours. Participants can adapt to or resist the scenario conditions; this is their free choice and could not be set at the start by the facilitator.

Especially in the last workshop, in which the context of the foresight exercise was better outlined thanks to a longer plenary introductory session and adequate time for discussion, the participants asked more questions about the final outcome of the exercise.

Logistics

The participants also made useful recommendations in terms of logistics. Some highlighted the need to reduce the noise during the discussions, as it can be disturbing for people trying to concentrate on their group's conversation. Noise levels should be checked regularly by the facilitators. Some other players suggested providing bigger tables to have more space to write notes.

In addition, the use of paper for the workshop and the use of plastics for the catering were noted as a possible improvement area. This was considered when organising the final event, in Ispra, for which it was suggested that participants bring their own reusable bottles in order to reduce the plastic waste. The suggestion to have a digital copy of the feedback survey was not adopted, because a major aspect of the physical workshop was to disconnect from the digital environment, focus on the conversation at the tables and give spontaneous written feedback immediately afterwards.

Based on these proposals, some simplifications could be introduced in the use of the SES tool in the future, such as:

- briefing the participants beforehand, so that they spend some time reflecting about their role in advance;
- describing the scenarios in simpler language, still considering the complexity of the situations;

- summarising the content and description of the detail cards, which might be too complex to achieve good understanding;
- potentially skipping some of the SES elements (megatrends, variable drivers, scenario detail cards).

Annex 2. Variable driver cards

This annex is drawn from Fritsche et al. (2021).

Scenario 1 – do it for us

In this scenario, the variable drivers were specified as follows.

- **Awareness and engagement for change (round 1: 10 years ahead).** Confidence in the EU green policies has convinced a growing share of EU citizens that green products are worth higher prices, and they are willing to pay for higher quality. However, EU citizens are not ready to radically change their eating, housing and mobility habits, and levels of consumption remain at the same level as in 2020.
- **Agroecology⁽¹⁸⁾ (round 2: 20 years ahead).** Agroecology designs sustainable agroecosystems by applying ecological and agronomic concepts and principles. Agroecology has the unique comparative advantage of avoiding negative externalities (to air, biodiversity, soil and water) linked to specialisation, simplification of farmland, intensification and mechanisation. It has a huge potential to transform the EU food system while providing biodiversity benefits and rural employment and income (farm-to-fork strategy). In this scenario, application of agroecology is increasing.
- **Bio-based employment (round 3: 30 years ahead).** Saving on energy costs due to efficiency gains and high shares of low-cost renewables allows families whose spending power has increased to buy higher-quality goods and services. The business community, and especially large corporates, has strongly supported the policy-driven push for the sustainable transformation. The investments in 'green' R & I have increased by 20 %. The financial system has promoted sustainability standards as criteria for evaluation.

Scenario 2 – do it together

In this scenario, the variable drivers were specified as follows.

- **Awareness and engagement for change (round 1: 10 years ahead).** Influential social movements help radically change both supply and demand (patterns and levels). People – as citizens, consumers and members of civil society groups – are active in participating and shaping society and transforming the (bio)economy. They are driving policies towards more integrative, long-term approaches, and they are increasingly organised at local (cultural and production) levels while maintaining links to the outside through very high-level digitalisation.
- **Agroecology (round 2: 20 years ahead).** In this scenario, due to agroecology, agricultural production is, on average, 35 % less than in 2020, with less animal protein production, and arable land and grassland are being converted back to nature. Climate change impacts are mediated through innovation and less intensive farming methods.
- **Bio-based employment (round 3: 30 years ahead).** Between 2030 and 2050, biomass demand for bio-based products (especially bioplastics and fibres) increased significantly, but residues and waste provide the primary feedstock due to successful recycling and efficiency gains in production. The bio-based industry has grown by about 50 % by 2050, especially in bioplastics and fibres, driven by consumer demands and high innovation rates for new products.

Scenario 3 – do it ourselves

In this scenario, the variable drivers were specified as follows.

- **Awareness and engagement for change (round 1: 10 years ahead).** Under the thrust of increasingly influential social movements and in the aftermath of a series of dramatic crises, people radically change attitudes and behaviour, and the resulting change in demand (patterns and levels) drives the supply system to adapt. Young activists and minority groups (race, age, income, etc.) communicate and educate through social media and activist campaigns.
- **Agroecology (round 2: 20 years ahead).** In this scenario, the application of agroecology remains stable. A growing part of agricultural land is transformed into mixed farming by implementing carbon farming practices such as agroforestry and crop rotation.

