

For Official Use

English - Or. English

18 November 2021

**DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INNOVATION
COMMITTEE FOR SCIENTIFIC AND TECHNOLOGICAL POLICY**

Working Party on Biotechnology, Nanotechnology and Converging Technologies

Bioeconomy in the G20 and OECD countries: sharing and comparing existing national strategies and policies

Report of virtual workshop held in Rome on 16 July 2021

BNCT 14th Session to be held via Zoom on 8 December 2021

This is a report of a virtual workshop organised on 16 July 2021, in Rome, under the Presidency of Council of Ministers, by the National Bioeconomy Coordination Board (National Committee of Biosafety, Biotechnology and Life Sciences) of the Italian Presidency of Council of Ministers, the Italian Ministry of the Ecological Transition, and the OECD.

Delegates to BNCT are asked to review the report and give written comments to the BNCT Secretariat by 15 January. If there are no comments, or only minor comments, by then, the report will be transmitted to the Committee for Scientific and Technological Policy for declassification and then publication on-line...

Contact. James Philp, (james.philp@oecd.org), Science and Technology Policy Division (STP), Directorate for Science and Technology Policy, OECD.

JT03485758

Note from the Secretariat

This report represents the proceedings of an international workshop co-organised under the initiative of the Italian G20 presidency and the OECD, entitled, “Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective bioeconomy governance mechanisms and monitoring systems.” Held on 16 July 2021, the workshop aimed to share and compare developments in the bioeconomy sectors, as well as the governance and monitoring tools of bioeconomy strategies under implementation in the OECD and G20 member states. The ultimate objective was to support the identification and co-design of more robust governance tools and common and more comprehensive bioeconomy monitoring systems. The report was jointly developed by Jim Philp of the OECD Secretariat and the Italian delegation to the BNCT Working Party.

Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective bioeconomy governance mechanisms and monitoring systems.

Presidency of Council of Ministers, Rome, July 16, 2021

Organisers: The National Bioeconomy Coordination Board (National Committee of Biosafety, Biotechnology and Life Sciences) of the Italian Presidency of Council of Ministers, the Italian Ministry of the Ecological Transition, and the OECD

Introduction

1. The world has realised that building a sustainable bioeconomy can ally economic growth with environmental policy goals. At least 50 nations (Figure 1) have put in place national tailored bioeconomy strategies or have policies that are steering towards a sustainable bioeconomy (El-Chichakli et al., 2016).
2. For bioeconomy policy makers, the future is complex and multi-faceted. As the first generation of bioeconomy policies comes to a close, the vision of a bioeconomy pitched against grand challenges clearly needs better national and international policies and governance to succeed (OECD, 2018).

Figure 1. National bioeconomy strategies and related policy instruments.



Source: OECD compilation of national sources? Or El-Chichakli?

3. The pervasiveness of national bioeconomy strategies manifests the increasing commitment to the green transition, i.e. replacing fossil carbon with renewable resources by regenerating the environment. While the fundamental justification for public intervention in the bioeconomy is improved sustainability (Marvik and Philp, 2020), there is a need to agree on informative and practical measurement tools and indicators as a basis for policy development. This is especially important as bioeconomy strategies have diversified since a landmark OECD publication (OECD, 2009) laid out the bioeconomy in terms of economic impacts of biotechnologies. One of the earliest strategies was the US bioeconomy blueprint (US White House, 2012), which maintained the link between economic activity and biotechnologies. Since then, the links to major economic sectors have been reinforced while the emphasis on biotechnologies has decreased (Bell et al., 2021).

4. There is no internationally accepted definition of ‘bioeconomy’, and different definitions have often arisen in response to the priorities of an individual country (Frisvold et al., 2021). As bioeconomy strategies are set at the national level this is not an issue per se. However, the bioeconomy is meant to stimulate international trade, and then a lack of an agreed definition means that the measuring and monitoring the bioeconomy cannot be carried out on an internationally comparable basis. Moreover, there is wide agreement that sustainability encompasses the three pillars of economic, environmental and social. This further complicates sustainability assessment.

Measuring biomass sustainability

5. There are no internationally agreed tools or indicators to measure biomass sustainability. Life cycle analysis (LCA) is frequently discussed as a tool, but it does not cover the three pillars of economic, social and environmental completely. Other sustainability tools fail to meet fundamental scientific requirements for index formation (Böhringer and Jochem, 2007). No one assessment tool fits the needs of biomass sustainability.

6. There is also no international agreement on criteria to measure biomass sustainability. International harmonisation requires not only robust analysis, but also consensus, which is often more difficult to achieve. Social criteria are sometimes regarded as unreliable and impractical because they are difficult to measure. As a result, they tend to be assigned a low ranking (van Dam and Junginger, 2011). But they may have strong bearing on true sustainability by analysing issues such as workers’ rights and land rights (Shawki, 2016).

A need to update OECD work on sustainability and the bioeconomy

7. Not only has the bioeconomy concept diversified, but several G20 and OECD countries have revised, or are revising, their bioeconomy strategies. In Europe, there has been a significant association of the bioeconomy with the circular economy (Stegmann et al., 2020). As this evolution has occurred, there has been a consistent association between bioeconomy and sustainability. Further, bioeconomy approaches have the capacity to regenerate the environment, coastal, rural and abandoned lands as well as former industrial sites. Therefore an inescapable conclusion is that sustainability and environmental regeneration will be a major mode of governance for the bioeconomy of the future. But with continuing debate about how to measure and monitor sustainability, it is timely for an OECD event organised in the frame of a G20 environment chaired by a Ministry for the Ecological Transition to revisit the topic and identify a way forward for OECD economies. The Italian Presidency of Council of Ministers workshop in Rome held a forum to highlight

recent developments in bioeconomy strategies and ask some key questions of the governance of the bioeconomy. All G20 and OECD countries with a bioeconomy strategy in place or under preparation were invited to contribute to the event.

8. With this in mind, the event was designed as two panel sessions. The first examined the essential elements of bioeconomy strategies relating to governance through three questions. The second attempted to identify the gaps and opportunities in policy to ensure this sustainable future, again using three questions.

Panel 1: Bioeconomy strategies in the different OECD countries: comparison of their objectives, priorities, governance and implementation guidelines

Question 1

Which sectors comprise your national bioeconomy (i.e., agriculture, livestock, aquaculture, fisheries, forestry, food industry, industrial biotechnology and biorefineries – plus the use of products in the pharmaceutical, cosmetic, chemical, textile, energy industries, municipal biowaste and wastewater valorisation, composting, etc.) and the reasons for their selection.

Argentina

9. Argentina's government believes that bioeconomy, as a development paradigm, includes both modern biotechnology and bioproducts. The bioeconomy in Argentina includes various innovative scientific sectors, such as biotechnology, bioenergy, bio-inputs and biomaterials, as a contribution to the achievement of sustainable development in its economic, social and environmental dimensions in a balanced manner.

10. Argentina has developed these sectors due to its natural competitiveness and comparative advantages, producing safe and healthy food and bioproducts to the world, thereby contributing to safeguarding food security and moving towards a circular economy. This is even more important in the face of the pandemic due to the need to tackle rising hunger, and the need to achieve an inclusive and sustainable post-COVID-19 recovery, to which the bioeconomy can make a positive contribution.

11. Argentina seeks to establish a bioeconomy approach in which science and risk assessment-based regulations are critical, in order to implement the United Nations 2030 Agenda and its Sustainable Development Goals.

12. The objective is to complement and combine the conventional production models with circular economy approaches (which do not oppose them), as one of the tools available to achieve sustainable development, in accordance with national priorities and policies.

Austria

13. The Austrian bioeconomy strategy starts with guidelines based on the United Nations Sustainable Development Goals (SDGs) to address the synergies and possible conflicts with the bioeconomy. Consequently, consumption patterns, material reduction and efficiency in all production steps are analysed based on these guidelines. Austria focuses on the potential of agriculture and forestry. As these resources are limited and efficiency is a priority in Austria, the country sees the future main source for additional biomass potentials in waste and residues. Therefore the circularity and cascading use have an important role in the Austrian bioeconomy strategy. The most important industrial sectors of bioeconomy in Austria are wood processing, pulp and paper and bioenergy.

Brazil

14. The debates and efforts for the development of the Brazilian bioeconomy are structured in three main themes:

1. The sustainable and rational use of its biodiversity, the associated traditional knowledge, and the ecosystem services of its biomes.
2. The development of its agricultural production, promoting sustainability and added value, including its co-products.
3. The expansion and strengthening of the national bioindustry, with a focus on technologies for biorefineries, industrial biotechnology and the -omic sciences.

15. These themes reflect areas in which Brazil has comparative advantages and/or opportunities for development of bioeconomy, that is, its biodiversity, its agriculture, its academic sector with great relevance in biological, agricultural and health sciences and its industrial sector, with experience in the production of primary bioproducts, especially bioenergy.

Canada

16. Canada's national bioeconomy strategy reflects the views of more than 400 industry partners representing the agriculture and forestry sectors from across the country. With this strategy, industry has addressed the ways in which Canada's competitive advantages, including access to biomass, global leadership in forestry and agriculture, sustainable resource management, and a skilled workforce, can make Canada a world leader in the industrial bioeconomy focused on producing cost competitive, net-zero carbon bioenergy, biofuels, biochemicals and biomaterials.