⁽¹⁸⁾ See also https://knowledge4policy.ec.europa.eu/global-food-nutrition-security/topic/agroecology/brief-me-agroecology_en; https://knowledge4policy.ec.europa.eu/global-food-nutrition-security/topic/agroecology/navigation-page/eu-action-agroecology/eu-policies-agroecology_en.

- **Bio-based employment (round 3: 30 years ahead).** The most relevant economic outcome of this scenario is the increased rates of local, smart, community-based production of high quality. The bioeconomy – including the food industry – slightly increases innovation for health and sustainability products, based on own funds, but parts of the traditional ‘mass production’ industry remain.

Scenario 4 – do what is unavoidable

In this scenario, the variable drivers were specified as follows.

- **Awareness and engagement for change (round 1: 10 years ahead).** The worsening of environmental and food-related health conditions have created discontent in society and the rise of a strong but fragmented environmentalist movement, underrepresented in the political system. Member States accuse each other of not doing enough for the environment. The prevailing short-term vision generates winners and losers in society.
- **Agroecology (round 2: 20 years ahead).** In this scenario, the agroecology concept is not pursued, and climate change will accelerate soil degradation, leading to loss of agricultural area and land abandonment.
- **Bio-based employment (round 3: 30 years ahead).** Due to ageing and agricultural restructuring, the number of farms has decreased from 10 million in 2020 to 5 million in 2050. Polarisation between large-scale farms, often vertically integrated, and small and medium multifunctional farms has intensified. In this scenario, bio-based employment is decreasing.

Annex 3. List of workshop participants

The participants listed below have given their consent for their name and affiliation to be included in this report.

Workshop 1: 5 October 2022

| No | Surname | Name | Affiliation/role |
|----|-----------------|--------------|---|
| 1 | Aktas | Sevim | European Commission, DG Climate Action |
| 2 | Araujo | Rita | European Commission, DG Research and Innovation |
| 3 | Avraamides | Marios | European Commission, JRC |
| 4 | Barbero vignola | Giulia | European Commission, JRC |
| 5 | Bock | Anne-Katrin | European Commission, JRC |
| 6 | Bontoux | Laurent | European Commission, JRC |
| 7 | Borzacchiello | Maria Teresa | European Commission, JRC |
| 8 | Buchholzer | Florence | European Commission, DG Agriculture and Rural Development |
| 9 | Filippousi | Paraskevi | European Commission, DG Research and Innovation |
| 10 | Gerlach | Hildegard | European Commission, JRC |
| 11 | Maenhout | Greet | European Commission, JRC |
| 12 | Sanchez Lopez | Javier | European Commission, JRC |
| 13 | Sinkko | Taija | European Commission, JRC |
| 14 | Tahvanainen | Veera | European Commission, DG Research and Innovation |
| 15 | Turóczy | Zsuzsa | European Commission, JRC |
| 16 | Wehrheim | Peter | European Commission, DG Research and Innovation |
| 17 | Johnson | Chloe | Circular Bio-based Europe Joint Undertaking |
| 18 | Padella | Monica | Circular Bio-based Europe Joint Undertaking |
| 19 | Barrett | Patrick | Department of Agriculture, Food and the Marine, Ireland |

| | | | |
|----|----------------|-------------------|--|
| 20 | Bertacchi | Stefano | EU Bioeconomy Youth Ambassador, Italy |
| 21 | Ciantar | Hailey Marie | EU Bioeconomy Youth Ambassador, Malta |
| 22 | Cogley | Daragh | EU Bioeconomy Youth Ambassador, Ireland |
| 23 | Dirdaite | Ugne | EU Bioeconomy Youth Ambassador, Lithuania |
| 24 | Escórcio | Rita | EU Bioeconomy Youth Ambassador, Portugal |
| 25 | Fritsche | Uwe | International Institute for Sustainability Analysis and Strategy |
| 26 | Gaffey | James | Munster Technological University – Circular Bioeconomy Research Group, Ireland |
| 27 | Gomez San Juan | Marta | Food and Agriculture Organization of the United Nations |
| 28 | Haluskova | Katarina | Academy of Business in Society |
| 29 | Jentoft | Håkon | Urban Agenda Partnership on Circular Economy |
| 30 | Jõgi | Katrin | EU Bioeconomy Youth Ambassador, Estonia |
| 31 | Kohl | Johanna | Natural Resources Institute Finland |
| 32 | Lázár | József | EU Bioeconomy Youth Ambassador, Hungary |
| 33 | Lenzi | Diana | European Council of Young Farmers |
| 34 | Mangano | Antonino | Academy of Business in Society |
| 35 | Martinelli | Filippo Giancarlo | Irish Bioeconomy Foundation |
| 36 | Matser | Ivo | Academy of Business in Society |
| 37 | Mayorga Duarte | Lina | University of Hohenheim, Germany |
| 38 | Ní Choncubhair | Órlaith | Teagasc Research Support Office, Ireland |
| 39 | Pelkmans | Luc | International Energy Agency – Bioenergy |
| 40 | Pinyol | Josep | Academy of Business in Society |
| 41 | Pocaterra | Chiara | Agenzia per la Promozione Ricerca Europea, Italy |

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|----|---------------|-------------|--|
| 42 | Pohjala | Maria | Confederation of European Forest Owners |
| 43 | Sciotti | Carmen | EU Bioeconomy Youth Ambassador, Italy |
| 44 | Sobczak | Karolina | Academy of Business in Society |
| 45 | van den Brink | Anton | European Former Foodstuff Processors Association |
| 46 | Verdelho | Vitor | European Algae Biomass Association |
| 47 | vom Berg | Christopher | nova-Institute |
| 48 | Zaitseva | Daryna | EU Bioeconomy Youth Ambassador, Ukraine |

Workshop 2: 13 December 2022

| No | Surname | Name | Affiliation/role |
|----|--------------------|--------------|--|
| 1 | Albertini | Susanna | European Bioeconomy Network |
| 2 | Avraamides | Marios | European Commission, JRC |
| 3 | Barbero Vignola | Giulia | European Commission, JRC |
| 4 | Bontoux | Laurent | European Commission, JRC |
| 5 | Borzacchiello | Maria Teresa | European Commission, JRC |
| 6 | Bravo | Ana Maria | International Flavours & Fragrances |
| 7 | Brenne | Roman | European Commission, DG Research and Innovation |
| 8 | Ciantar | Hailey Marie | EU Bioeconomy Youth Ambassador, Malta |
| 9 | Cossu | Fabio | European Commission, DG Agriculture and Rural Development |
| 10 | Dirdaite | Ugne | EU Bioeconomy Youth Ambassador, Lithuania |
| 11 | Fernandez Martinez | Lucia | Circular Bio-based Europe Joint Undertaking |
| 12 | Fouquet | Cecile | Aquaculture Advisory Council, Aliénor |
| 13 | Freienstein | Hanna | European Commission, DG Internal Market, Industry, Entrepreneurship and SMEs |
| 14 | Fritsche | Uwe | International Institute for Sustainability Analysis and Strategy |
| 15 | Gerlach | Hildegard | European Commission, JRC |
| 16 | Guillauime | Bruno | Comité National de la Conchyliculture, France |
| 17 | Haluskova | Katarina | Academy of Business in Society |
| 18 | Kargyte | Virginija | Lithuanian Biotechnology Association |

| | | | |
|----|----------------|----------|---|
| 19 | Kulisc | Biljana | European Commission, DG Energy |
| 20 | Letina | Doris | European Council of Young Farmers |
| 21 | Liebeton | Johann | International Advisory Council on Global Bioeconomy, Germany |
| 22 | Lizzi | Giulia | Academy of Business in Society |
| 23 | Llorente | Pilar | Circular Bio-based Europe Joint Undertaking |
| 24 | Luiten | Marinus | FarmTech Society, Belgium |
| 25 | Magnolfi | Valeria | European Commission, JRC |
| 26 | Mangano | Antonino | Academy of Business in Society |
| 27 | Mayorga Duarte | Lina | University of Hohenheim, Germany |
| 28 | Matser | Ivo | Academy of Business in Society |
| 29 | Nachtergaele | Pieter | EU Bioeconomy Youth Ambassador, Belgium |
| 30 | Ní choncubhair | Órlaith | Agriculture and Food Development Authority, Ireland |
| 31 | Nyssens | Célia | European Environmental Bureau |
| 32 | Pinyol | Josep | Academy of Business in Society |
| 33 | Puzzolo | Virginia | Circular Bio-based Europe Joint Undertaking |
| 34 | Silva | Emília | General Secretariat of the Ministry of the Environment and Climate Action, Portugal |
| 35 | Slusarczyk | Heike | Bioeconomy Science Center, Forschungszentrum Jülich, Germany |
| 36 | Sobczak | Karolina | Academy of Business in Society |
| 37 | Turóczy | Zsuzsa | European Commission, JRC |
| 38 | Vandrich | Jasmina | European Commission, DG Research and Innovation |
| 39 | Vlandas | Penelope | European Commission, DG Agriculture and Rural Development |