17. This strategy, although not officially adopted by government, is largely focused on agriculture and forestry as the two largest feedstock sources for the bioeconomy. It is anticipated that a national government-endorsed bioeconomy strategy would expand to include other sectors listed above and numerous cross-sectoral, value chain stakeholders.

Finland

18. In Finland the process to update the national bioeconomy strategy is ongoing, with the target to finalise the process this autumn. The main reasons for the update processes were the EU bioeconomy strategy update in 2018 and major changes in the operational and public environment.

19. The Finnish bioeconomy strategy of 2014 did not pick up any specific sectors. Finland has done a map of other existing strategies and programmes related to, or supporting, the bioeconomy. Agriculture and forest management have their own strategies, so the bioeconomy strategy is built on top of those. Finland has environmental programmes and biodiversity requirements, setting the boundaries for the bioeconomy. There are governmental targets for carbon neutral energy and transportation, which together with wood construction programmes create market demand for bioeconomy products.

20. Circular economy and bioeconomy are linked in Finland. Forest-based industry has been one of the front runners in circulating both products and materials within the process. The national circular economy programme (published 01/2021) excluded the bioeconomy part, and Finland is now working to take it to the next level in bioeconomy strategy.

Germany

21. The Federal Government of Germany defines the bioeconomy as the production, exploitation and use of biological resources, processes and systems to provide products, processes and services across all economic sectors. For Germany, bioeconomy comprises not only material flows of resources from the agrarian, forest and fishery sectors; it also considers residuals and waste streams from respective sectors.

Ireland

22. The national bioeconomy in Ireland comprises all of the above, but the focus is on agriculture and food with industrial biotechnology also of importance. The focus on agriculture and food reflects Ireland's sources of competitive advantage and the envisaged role of the bioeconomy in supporting rural areas and providing employment. The significance of industrial biotechnology reflects the scientific and research capabilities nationally and their focus on valorising agriculture, marine and food industry co-processing streams.

Italy

23. The Italian bioeconomy is composed of the following sectors: agriculture, livestock, aquaculture, fisheries, forestry, food industry, industrial biotechnology and biorefineries – plus the use of products in the pharmaceutical, cosmetic, chemical, textile, energy industries, along with the agrifood and forestry and municipal biowaste and wastewater valorisation. They have been selected in line with the EU bioeconomy strategy and because they are of core relevance for the country's economy and ecosystems, and industrial specificities. Because of the synergy between primary production and the industry sectors mentioned, the bioeconomy is contributing to revitalising territories starting from quality and low impact agriculture and by leveraging the capital of rural communities.

Japan

24. Japan's bioeconomy strategy has nine market segments designated to be developed as target domains. In this context, the bioeconomy does not exclude any area of industry. It covers wide areas as shown in the examples but not limited to them. For Japan, the essence of bioeconomy is to apply biotechnology and renewable resources and to contribute to the expansion of sustainable, renewable and circular economy and society. Japan has been evolving the traditional fermentation food culture to current bio-manufacturing industries and has a wide variety of genetic resources to utilise. In the healthcare sector, Japan has a population of 100 million with health and disease-related records. It is hoped to make use of such data and know-how to contribute to the world's wellness while transitioning to the bioeconomy.

Norway

25. Within the framework of the national strategy, the bioeconomy concept includes sustainable, efficient and profitable production, extraction and use of renewable biological resources for food, feed, ingredients, health products, energy, materials, chemicals, paper, textiles and other products. The strategy states that priority should be given to the parts of the bioeconomy with an impact on both value and job creation on the one hand and the reduction of climate emissions and/or more effective use of natural resources on the other. This could for instance imply that some parts of the food and health industries would not be prioritised, because they have no clear effect on climate emissions or the use of

resources. Similarly some other bioeconomy fields would not be prioritised because the potential for national value creation is not clear enough.

South Africa

26. The South African Bioeconomy Strategy (2013) supports innovation contributing to:

- Agriculture - including the broader definition ranging from primary production, agro-processing, food/feed, forestry and fisheries.
- Health - diagnostics, therapeutics, biologics, devices, precision medicine related to the burden of disease.
- Industry - biorefineries, biocatalysis, biomaterials, bioprocessing support, environmental applications including wastewater, biowaste, etc.
- Indigenous knowledge-based innovation (a cross-cutting application) - African natural medicines, cosmeceuticals, nutraceuticals, health beverages.

27. These were identified as the main areas where biotechnology can have a more profound socio-economic impact (including livelihoods, job multiplier effect, competitiveness, social relevance).

United States

28. The sectors that comprise the United States bioeconomy are defined in the “Safeguarding the Bioeconomy” publication (National Academies of Sciences, Engineering and Medicine, 2020). Sectors wholly included are pharmaceuticals, biotechnology R&D and medical diagnostics. Sectors partially included are crop production, electricity generation, processed food, chemicals, plastics and rubber, and other physical engineering and life sciences R&D. Emerging sectors are livestock production, fisheries/aquaculture, forestry, mining, and textiles.

Question 2

How is the strategy on bioeconomy in your country implemented? Did your country develop an Implementation Action Plan following the Bioeconomy Strategy definition?

Austria

29. The Austrian strategy was a follow up of the integrated climate and energy strategy of Austria and was adopted in 2019. The strategy defines fields of action that will contribute to the further development of the bioeconomy in Austria. Building on this, the process of creating the Bioeconomy Action Plan was started. For both, the Strategy and the Action Plan, three federal ministries, and in particular the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, the Federal Ministry of Agriculture, Regions and Tourism and the Federal Ministry of Education, Science and Research are working together to address all areas of the bioeconomy. Additionally, an expert group, the so-called “bioeconomy platform”, was implemented to act as a sounding board to the three involved ministries. This platform includes scientists, enterprises and environmental NGOs.

30. More information on the strategy are available at: https://www.bmk.gv.at/en/topics/innovation/publications/bioeconomy_strategy.html.

31. Information on the bioeconomy flagship projects are available at: https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/biooekonomie/leuchttuerme.html.

Brazil

32. Brazil still does not have a formally approved national bioeconomy policy. However, government sectors have been articulated to coordinate actions aimed at developing the bioeconomy and a future national policy. The Ministry of Science, Technology, and Innovation (MCTI) has been leading part of these efforts by conducting studies that focus on structuring questions for the national policy.

33. Despite not having a national policy, Brazil has the Action Plan on Science, Technology and Innovation for Bioeconomy, launched by the MCTI in 2018. In addition, the MCTI is also structuring the National Research and Development Strategy for Bioeconomy, which will focus on:

- Biodiversity value chains.
- Integrated and sustainable production systems.
- Pollinators and pollination.
- Technology for biorefineries.
- Alternative proteins and next-generation foods.
- Chemicals from renewable sources.
- Support for small bio-based businesses.
- Management tools for sustainability.
- Monitoring of the bioeconomy.

34. Below are the links to the executive summary of the National Strategy for Science, Technology and Innovations and the Action Plan on Science, Technology and Innovation for Bioeconomy, both from MCTI.

https://antigo.mctic.gov.br/mctic/export/sites/institucional/ciencia/SEPED/Arquivos/PlanosDeAcao/PACTI_Sumario_executivo_Web.pdf

https://antigo.mctic.gov.br/mctic/export/sites/institucional/ciencia/SEPED/Arquivos/PlanosDeAcao/PACTI_BIOECONOMIA_web.pdf

Canada

35. The strategy asserts that Canada has valuable assets and significant new capacities to ensure the highest value development of Canada's natural capital to establish Canada's bioeconomy. All stakeholders should align on the execution of the strategy and take coordinated action to deliver successfully on its recommendations.

36. The development of Canada's bioeconomy strategy by industry is informed by the work of the Economic Round Tables and the Forest Bioeconomy Framework, in addition to other reports that are key to building a sustainable economy.

37. To date, there is no implementation action plan across ministries. Natural Resources Canada (NRCan) has taken a leadership role focused on the implementation of specific aspects of this strategy within the Canadian forest sector in cooperation with Canadian provinces through the Canadian Council of Forest Ministers task teams. Natural resource implementation in Canada is largely the jurisdiction of the individual provinces.

Provinces are at different stages and emphasise different areas of bioeconomy interests depending on their natural resource mix, municipal and industrial sector priorities and current political agendas.

38. It is worth mentioning that although no official strategy has been adopted, the federal government has initiated a Greening Government Strategy that is consistent with the United Nations' 2030 Agenda for Sustainable Development. This strategy will also leverage Canada's competitive advantages while helping the country meet its commitment to net-zero emissions by 2050.

39. More information on the Canada's Bioeconomy Strategy and Forest Bioeconomy Framework are available at the links:

https://canadabiodesign.com/wp-content/uploads/2019/08/b22338_913d63ade932490091eb5ae9b2edaad5.pdf

<https://cfs.nrcan.gc.ca/publications?id=39162>

Finland

40. The Finnish bioeconomy strategy includes both strategy and action plan proposals. The first strategy of 2014 was adopted as a governmental guideline and then after the 2015 elections the new government adopted many of the strategy actions and thus resources were allocated to these selected tasks. Bioeconomy was one of the five strategic main themes of the programme.