Workshop 3: 4 May 2023

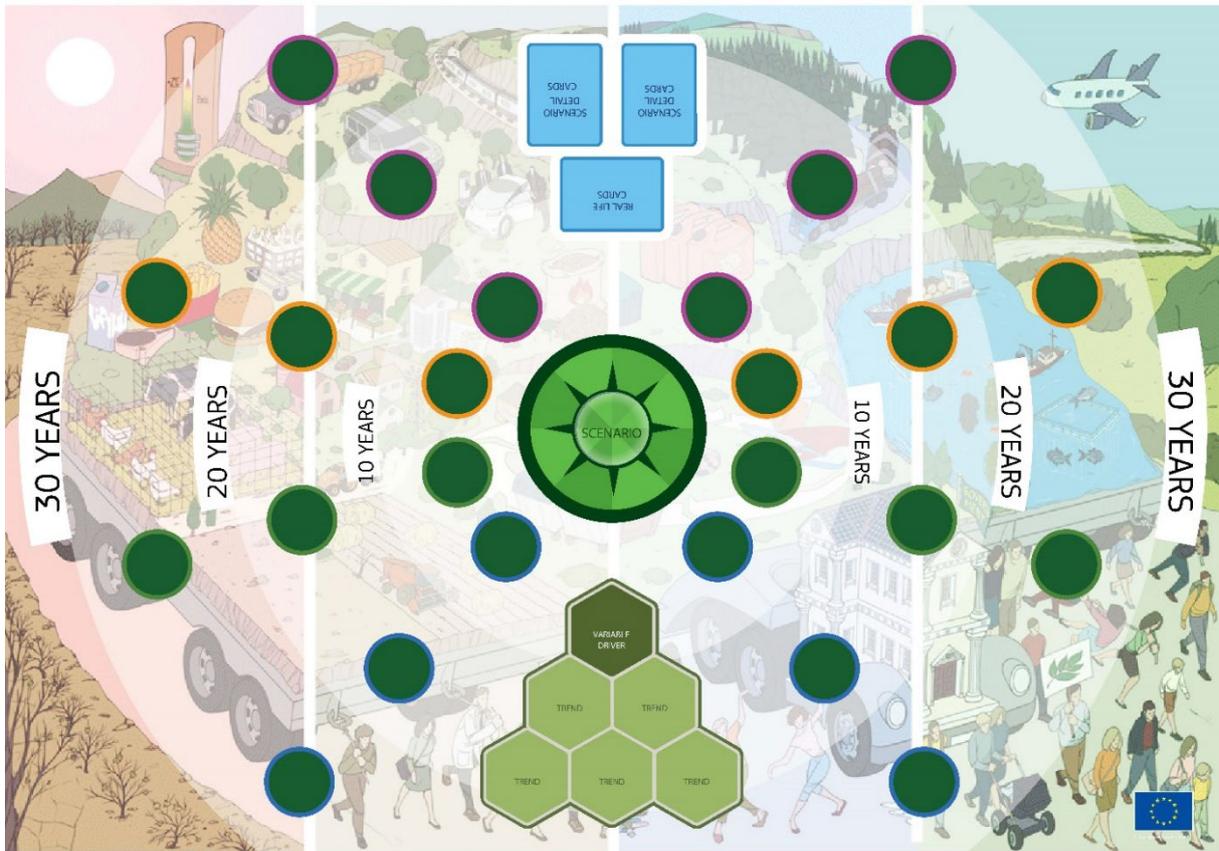
| No | Surname | Name | Affiliation/role |
|----|-----------------|--------------|---|
| 1 | Ambros | Ivan | Competence Centre Ltd for Research and Development, Croatia |
| 2 | Barbero vignola | Giulia | European Commission, JRC |
| 3 | Borzacchiello | Maria Teresa | European Commission, JRC |
| 4 | Buțu | Alina | National Institute of Research and Development for Biological Sciences, Romania |
| 5 | Camia | Andrea | European Commission, JRC |