41. The coordination of the strategy and governmental programme implementation was combined. The secretariat was formed from the public servants of three ministries, (economy, environment, agriculture), reporting to undersecretaries of these ministries. Officials reported and requested political selection criteria from the ministerial bioeconomy working group (2 ministers/party in the government). The National Bioeconomy Panel included over 40 stakeholders (the new one has over 60), and ministers of economy and agriculture shared the chairmanship in the panel. The National panel was renominated among the first actions to renew the strategy, and there have been fruitful workshops. Also the secretariat is expanded now, to include ministries related to transport, health and safety and education.

42. More information on Finland's bioeconomy strategy is available at the web page www.bioeconomy.fi. Bioeconomy numbers are available at the web page of the Natural Resources Institute Finland (LUKE) that follows the bioeconomy together with Statistics Finland (www.LUKE.fi/en).

43. About half of Finland's bioeconomy industry consists of the forest industry, which has been the mainstay of the Finnish economy for centuries. Finland's success is based on a deep understanding of the entire bioproduct value chain, leading experimental research, integration of cross-disciplinary sciences and open-access pilots and demonstration platforms. Innovative new biomaterials are already produced by large companies, and to accelerate the transition from basic research to commercialisation, research-based start-ups and growth companies are a core part of the business ecosystem. With strong relationships between end-users, companies and researchers, Finland offers a development platform for innovation and cooperation.

<https://www.businessfinland.fi/en/do-business-with-finland/invest-in-finland/business-opportunities/bioeconomy>

44. Raw materials from Finnish agricultural and forestry have potential to provide the global bioeconomy product market with products of significantly higher value, superior

quality and serving new emerging needs. A joint white paper compiled by VTT and LUKE described the kind of bioeconomy products and services that can be produced in Finland for the domestic market and export during the next 15 years.

<https://www.vttresearch.com/en/news-and-ideas/finnish-bioeconomy-changing-world-market>

45. The publication was prepared as a background document for Finland's bioeconomy strategy, which is currently being updated.

https://www.vttresearch.com/sites/default/files/2021-02/Bioeconomy-products-2035-whitepaper-VTT-LUKE_1.pdf

46. LUKE research activity is divided into four research programmes:

1. Profitable and responsible primary production.
2. Circular bioeconomy.
3. Climate smart carbon cycle.
4. Adaptive and resilient bioeconomy.

47. In addition LUKE provide statutory and expert services. LUKE is the vital part of Finland bioeconomy strategy work (<https://www.LUKE.fi/en/research/>).

Germany

48. The German National Bioeconomy Strategy is a strategy of the federal government and hence is involving all respective ministries. It has been developed under the lead management of the German Federal Ministry of Education and Research (BMBF) and the German Federal Ministry of Food and Agriculture (BMEL). Working together, the policy guidelines and goals, building blocks of research funding and action areas for a coherent policy framework have been defined. The strategy comprises cross-cutting instruments like a Bioeconomy Council, cooperation between all levels, communication and open dialogue as well as a monitoring system.

49. More information on the German Bioeconomy Strategy and related documents are available at the following links:

https://www.bmbf.de/upload_filestore/pub/BMBF_Nationale_Biooekonomiestrategie_Laengfassung_eng.pdf

<https://www.bmbf.de/de/nationale-biooekonomiestrategie-fuer-eine-nachhaltige-kreislauforientierte-und-starke-10654.html>

<https://www.ptj.de/en/project-funding/bioeconomy>

<https://www.bmel.de/SharedDocs/Downloads/EN/Publications/national-bioeconomy-strategy-summary.html>

<https://buel.bmel.de/index.php/buel/article/view/40/Sonderheft-220-EN.html>

Ireland

50. Ireland formally published its national bioeconomy policy statement in March 2018. A policy statement was developed rather than a strategy for several reasons. The development of the policy statement was led by Prime Minister's Office but implementation was to be followed through by sectoral ministries (Agriculture, Food & Marine (DAFM) and Environment, Climate & Communications (DECC)). The policy was considered to be so new that it was deemed that further structural development was

necessary before priorities and targets were set. A Bioeconomy Implementation Group, comprising relevant government ministries and public bodies, co-chaired by DAFM and DECC, is charged with following through on the statement and reporting on an annual basis. Four strategic objectives were set relating to the following:

1. Sustainable economy and society.
2. Decarbonisation of the economy.
3. Jobs and competitiveness.
4. Regional prosperity.

51. Significant investment has been allocated to science and technology through the establishment of a Bioeconomy Centre (BiOrbic) co-funded by government and industry. Furthermore, activities have been undertaken in the areas of policy integration and coherence (dovetailing with actions in Project Ireland 2040, Future Jobs Ireland and the climate action plan), industrial and commercial infrastructural development, including securing Horizon 2020 funds for establishing an industrial-scale flagship biorefinery (the Agrichemwhey project), awareness raising (establishment of Bioeconomy Week), education and training (establishment of level 9 Bioeconomy with Business course involving UCD, MTU and Teagasc) and financing (engaged with Irish Strategic Investment Fund and European Circular Bioeconomy Fund). Support for clustering and networking activities was provided formally and informally, informed by a social network analysis.

52. More specific information on the strategies and related documents are available at the following web sites:

<https://www.gov.ie/en/publication/c1e596-national-policy-statement-on-the-bioeconomy/>

<https://www.gov.ie/en/collection/55768f-consultation-on-the-bioeconomy-submissions/>

<https://biorbic.com/>

<https://www.agrichemwhey.com/news/agrichemwhey-first-newsletter-issue/>

<https://biorbic.com/farm-zero-c/>

<https://www.teagasc.ie/rural-economy/rural-economy/spatial-analysis/bioeconomy-ireland-week-map-series/>

Italy

53. To better realise the potential of the Italian Bioeconomy, the Prime Minister's Office (Renzi and Gentiloni governments) promoted in 2016 and 2017 the establishment of a national bioeconomy strategy (BIT) and, more recently (2019, 1st Conte Government), its update (BIT II). The documents aim for a more effective integration of the several sectors of the national bioeconomy and to facilitate the cooperation between the country's ministries, regions and autonomous provinces in terms of policies and regulations, R&I funding programmes, development/maintenance of infrastructure, etc. An Implementation Action Plan of BIT II has been recently developed (2021).

54. All these documents have been prepared and are currently under implementation by a National Bioeconomy Coordination Board, established in 2019 and recently confirmed (with a three year mandate) with a specific decree within the Presidency of Council of Ministers of the Italian Government. It is coordinating high level representatives of five ministries (Agriculture, Food, Forestry Policies; Ecological Transition; Economical Development; University and Research; Education) and of the 21

national regions and provinces (X and XI Conferences of 21 Regions & Provinces), as well as core representatives of the Territorial Cohesion Agency, Institute for Environmental Protection and Research, SVIMEZ, and of the Italian Technology Clusters (each with partnerships with more than 100 partners from the public and private sectors): Green Chemistry/Circular Bioeconomy SPRING, AgriFood CLAN, BlueGrowth BIG.

55. Information on the Italian strategy and the related documents are available at the website: <http://cnbbsv.palazzochigi.it/en/areas-of-work/bioeconomy/>

Japan

56. Japan's bioeconomy strategy's contents has been accumulated by joint effort of independent experts and government ministries. The expert panel consists of academia, industry, legal and venture company and supplies industrial capabilities and possibilities, whereas the ministries supply on-going action items and possible policy measures. This information is presented to the Cabinet Office which compiles it as one strategy. The strategy has been adopted in the Integrated Innovation Strategy Promotion Committee, which is approved by the Prime Minister and headed by the Chief Cabinet Secretary, and reviewed for follow-up every year until 2030. After the first formulation of the strategy in 2019, a follow-up meeting every year designs roadmaps of nine target market segments and elucidates the outlook of execution.

Norway

57. The Norwegian national bioeconomy strategy was developed collectively by eight different ministries, coordinated by the Ministry of Trade, Industry and Fisheries, and in close collaboration with national support and regulatory agencies. As a follow up of the strategy, Innovation Norway, the Research Council of Norway and SIVA (the national innovation infrastructure agency) have developed a common implementation action plan. The annual public funding of research and innovation activities in the national bioeconomy is including around NOK 3 billion in loans and subsidies from Innovation Norway, NOK 1 billion in subsidies from the Research Council of Norway, and about NOK 250 million in real estate or company investments through SIVA.

South Africa

58. The Department of Science & Innovation (DSI) took the lead for the national bioeconomy strategy, published in 2013. A variety of instruments has been created or harnessed for the strategy (including funding instruments, Centres of Excellence, Research Chairs, High End Infrastructures, and some of these are managed by the appropriate agencies like the National Research Foundation, the Technology Innovation Agency, the Council for Scientific and Industrial Research, and the SA Medical Research Council). Each of the funding instruments has a committee comprising industry, government and academia to coordinate and guide the funding initiatives. An STI Ministerial Structure representing STI-intensive departments plus the National Treasury, is anticipated to do high-level STI agenda setting and coordination for government.

59. The Bioeconomy Strategy (2013) is available at:

<https://www.dst.gov.za/index.php/resource-center/strategies-and-reports/803-bio-economy-strategy>.

60. The White Paper on STI (2019) is available at: <https://www.dst.gov.za/index.php/legal-statutory/white-papers/2775-white-paper-on->

[science-technology-and-innovation](https://www.gov.za/issues/national-development-plan-2030) and the National Development Plan 2030 at <https://www.gov.za/issues/national-development-plan-2030>

United States

61. The United States is in the process of evolving its bioeconomy strategy. In addition, the Bioeconomy Initiative: Implementation Framework has been implemented and is available. Specific to the bioeconomy strategy definition, the Biomass R&D Board has authority over the Bioeconomy Initiative in terms of strategy, direction, and governance. By statute, the Secretaries of Energy and Agriculture designate points of contact for DOE and USDA, with the consent of the US Senate. The point of contacts from DOE and USDA serve as co-chairs of the board and have oversight of board activities. The board consists of senior officers of DoD, DOI, DOT, EPA, NSF, and OSTP, each of whom has a rank that is equivalent to the rank of the co-chairs.

62. Some relevant documents are quoted below:

- Text - S.3734 - 116th Congress (2019-2020): Bioeconomy Research and Development Act of 2020 | Congress.gov | Library of Congress.
- Bioeconomy_Initiative_Implementation_Framework_FINAL.pdf. (biomassboard.gov).
- Biotech_national_strategy_final.pdf (archives.gov).
- Federal Register: Modernizing the Regulatory Framework for Agricultural Biotechnology Products.

Question 3

What are the missing policies, current needs and opportunities for your national bioeconomy?

Austria

63. The main need is to **foster the role of bioeconomy and its relevant technologies in context of the European Green Deal**. Missing policies on EU level are a link to the bioeconomy in the European guidelines on state aid for climate, environmental protection and energy 2022. While the switch from fossil to renewable (and biogenic) energy sources is well and sufficiently taken into account in the guidelines, **the replacement of fossil resources with renewable raw materials - in the sense of the bioeconomy - is not mentioned**. Past experience has shown that the switch to bioeconomy-relevant technologies can result in high investment costs, and so **there is a need for state aid**.

Brazil

64. The Brazilian bioeconomy needs, first, a national policy for its structuring and coordination. Brazil has several specific and isolated actions for the bioeconomy, requiring **the structuring of governance at the federal level** to guide these actions focused on taking advantage of opportunities and overcoming challenges.

65. As opportunities, the development of products, processes, and services based on biodiversity, socio-biodiversity, and agricultural production are highlighted. **Brazil must add value to national production chains**, as well as **promote the post-pandemic growth recovery on a green basis**, strengthening and expanding the national agroindustry and bioindustry.

66. As challenges, Brazil highlights the difficulty in policymaking that allows national development while promoting regional development in a continental country with great biological and human diversity. Policies must consider local competencies and gaps before any other aspects, considering that Brazil has several possible bioeconomy bases (forest-based, biodiversity, agricultural, marine, agro-extraction, etc.).

Canada

67. The main needs of the Canada's bioeconomy are the following:

- A **modernised regulatory system** that enables innovation, provides certainty to industry and enables the bioeconomy. Policies and regulations governing the key sectors of the bioeconomy – agriculture, forestry and aquaculture – need to be coherent with the development of technologies, and accountabilities need to be structured so as to permit timely responses.
- Establish exemplary stewardship of Canada's natural capital including agricultural and forestry. In particular, Canada needs to review how it **values its natural capital** and how to optimise feedstock valorisation to realise the optimum impact on the economy.
- A business climate that supports scaling up of Canadian bio-based companies and makes Canada a leading bioeconomy country in which to invest. Companies require **greater access to risk capital**; business services that can **assist the later stages of commercialisation**; support for **building strong ecosystems**; and support to enable **new models for collaboration** within commercial value chains.
- To **support a strong sustainable innovation ecosystem** with an emphasis on high performing clusters, job training and skills development.

Finland

68. In Finland bioeconomy is a quite advanced sector with more than 100 years positive legacy, starting from sustainable forest management. **The main theme missing was added value.** How to grow and make it sustainable are the main themes in the new Finnish strategy. Finland is also looking for larger bounces and smaller steps towards sustainable added value within the sectors.

Germany

69. Bioeconomy is a dynamic field in Germany. Thus, **flexibility is needed** to response to respective needs and requirements in the field of bioeconomy and sustainability. In the past ten years the focus was widened considerably and the bioeconomy covers topics that are relevant for most economic sectors and large parts of society. A crucial instrument to observe and assess current developments is the German bioeconomy monitoring, which has already been implemented and will be extended in future. In addition, **a strong shift towards sustainability**, the United Nations SDGs and policies in relation to sustainable economy in particular, are now necessary and it is intrinsic in the National Bioeconomy Strategy and will be promoted within this approach.

Ireland

70. One of the major needs of Ireland is **to involve farmers and the other primary producers in the future direction of the bioeconomy.** National funding, involving a partnership between a wide range of actors (academic, industry, innovation intermediaries and others) is supporting the development of a Zero Carbon commercial dairy farm,

presenting a holistic view of the farm to reduce greenhouse gas emissions and increase the health and resilience of the farm. This will help to communicate the relevance of the bioeconomy to primary producers and enable them to shape its future direction. **A greater role for the marine sector** is also required. Conscious of the linkages and interdependencies between the circular economy and the bioeconomy, and **the need to develop a sustainable circular bioeconomy**, circular economy national legislation is being developed with the bioeconomy integrated into it.

Italy

71. The following are identified by Italy as future needs:

- **Identify and adopt common, comprehensive, simple and cheap indicators for monitoring bioeconomy** growth and impacts in the different countries.
- **New or revised EU NACE¹ codes** (the bioeconomy does not currently fall under a specific NACE code) for better measuring and implementing legislative measures, financing actions and the products end-of-life issues in the bio-based sector.
- Clearer role/positioning of the bioeconomy in the current and future EU and international policies (e.g. **EU Green Deal** policies/implementation action plans, etc.) to have then more bioeconomy-centered national and regional policies and initiatives.
- **Wider and more effective involvement of primary producers and citizens** in the co-designing the bioeconomy policies, R&I priorities and actions.
- More room to the **blue bioeconomy** and urban bioeconomy.

Japan

72. Some of the main needs of the Japan's bioeconomy are: to **create a bio-community** (of academia, industry, government and the local society); and to improve on the coordination (cross-linking) of biology/biotechnology data. Japan also **needs to develop quality evaluation methodologies with appropriate KPI, quantitative and qualitative indicators**. We hope to exchange information with other countries to consider convincing indicators.

Norway

73. In Norway, traditional bio-based industries employ about 5% of the total labour force, and represent about 5% of the value creation in mainland Norway. As such, the bioindustries only represent a moderate part of the economy. In the short term, it is likely that an increased focus on the bioeconomy will contribute primarily to sustainable adaptation and increased competitiveness within established bioindustries. If developments in the bioeconomy are to contribute to significant economic growth in terms of new economic activity and new jobs, this will likely require **significant adjustment and renewal in the established structures and patterns of interaction in industry**. Public policy could have an important role to play in **creating incentives** in this respect.

74. Familiar resources – undreamt of possibilities (https://www.regjeringen.no/contentassets/5b2dc02e8dd047adba138d7aa8b4dcc1/nfd_bi_oekonomi_strategi_engelsk_uu.pdf).

South Africa

75. Arguably, **inter-ministerial coordination/guidance is still lacking**, but such a structure is anticipated. There is policy (e.g. the National Development Plan, 2017), and various sector ‘Master Plans’ currently under development) that provides guidance (for all pillars of the triple helix) towards common objectives.

76. The South African **bioeconomy strategy focuses heavily on harnessing biotechnologies** for improving livelihoods of South Africans. Whilst not blind to the circular (renewable) and sustainable aspects of a bioeconomy, these are currently of lesser importance. Resourcing of R&D&I remains sub-optimal (SA GERD ~ 0.7% GDP), particularly under the Covid-19 pandemic situation.

77. Opportunities include:

- **Linking the recycling/circular bioeconomy** approach (towards environmental sustainability) of many countries of the global north, with the need for industrial / economic development in the global south.
- **Indigenous knowledge-based technology innovation** (incorporating traditional knowledge holders, communities, scientists and business objectives) has significant opportunity.

United States

78. Proposed new legislation entitled the Bioeconomy Research and Development Act of 2020 suggests several additional opportunities for the US bioeconomy. These include a variety of funding mechanisms recognising the need to “*expand[...] the number of researchers, educators, and students and a retooled workforce with engineering biology training, including from traditionally underrepresented and underserved populations*”.

79. Several stakeholder engagement discussions, including the National Laboratory hosted InnovationXlab: Biomanufacturing Summit in 2020, identified the need to expand fermentation and downstream processing **scale-up infrastructure** in the United States to **enable rapid commercialisation of biomanufacturing technologies**. Additionally, there is a need to iteratively **evaluate the sustainability, safety, and security of US bioeconomy practices**, in ways that do not inhibit innovation and transparency.

Panel 2: Targets and monitoring tools: towards a common framework to monitor progress in the bioeconomy

Question 1

Objectives versus indicators: Taking into account the context of your national bioeconomy, what indicators (economical, environmental and social) are you using and would be appropriate for the corresponding monitoring?

Austria

80. The Austrian Bioeconomy Action Plan will be published in form of a transparent digital database soon. It will list the individual measures in the field of the bioeconomy and their status of implementation. We want to use the database and the therein mapped measures, to **show the public** the level of achievement of the strategic goals of the Austrian bioeconomy strategy. The **monitoring system** is still under consideration and will be a task of the Bioeconomy Platform.