| No | Surname | Name | Affiliation/role |
|-----------|----------------|--------------|--|
| 6 | Ciantar | Hailey Marie | Tilburg University, Netherlands |
| 7 | Csonka | Valéria | Research Institute of Organic Agriculture, Hungary |
| 8 | Dzelme | Anita | Latvian Rural Advisory and Training Centre / European Forum for Rural Advisory Services) |
| 9 | Escórcio | Rita | Institute of Chemical and Biological Technology António Xavier, NOVA University Lisbon, Portugal |
| 10 | Fritsche | Uwe | International Institute for Sustainability Analysis and Strategy, Germany |
| 11 | Fronza | Verdiana | European Commission, JRC |
| 12 | Gerlach | Hildegard | European Commission, JRC |
| 13 | Haluskova | Katarina | Academy of Business in Society |
| 14 | Ispiryan | Audrone | Lithuanian Association of Berry Growers, Processors and Traders |
| 15 | Jõgi | Katrin | Fibinol OÜ, Estonia |
| 16 | Kovacs | Barna | Permanent Representation of Hungary to the EU |
| 17 | Kubáňková | Marie | BIOEAST Hub, Czechia |
| 18 | Kum | Erika | Ministry of Agriculture, Forestry and Food, Slovenia |
| 19 | Liepina | Laura | European Commission, DG Research and Innovation |
| 20 | Lizzi | Giulia | Academy of Business in Society |
| 21 | Maenhout | Greet | European Commission, JRC |
| 22 | Maghella | Alessia | European Commission, JRC |
| 23 | Magnolfi | Valeria | European Commission, JRC |
| 24 | Mangano | Antonino | Academy of Business in Society |
| 25 | Marjanović | Marijan | Stancia St. Antonio, Croatia |
| 26 | Matser | Ivo | Academy of Business in Society |
| 27 | Mitova | Dilyana | Institute of Agricultural Economics, Bulgaria |
| 28 | Mubareka | Sarah | European Commission, JRC |
| 29 | Noorkõiv | Katrin | Osaihing Sentafarm, Estonia |
| 30 | Pau | Urmas | Est-Agar AS, Estonia |
| 31 | Peepson | Argo | Ministry of Rural Affairs, Estonia |
| 32 | Rodino | Steliana | Research Institute for Agricultural Economics and Rural Development, Romania |
| 33 | Sakellaris | George | Institute of Experimental Medicine of the CAS, Greece |
| 34 | Sanchez Lopez | Javier | European Commission, JRC |

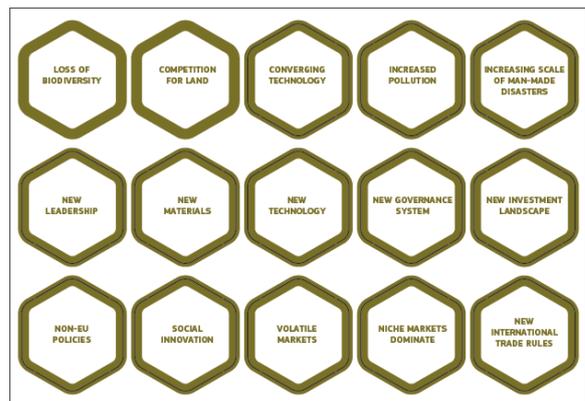
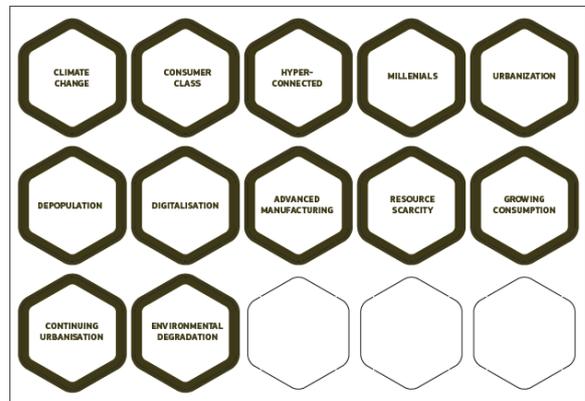
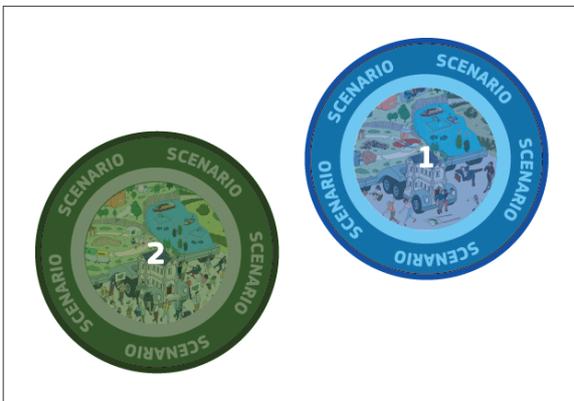
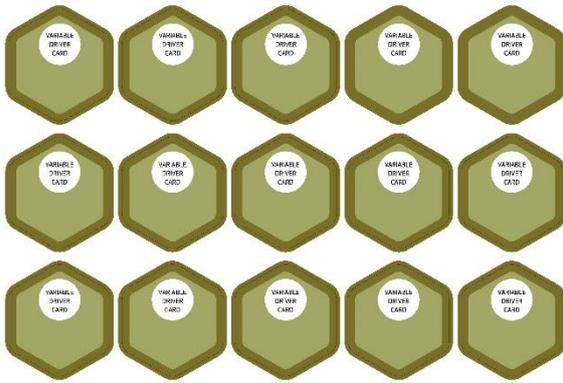
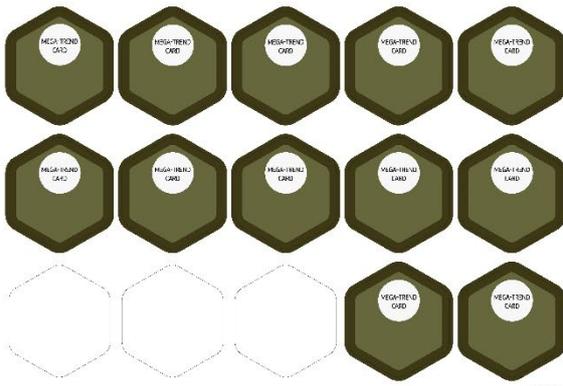
| No | Surname | Name | Affiliation/role |
|-----------|-----------------------------|-------------|---|
| 35 | Šermukšnytė- Alešiūnienė | Kristina | AgriFood Lithuania |
| 36 | Sinkko | Taija | European Commission, JRC |
| 37 | Sobczak | Karolina | Academy of Business in Society |
| 38 | Stoychev | Vassil | Institute of Agricultural Economics, Bulgaria |
| 39 | Turóczy | Zsuzsa | European Commission, JRC |
| 40 | Vizzarri | Francesco | National Agricultural and Food Centre, Slovakia |
| 41 | Woś | Przemek | Polish Natural Building Association |
| 42 | Zampieri | Alessandra | European Commission, JRC |

Annex 4. Scenario Exploration System – bioeconomy edition visual material

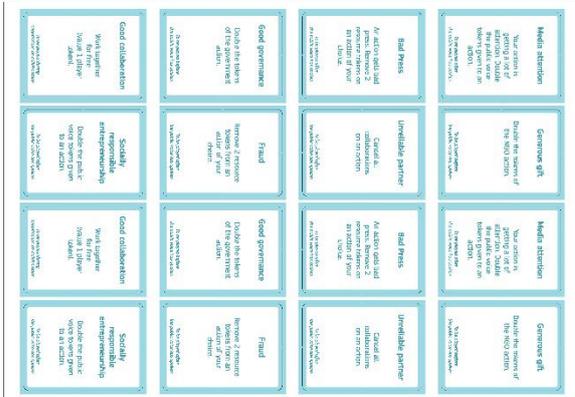
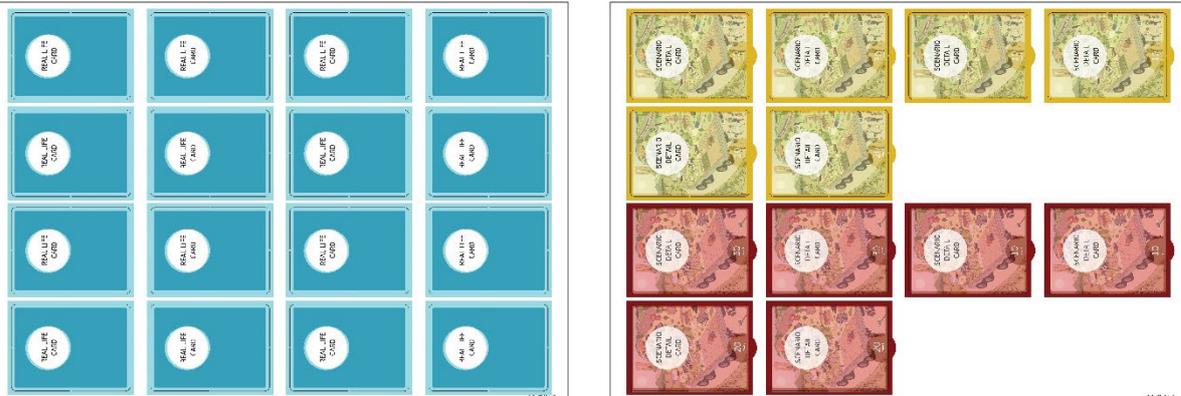
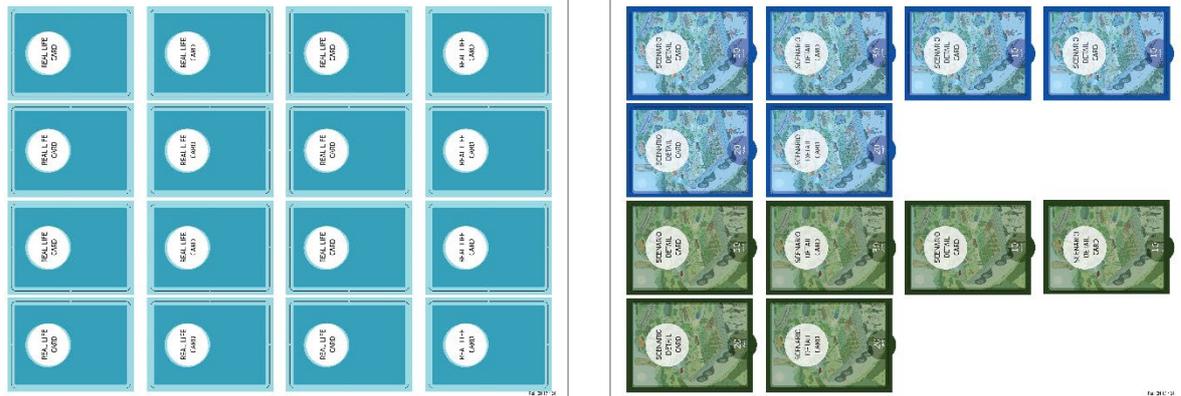
SES bioeconomy board