Canada

81. Canada has sectoral and regional frameworks in place that cover elements of the bioeconomy. Canadian industry has also led the development of a national bioeconomy strategy. Each sector draws upon a wide array of data and measures to monitor and evaluate their performance and sustainability. The **Montreal Process is a framework of criteria and indicators for countries to report progress towards achieving sustainable forest ecosystem management**. Statistics Canada maintains surveys on economic activity as well as trade in goods and services relevant to the bioeconomy. Canadian companies are also actively preparing ESG reports for their stakeholders.

Finland

82. Monitoring of bioeconomy takes place sectorially, especially in LUKE. There is also **annual monitoring of Bioeconomy on selected indicators**: <https://www.LUKE.fi/en/natural-resources/finnish-bioeconomy-in-numbers/>.

83. As one of the action points regarding the strategy update, we are looking for **collaboration in environmental and social indicators**, as they are now part of the larger national sustainability programme and SDGs.

Germany

84. For the monitoring of the German Bioeconomy, **a collaborative approach of different German Federal Ministries (Research, Agriculture, Economic Affairs) has been set up**. First, the monitoring comprises material flows of resources from the agrarian, forest and fishery sectors, but also data on residuals and waste streams. Second, it comprises more than 60 economic indicators. And third, developed a systemic view on the sustainability by modelling five global footprints of the German bioeconomy (agrarian and forest land use, material use of wood, water use, GHG balances). In a second, consolidating phase, starting end of this year, the monitoring will refine data, indicators and models, will elaborate links to other monitoring systems and **expand its scope by further aspects like biodiversity**.

Ireland

85. Part of the proposed development of monitoring the bioeconomy is **the identification and selection of appropriate indicators**. As such no definitive set of indicators has of yet been identified. Indicators envisioned to be used are the availability of **primary feedstock**, the **output from economic sectors** considered part of the bioeconomy, and **a number of sustainability indicators**, including economic (e.g. employment), social (e.g. wellbeing), and environmental (e.g. accounting of natural capital and ecosystem services such as carbon sequestration).

Italy

86. Coordination and monitoring of the actions put in place in the Italian bioeconomy strategy as well as in the Implementation Action Plan (IAP) will be carried out and monitored under the responsibility of the National Bioeconomy Coordination Board (NBCB) of the Presidency of Council of Ministers. **An ad-hoc working group has been established to fulfil the task**. The NBCB gathers ministries, national agencies, institutions, stakeholders (National Technological Clusters) and regional authorities involved in the implementation of Bioeconomy both at national and local level.

87. To ensure the effective delivery of the strategic objectives of the IAP, NBCB will review the implementation actions in progress every year and will report regularly on the progress, by also adapting or discontinuing activities that do not contribute to the objectives of the IAP in a satisfactory manner.

88. Measuring bioeconomy performance through indicators is a complex activity. The bioeconomy involves a wide number of different products, commodities, intermediate goods and technologies and it is an economy in evolution. A great part of its future development will emerge from the convergence and transformation of markets and industries and from the creation of new markets, phenomena for which statistical data and indicators are currently unavailable. In addition to this, **there is still some uncertainty on the constituents of the bioeconomy value chain**. However, it is possible to try to relate the overall objective to a tentative set of EU key performance indicators (KPI) to monitor the Bioeconomy developments on the supply and demand side (Table 1). These indicators refer to Eurostat and national data and allow for the implementation of benchmarking analysis.

89. Some of the selected indicators are based on:

- Synthesis on bioeconomy monitoring systems in the EU member states - indicators for monitoring the progress of bioeconomy. Natural resources and Bioeconomy studies 38/2018. 44 p.; Natural Resources Institute Finland, Helsinki 2018; Vincent Egenolf and Stefan Bringezu, Conceptualization of an Indicator System for Assessing the Sustainability of the Bioeconomy, MDPI, *Sustainability*, 16 January 2019.
- Results of BERST project consortium, BioEconomy Regional Strategy Toolkit, Criteria and Indicators describing the Regional Bioeconomy, Cambridge (UK), 31 October 2014 and Correlation of I&M with the developed Criteria, Mol (Belgium), 3 December 2014.

Table 1. Italy's key performance indicators at national and regional level.

Criterion	Indicators
Biomass availability	Agricultural biomass production (kg/capita) – import of agricultural biomass Blue biomass production (kg/capita) – import of blue biomass Forestry biomass production (kg/capita) – import of forestry biomass Waste biomass production, including OFMSW (kg/capita) – import of waste biomass
Productive structure	Firms in total bioeconomy sectors (% of total firms) Firms in bioeconomy sub-sectors (% of total firms) Innovation start-ups in total bioeconomy sectors (% of total innovation start-ups) Innovation start-ups in bioeconomy sub-sectors (% of total innovation start-ups)
Employment structure	Employment in total bioeconomy sectors (% of total employment) Employment in bioeconomy sub-sectors (% of total employment)
Human capacity	R&D Employment in total bioeconomy sectors (% of total employment) R&D Employment in bioeconomy sub-sectors (% of total employment) University courses in bioeconomy sectors (% of total university courses) Research institutes in bioeconomy sectors (% of total research institutes)
Innovation	IPRs (patents, trademarks, design) applications in total bioeconomy sectors (number of applications per 1000 population) IPRs (patents, trademarks, design) applications in bioeconomy sub-sectors (number of applications per 1000 population)
Investment	Private R&D expenditure (Index [EU=1]) Public R&D expenditure (Index [EU=1])
Demographics	Population growth (% year) Population 15-65 years (% of total population) GDP (PPP) (Index [EU=1])

Markets	Turnover of total bioeconomy sectors Turnover of bioeconomy sub-sectors Value-added of total bioeconomy sectors Value-added of bioeconomy sub-sectors Exports of total bioeconomy sectors related goods (% of total exports) Exports of bioeconomy sub-sectors related goods (% of total exports) Imports of total bioeconomy sectors related goods (% of total exports) Imports of bioeconomy sub-sectors related goods (% of total exports)
----------------	--

Source: Adapted from Gardossi (2021).

Japan

90. So far Japan has identified market segments with specific target figures to be achieved by 2030 in order to take advantage of its academic and industrial strengths and expand them respectively. The bioeconomy does not only impact the economy but also has a great influence on the environmental and social values. In order to encourage and monitor the progress of bioeconomy, it is important to expand bio-related market size and **it is required to establish economic indicators to assess the market size** as a start.

South Africa

91. At the time of writing of the strategy, data for the metrics were not readily available, and while the scope and activities were well defined, the target was thus merely set as a significant contribution of the bioeconomy to the GDP. Despite this, the focus of much of government attention is on addressing the challenges that arose due to apartheid – simply put **poverty, unemployment, and inequality**. The strategy thus seeks to assist in developing household food security, reducing the impacts of the disease burden, encouraging entrepreneurial opportunity, and relevant skills development, together with the establishment of an enabling system of innovation.

92. There is a time lag between the innovation inputs to a bioeconomy, and the high level macroeconomic outputs. As an early stage and emerging bioeconomy, private sector innovative companies are start-ups or SMEs, for which data (in standard socio-economic indicators) are often not available. There are very few medium to large biotechnology companies to absorb smaller and entrepreneurial companies, so the development trajectory is necessarily more complicated.

93. **The strategy focuses on innovation as the input to the bioeconomy**, and because there are multiple other policy/regulation/initiatives/actions related to agricultural, industrial inputs to a bioeconomy, the link between innovation and the strengthening of the bioeconomy is somewhat tenuous.

94. Current metrics focus on innovation initiatives/programmes currently underway, although **a broader macroeconomic system is under development** too, and will include innovation input measures, innovation output measures, and more economic measures including economic growth, employment, investment and export measures.

United States

95. The Bioeconomy Initiative Implementation Framework **tracks key indicators (economic, environmental, and social)**. Board member agencies complete an annual or biennial evaluation, leveraging resources such as EPA reports and RFS databases; USDA's various databases, statistical services, and market reports; DOE's biomass assessments; and other data and reports.

96. The US Administration priorities include a requirement to reach net-zero emissions by 2050. Many sectors of the bioeconomy can **help contribute to emissions reduction**

goals and indicators measuring bioeconomy progress toward emissions targets will be a priority. Additionally, **indicators that focus on environmental justice will be key** to ensuring that the bioeconomy benefits all Americans including traditionally underserved communities.

Question 2

Managing complexity and interlinks: How did your country tackle the challenge of accessing statistical sources of high quality, homogeneous and aggregated data for monitoring and assessing the impact of the national bioeconomy strategy?

Austria

97. As in other countries Austria has a lot of different sectoral data available, as well as studies on potentials. There are, however, **significant data gaps for the overall bioeconomy**. As many actions are cross-cutting and the proposed measures influence each other, modelling the outcomes has not yet started. Austria just started the implementation and is now creating a **bioeconomy cluster** to summarise and evaluate the effects.

Canada

98. Work continues in Canada to develop **a more comprehensive set of data specific to the bioeconomy and circularity** that will be needed to measure implementation progress and impact on various federal priorities (i.e achieving net-zero, reducing waste, improving energy and material efficiency, protecting and enhancing biodiversity). Within economic sectors, stakeholder engagement is ongoing to assess data requirements and availability as well as to conduct periodic programme reviews to assess impacts and future needs.

Finland

99. **As bioeconomy is not a discrete sector, the data are not easily available**, at this stage not even possible. As an example, in the modern biorefinery most of the people working there are not considered as employees in the bioeconomy sector. They are working with automation, digitalisation, service, maintenance and cleaning, among others, typically as outsourced personnel. As one of the upcoming actions in the updated strategy, **the map of sectors and what/how to follow are investigated to get a better understanding about the bioeconomy**. This challenge is also related to the challenges to follow circular economy.

Germany

100. German bioeconomy monitoring has put much effort in quantifying the shares of different industries in the bioeconomy e.g. like the chemical industry. Nonetheless, **disaggregation of sectors and the bioeconomic shares in terms of value-added and employment remains an important task**. Additionally, a special focus of the German monitoring has been done to show global effects of the German bioeconomy by modelling the aforementioned global footprints and their development over time. Longitudinal data are highly important to understand bioeconomy developments.

Ireland

101. Aware of the statistical challenges, a current proposal to monitor the Irish bioeconomy includes a work package on reviewing potential indicators for their suitability in the Irish context, as well as a **gap analysis to identify shortcomings** in the available

data. Furthermore, an ad-hoc working group including the Irish Department of Agriculture, Food and the Marine, the Irish Central Statistics Office, and a range of research organisations (e.g. MTU and Teagasc) was established. Linkages to EU level networks and projects (e.g. Biomonitor) were established.

Italy

102. Indicators have been selected in function of data availability. **There is a general problem of data gaps and quality homogeneity**, especially at the most disaggregated data levels. In some cases, it could be difficult to find data for all bioeconomy sub-sectors or **to distinguish between bio-based and non-bio-based products and sectors**. Therefore, also the construction of monitoring tools is subjected to an evolutionary process of data availability to meet public awareness and assessment needs. Another set of indicators refers to the sustainability of the bioeconomy in order to monitor the pressure and the impact on the environmental and social systems.

103. In the implementation phase of the bioeconomy monitoring system, new methodological approaches – currently subject to in-depth analysis at EU level - will be considered to measure the related biophysical indicators. This could also imply an update of the identified indicators to be consistent and comparable with a common EU Bioeconomy monitoring system.

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

Japan

105. Japan is in the learning phase of data accumulation and utilisation for the survey of bio-communities.

South Africa

106. South Africa has three well established institutions: Centre for Science, Technology and Innovation Indicators (at the Human Sciences Research Council), the Centre for Research on Evaluation, Science and Technology (at the University of Stellenbosch), and Quantec, a consultancy specialising in economic and financial data. However, **such mechanisms often do not detect early stage companies (SMMEs), which is a key feature of biotechnology development**. While surveys have been undertaken, the dynamic nature of start-ups/spin-outs means that obtaining reliable data is complicated. Given the importance of SMMEs in employment (a priority for SA), this remains problematic.

United States

107. The Safeguarding the Bioeconomy report from the National Academies of Sciences, Engineering and Medicine recommends on page 8 “*The existing North American Industry Classification System (NAICS) and North American Product Classification System (NAPCS) codes should be revised to more accurately capture and track commercial activity and investments related to the biological sciences and track the growth of individual segments of the bioeconomy*”.

108. The US Department of Agriculture Biopreferred Program helps to ensure that the federal government prioritises purchasing of bio-based materials for federal procurement and monitors the impact of that programme on the US bioeconomy. The USDA tracks

developments in the US bioeconomy with a report entitled “Indicators of the U.S. Biobased Economy” which details developments bioenergy jobs, revenues, and bio-based products.

Question 3

What kind of cooperation is needed/you suggest between countries and actors active in this field, such as the FAO, JRC Bioeconomy Observatory, in order to reach consistent and comparable country assessment and results?

Austria

109. It is necessary to **look at the bioeconomy from a holistic perspective**. It should be possible to demonstrate the sustainability of the bioeconomy through key indicators to proceed a comparable country assessment. We are contributing our expertise to the European Bioeconomy Policy Forum and the actions formulated therein. In this context, it is important that all MS work together with the JRC to develop indicators which gives a view to the wider context.

Canada

110. Countries will need to better understand the context of their unique bioeconomies when working toward gathering and analysing data. Canada co-chairs the Forest Bioeconomy Working Group of the International Bioeconomy Forum. It is **undertaking data and monitoring work that overlays bioeconomy indicators to the UN SDGs** to gather a more comprehensive dataset of bioeconomy indicators, with the SDGs providing context for comparison.

Finland

111. It is necessary to create an encouraging and enabling operating environment at the global level for sustainable bioeconomy, sustainable forestry and forest industry side-by-side and cross-linking with other biomass sources. This is possible only if **bioeconomy and the forest sector are included as an integral part of the industrial strategy and qualify as a solution for green transition**. At this stage, this is not the case.

112. It is necessary to remember and underline that bioeconomy possibilities and needs vary from country to country and even within the country. The issue with the statistical considerations may lead to conclusions based to average numbers, that are not valid in any country. **Too centralised, too simplified presentations may lead decision makers to wrong conclusions**. Also **the load given to companies, forest owners and farmers regarding reporting must be fair**. It is even more important to study, what kind of opportunities digitalisation, sensors, AI and analytical tools combined with satellites could provide to the monitoring systems.

113. **Good coordination and cooperation** between all relevant institutions and stakeholders is essential. In particular, a common positive and forward-looking approach should be encouraged, which stresses the future opportunities of sustainable bioeconomy and provides means to exploit these possibilities. This is of utmost importance as several far-reaching EU policy decisions in different policy areas will take place in the near future.

Germany

114. Bioeconomy has a different shape in different European countries and their bioeconomy strategies focus on various priorities. This requires **different adjusted monitoring approaches**. On the other hand, it is useful to have some **common indicators**

to facilitate a comparative view of bioeconomic developments. Like other sectors, the German bioeconomy is globally interlinked. German agriculture for example produces for export to a relevant degree. Therefore, Germany thinks that **cooperation and open access data bases are key elements** to allow for further interpretation of monitoring results. For instance, Germany provides an online database on residuals and waste streams which is free of charge. This database (available at <http://webapp.dbfz.de/resources>) has been set up as a long-term database to ascertain replication and transparency.

Ireland

115. In order to ensure some agreement as to what constitutes the bioeconomy, how specific indicators should be measured and ultimately how results can be compared (over time, regions, sectors) and interpreted, it would be useful **to establish a network between bioeconomy monitoring groups, as well as stakeholders in the industry.** The exchange of ideas should be as seamless as possible. **Involvement of data collectors** (such as statistic institutions on national and European level) **is crucial to enable the establishment of consistent data codes** and to communicate future needs in data with regards to bioeconomy monitoring. It will be important for this group to also consider the future evolution of the bioeconomy (e.g. as new technologies are developed, as different aspects of sustainability come more into focus, etc.)

Italy

116. It is becoming increasingly evident that economic, social and environmental sustainability are strongly interlinked and that **new indicators are needed for accounting wealth and well-being within a systemic vision.** Having a common understanding on what the bioeconomy represents and the future opportunities connected to bioeconomy implementation is needed to guarantee for policymakers and stakeholders that all relevant aspects are considered. On that respect, **effective high level coordination of relevant institutions and stakeholders is crucial.** Despite the different objectives and needs of the local and national bioeconomies, all activities aimed at sharing good practices in monitoring will be of aid in the construction of robust but easy-to-handle tools for monitoring, also adaptable to local context.

Japan

117. It is crucial to expand the bioeconomy as a global movement and that will require **international collaboration and sharing of relevant experiences** among the like-minded countries. This will lead to reflecting outstanding cases in each country's own bioeconomy strategy and carrying out as actual actions. It is therefore very significant to conduct **international discussion in workshops.**

South Africa

118. There is no universally agreed-upon definition of the term. It is critical to recognise differences in the priorities, and **interpretation of bioeconomy which makes inter-country comparisons difficult and potentially meaningless** (e.g. some countries emphasise circularity/sustainability, others (bio)technological advancement). Nevertheless, **there may well be some metrics that could be universally applied.**

119. There is, however, a certain complementarity in the different approaches: one seeks to improve the carbon footprint of industry, and the other would welcome industry and job creation. There needs to be **far greater interaction across the globe** to enable and develop

this, to harness biotechnology for global sustainability (including socio-economic and environmental). This potentially could be led by organisations such as the FAO.

United States

120. International collaboration is vitally important to advancing the bioeconomy and promoting best practices. It is important to **collaborate internationally on the bioeconomy based on shared values**.

The Bioeconomy in the European Union: the position and the actions of the EU commission

a. The EU Bioeconomy strategy and the European Bioeconomy Policy Forum

121. The bioeconomy is a cornerstone of the European economy. For 2017, the bioeconomy turned over EUR 2.2 trillion and employed 17.5 million people². The EU bioeconomy strategy was updated in 2018 (European Commission, 2018) to place sustainability and circularity at its heart. For the update, the bioeconomy covers all sectors and systems that rely on renewable biological resources; it includes and interlinks land and marine ecosystems and the services they provide. Looking at individual member states and regions, nine member states and Norway and the UK have a dedicated bioeconomy strategy. At least another six have one under development. Importantly, more than 50 regions have bioeconomy-related strategies.