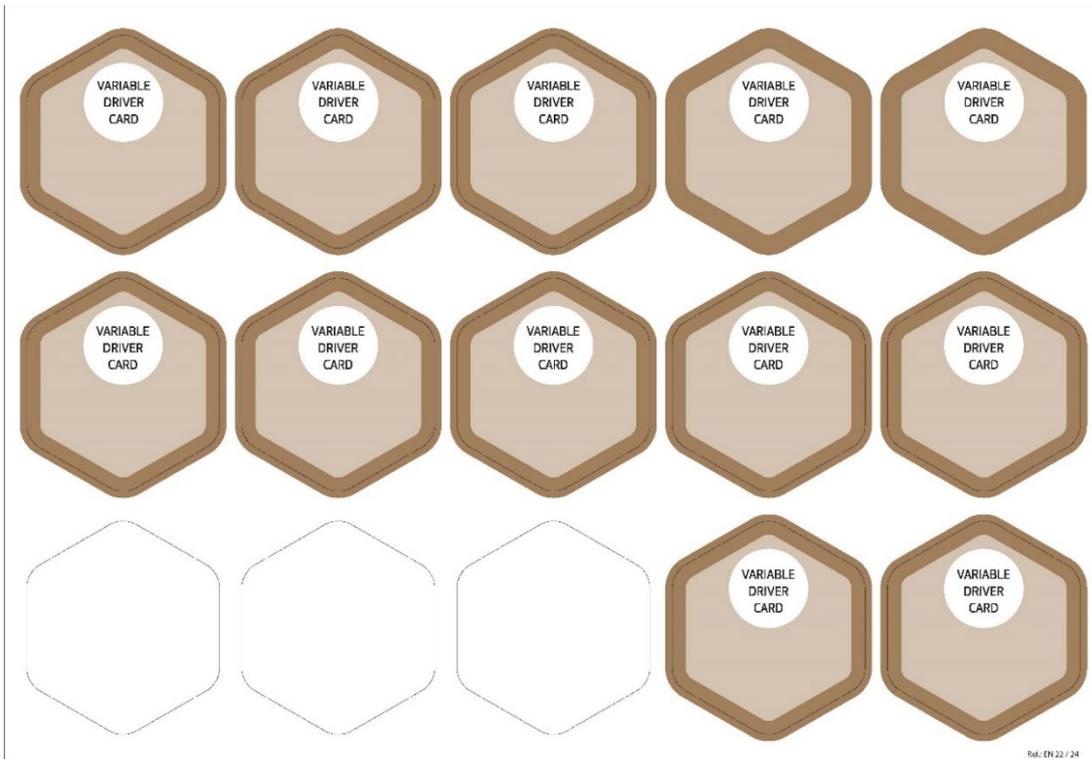
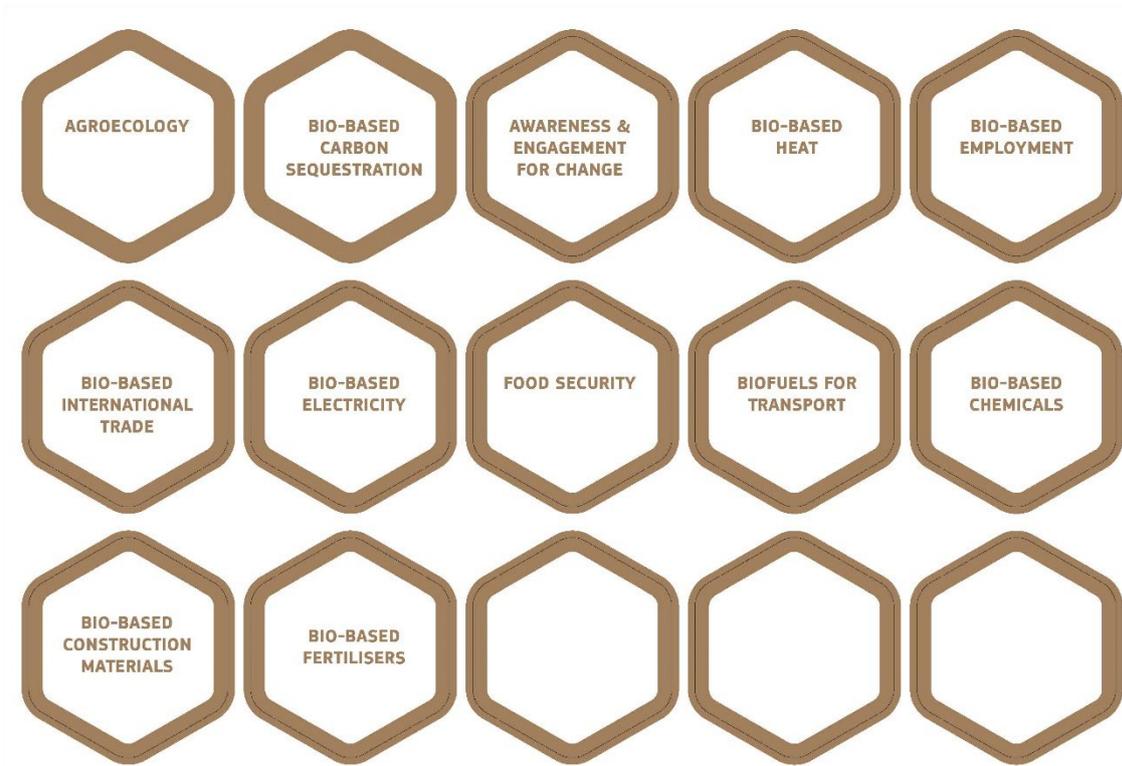
SES bioeconomy scenario cards and megatrend cards



SES bioeconomy scenario detail cards

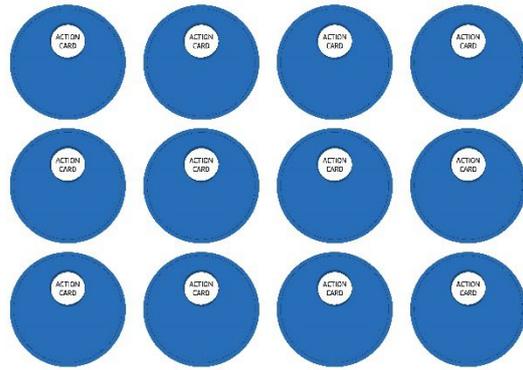
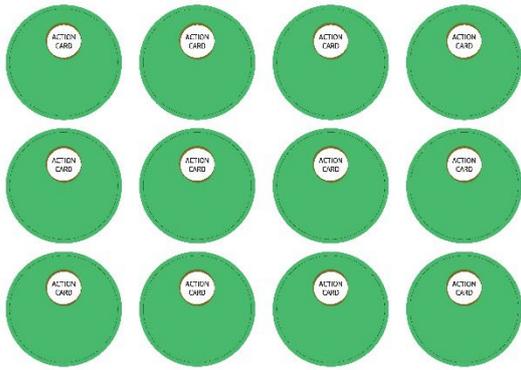
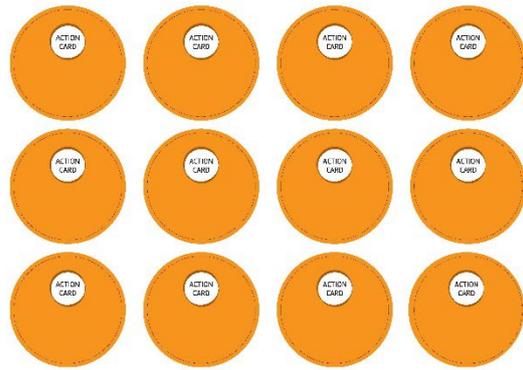
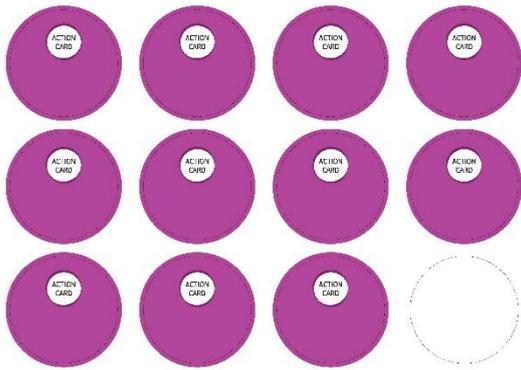


SES bioeconomy driver cards



Ref.: EN 22 / 24

SES bioeconomy action cards



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