122. The EU Bioeconomy Strategy and Action Plan takes a system-wide approach. It proposes more than research and innovation to strengthen the bio-based sectors and unlock investments. To deploy bioeconomies across Europe, policy must span the sectors, and address trade offs (ecological boundaries) and co-benefits. It must deliver its benefits for rural areas in particular. To achieve this, it has a set of 14 well-defined actions, including a monitoring system. The further deployment of bioeconomy strategies and policies within the EU is supported through two key mechanisms.

123. First, the European Bioeconomy Forum is a knowledge exchange and policy dialogue forum for EU member states. It has five objectives, enabled by a dual structure: a strategic/political level high level group, and an operational/working level expert level group. The five objectives are:

1. Support networking and interaction between member states.
2. Enhance cooperation and best practice exchange.
3. Shape a concrete agenda of joint actions.
4. Increase the visibility/potential of the bioeconomy.
5. Enable policy feedback and analysis.

124. Second, the Bioeconomy Policy Support Facility was formed, with the objective to support the member states in the development of their own dedicated national bioeconomy strategy/action plans. Concerning governance, the facility took the form of a Mutual Learning Exercise with the aim of identifying and sharing best practice by 19 member states. The process was steered by independent experts, and workshops were held, addressing specific objectives (e.g. encouraging inter-ministerial cooperation and stakeholder engagement, funding of bioeconomy development). A final report containing ten key policy messages and recommendations for the development of national (or regional) sustainable and circular bioeconomies will soon be published.

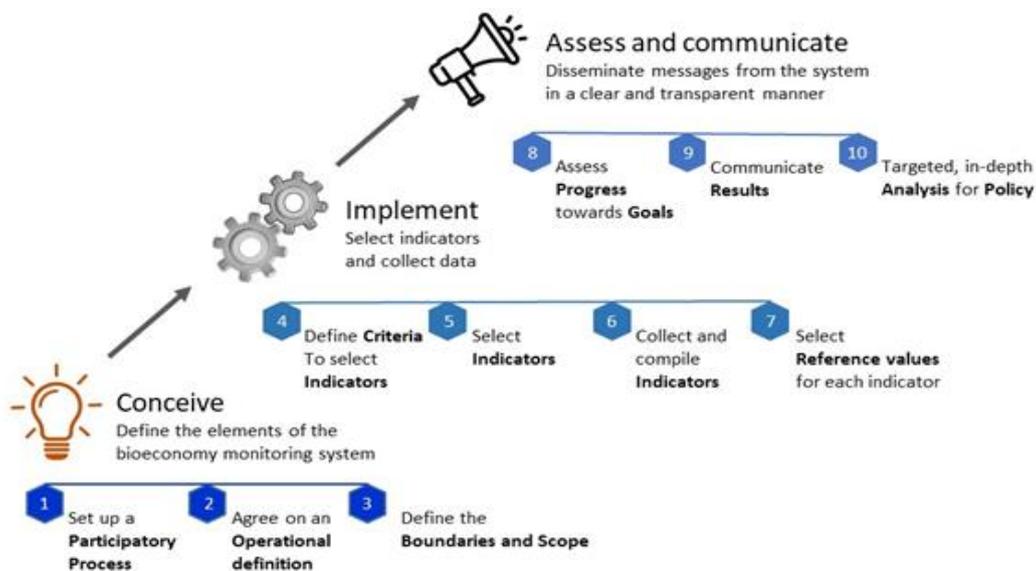
125. On the larger arena, the European Commission proposes transformation of EU economy and society to meet climate ambitions through the European Green Deal. The European Commission sees a knowledge-based, sustainable and circular bioeconomy as a model for green growth.

b. Bioeconomy monitoring tools: the Joint Research Centre (JRC) actions

126. The JRC is the European Commission's science and knowledge service. The EC's Knowledge Centre for Bioeconomy, managed by the Joint Research Centre, and the EU Bioeconomy Monitoring System are key tools for the deployment of a sustainable EU Bioeconomy³.

127. A robust knowledge base and a fit-for-purpose monitoring system are crucial elements for adaptive and effective governance. The JRC approach to bioeconomy monitoring considers the entire value chain. The system consists of ten steps to monitoring and evaluation (Figure 2), with the selection, collection and compilation of indicators at its core, along with selection of reference values for each indicator.

Figure 2. Ten steps to monitoring and evaluation of the bioeconomy.



Source: Adapted from De Santi (2021)

128. The EU Bioeconomy Monitoring System addresses the need for a comprehensive monitoring system by establishing a mechanism to measure the progress of the EU bioeconomy towards the five strategic objectives it tackles. It defines and implements a comprehensive monitoring framework for the EU bioeconomy, which covers environmental, social and economic dimensions of sustainability and relates to the overarching Sustainable Development Goals (SDGs) context.

129. The user interface of the EU Bioeconomy Monitoring System is nested within the Knowledge Centre for Bioeconomy (KCB)⁴. The analysis is output as user-friendly dashboards, showing indicator trends and enabling curation of the system (Kilsedar et al., 2021).

130. 'Headline indicators' are selected based on most frequently asked questions. This menu option leads to the main page of the monitoring system. The users are immediately presented with a dashboard showing selected indicators that cover different facets of the

EU Bioeconomy. This first page is meant as an entry point to the more detailed datasets in the monitoring system. It is designed to encourage users with different interests to go deeper into the indicators of the monitoring system. Each element within the dashboard is clickable, leading the users to a more detailed dashboard about that indicator. The headline indicators are: employment and value-added; biomass uses; GHG emissions and pressures from production systems.

The FAO initiative “Towards Sustainable Bioeconomy Guidelines (SBG)”

131. Through support provided by Germany, FAO has been working on the project ‘Towards sustainable bioeconomy guidelines’ to help countries develop coherent sustainable and circular bioeconomy strategies, programmes and action plans. As part of this project, in 2016, an International Sustainable Bioeconomy Working Group, led by FAO, was established to foster knowledge-exchange on sustainable and circular bioeconomy between countries and regions, but also between science, policy and the private sector.

132. The International Sustainable Bioeconomy Working Group has already achieved a number of concrete results. First, Working Group members have agreed on a set of principles and criteria that serve as guidelines to mainstream sustainability in bioeconomy strategies. These ten Principles and 24 Criteria cover the economic, environmental and social dimensions of sustainability, but also include governance as a fourth pillar.

133. Second, Working Group members have stressed the need for comprehensive metrics and data for monitoring systems to measure the development of the bioeconomy and its contributions to the SDGs. Based upon the principles and criteria the International Bioeconomy Forum has given a mandate to the Joint Research Centre of the European Commission and FAO to develop guidance on how to monitor bioeconomy in all its sustainability dimensions (see the previous section on JRC work).

134. Third, the International Sustainable Bioeconomy Working Group has stressed the need for bioeconomy initiatives to be linked more closely with multilateral policy processes, such as multilateral environmental agreements, including the Paris Agreement on climate change and the Aichi biodiversity targets.

The transition towards carbon neutrality: the OECD BNCT foresight study

135. An overarching question is how industry can be supplied with carbon in the future. Carbon management may capture the different facets of the answer: reduce the demand for carbon, reuse and recycle the carbon in the bio- and technosphere and remove carbon from the atmosphere.

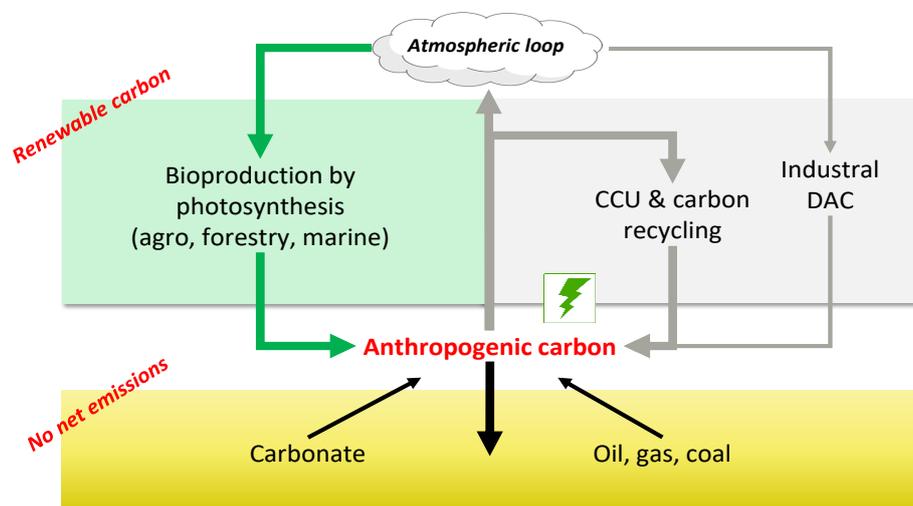
136. Even with the strongest intention to foster greater future sustainability and resilience, it is entirely foreseeable that the increasing use of biomass for food, materials, and chemicals, could lead to over-exploitation of natural resources. Limited resources could then lead to competition for land between bioenergy (climate action) and food crops (food security) or between the bio-based production and the preservation of biodiversity and natural ecosystems. This raises a series of critical questions. How much land can be used for economic purposes without disrupting wider ecosystem services? If land is limited how should it be best used - for food, feed, energy, or industrial products?

137. Meanwhile it has become clear from various lines of evidence that biological resources alone cannot replace fossil resources as feedstocks for the future. Aviation fuel consumption in the EU was 62.8 million tonnes 2018. Using sunflower oil as an aviation biofuel would require 60% of EU arable land⁵. Polymers in Europe has about the same

volume (64 million tonnes in 2019). Global plastics demand could continue growing to about 1 billion tonnes by 2050 (McKinsey, 2018). Even with 60% recycling (mechanical and chemical), this implies a fossil replacement of about 400 million tonnes. The heart of the issue is competition for land, and the international community will need to confront the inevitable trade-offs. Thus biomass must also be accompanied by other sources of renewable carbon, and completing the analysis will require policies to maximise the recycling of carbon, to create the renewable carbon paradigm (Carus et al., 2020).

138. Carbon management strategies which consider all available non-geological sources of carbon provide a holistic mechanism to plan for the efficient supply and use of carbon, putting the carbon in its various forms to best use (Figure 3). Carbon management strategies would bring together new tools to boost bioproduction (e.g. biotechnology), measures for resource efficiency (e.g. precision farming and cascading use of materials) and the circular economy.

Figure 3. Carbon management – a more complete narrative.



Source: Marvik (2021).

139. In the context of carbon management more work is required to understand the constraints on land use and identify methods of assessment which guide the sustainable use of land. Ecosystem management and the measurement of natural capital may provide a mechanism to compare the relative significance of different impacts assessed during LCA.

140. The question of how to deal with sustainable trade-offs may have found a surprising answer: expand the reference system to all alternative carbon sources as bioeconomy is no longer alone to replace the fossil feedstock. From this perspective, the bioeconomy is a significant but fully integrated part of a comprehensive renewable carbon economy.

141. Also, the question of the relevance of a carbon management perspective has a clear answer: carbon management is the new overarching challenge and could serve as an excellent framework for constructive discussions between all stakeholders in carbon-dependent value chains.

References

- Bell, J., J. Philp and R.I. Kitney, (2021), “Addressing the post-COVID era through engineering biology”, *Engineering Biology* 5, 21-34.
- Böhringer, C. and P.E.P. Jochem. (2007), “Measuring the immeasurable - A survey of sustainability indices”, *Ecological Economics* 63, 1-8.
- Carus, M., L. Dammer, A. Raschka and P. Skoczinski (2020), “Renewable carbon: Key to a sustainable and future-oriented chemical and plastic industry: Definition, strategy, measures and potential”, *Greenhouse Gases Science and Technology* 10, 488-505.
- De Santi, G. (2021), “The FAO initiative ‘Towards Sustainable Bioeconomy Guidelines (SBG)’”, Presentation at the G20 OECD-BNCT Workshop: *Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective bioeconomy governance mechanisms and monitoring systems*.
- El-Chichakli, B., J. Von Braun, C. Lang, D. Barben and J. Philp (2016), “Five cornerstones of a global bioeconomy”, *Nature* 535, 221-223.
- European Commission (2018), “A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy”, European Commission, Brussels.
- Frisvold, G.B., S.M. Moss, A. Hodgson and M.E. Maxon (2021), “Understanding the U.S. bioeconomy: a new definition and landscape”, *Sustainability* 13:1627.
- Gardossi, L. (2021), “From strategy to implementation: monitoring systems and indicators”, Presentation at the G20 OECD-BNCT Workshop: *Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective bioeconomy governance mechanisms and monitoring systems*.
- Kilsedar, C.E., S. Wertz, N. Robert and S. Mubareka (2021), “Implementation of the EU Bioeconomy Monitoring System dashboards. Status and technical description as of December 2020. Publications Office of the European Union, Luxembourg.
- Marvik, O.J. (2021), “Carbon management; a potential policy framework integrating the bioeconomy, carbon recycling and renewable energy”, Presentation at the G20 OECD-BNCT Workshop: *Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective bioeconomy governance mechanisms and monitoring systems*.
- Marvik, O.J. and J. Philp (2020), “The systemic challenge of the bioeconomy: A policy framework for transitioning towards a sustainable carbon cycle economy”, *EMBO Reports* 21:e51478.
- McKinsey (2018), “How plastics-waste recycling could transform the chemical industry”, <https://www.mckinsey.com/~/media/McKinsey/Industries/Chemicals/Our%20Insights/How%20plastics%20waste%20recycling%20could%20transform%20the%20chemical%20industry/How-plastics-waste-recycling-could-transform.ashx>
- National Academies of Sciences, Engineering, and Medicine (2020), “Safeguarding the Bioeconomy”, The National Academies Press, Washington, DC.
- OECD (2018), “Meeting policy challenges for a sustainable bioeconomy”, OECD Publishing, Paris.
- OECD (2009), “The bioeconomy to 2030: designing a policy agenda”, OECD Publishing, Paris.

Shawki, N. (2016), “Norms and normative change in world politics: An analysis of land rights and the Sustainable Development Goals”, *Global Change, Peace & Security* 28, 249-269.

Stegmann, P., M. Londo and M. Junginger (2020), “The circular bioeconomy: Its elements and role in European bioeconomy clusters”, *Resources, Conservation & Recycling: X* 6:100029.

USDA (2018), “An economic impact analysis of the U.S. biobased products industry (2018)”, USDA, Washington, DC,
<https://www.biopreferred.gov/BPResources/files/EconomicReport.pdf>.

US White House (2012), “National Bioeconomy Blueprint”,
https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf.

van Dam, J. and M. Junginger (2011), “Striving to further harmonization of sustainability criteria for bioenergy in Europe: Recommendations from a stakeholder questionnaire”, *Energy Policy* 39, 4051–4066.

End notes

- 1 Nomenclature Statistique des Activités Économiques dans la Communauté Européenne
- 2 https://ec.europa.eu/jrc/sites/default/files/kcb_brief_bioeconomics_2008-2017.pdf
- 3 <https://knowledge4policy.ec.europa.eu/bioeconomy>
- 4 https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring_en
- 5 <https://renewable-carbon.eu/news/can-the-european-unions-kerosene-demand-be-met-by-the-amount-of-biomass-produced-in-the-eu/>

Annex 1: Agenda of the workshop



G20 OECD-BNCT WORKSHOP: *Bioeconomy in the G20 and OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective Bioeconomy governance mechanisms and monitoring systems.*

**DATE AND VENUE: web meeting, Presidency of Council of Ministers, Rome
16 July 2021 (11.00-17.00)**

ORGANIZERS: The “National Bioeconomy Coordination Board” of the National Committee of Biosafety, Biotechnology and Life Sciences of the Italian Presidency of Council of Ministers, the Italian Ministry of the Ecological Transition and the OECD.

RATIONALE

The Bioeconomy encompasses the whole range of activities ranging from terrestrial and marine bioresource production to their processing towards food, feed, chemicals, materials and fuels. It provides a sustainable response to the need for food and bio-based materials and energy, and tools to address common goals: reducing the dependence on fossil fuels and finite feedstocks; preserving and restoring natural resources; and guaranteeing high-quality environmental services. Bioeconomy can be an effective accelerator for sustainable innovation, regenerating natural resources, marginal/desertified/abandoned lands and former industrial sites, and in the sustainable exploitation of marine and coastal areas, creating new economic growth and jobs in those areas, and leveraging geographic advantages and traditions. More than forty States worldwide currently pursue explicit political strategies to expand and promote their bioeconomies. Among them, there are nine European Countries along with Norway and other OECD G20 countries like Argentina, Brazil, Canada, Japan, South Africa, and the United States. Thus, Bioeconomy has already been adopted by a large number of middle and large size countries as a strategic path towards a sustainable, regenerative and healthier growth, in line with the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. According to the European view, it is composing the “renewable pillar” of the Circular and the Green Deal Economy.

The available Bioeconomy strategies differ in definition, content focus and in policies, depending on the resources and priorities in each country. As an example, several countries measure Bioeconomy contributions in terms of value added and employment but ignore social and environmental criteria. Furthermore, GDP is often assessed as in terms of economic value only. This has several limitations, due to the inadequacy of the standard industrial classification systems for bio-based production and the lack of systematic data at national level. Finally, the COVID-19 crisis calls for a more sustainable society and economy to emerge from the crisis. This provides additional room for a sustainable Bioeconomy, but this further requires a more robust alliance among national strategies and governments at a global level.

Bioeconomies often lacking effective governances and a common framework to monitor progress in reaching the planned targets. Thus, there is the need to compare the existing Bioeconomy strategies, objectives, policies, regulatory tools and monitoring actions. Such a comparison with help identify and co-design more robust governance tools and comprehensive Bioeconomy monitoring systems. These systems should be based on the three sustainability dimensions (social, economic and environmental) but also be cost-effective and easy to handle, and suitable for the large number of SMEs active in the Bioeconomy landscape. This would remarkably contribute expand and boost sustainable Bioeconomy at the global level.

Set in the frame of the G20 initiatives, this workshop aims to address these needs. The workshop also contributes to the OECD Bio-, Nano- and Converging Technologies (BNCT) Working Party work programme on Bioeconomy and on the concept of carbon management, as an overarching policy framework in the green transition. The learnings from the workshop will be complemented by national case studies on carbon related technologies and sustainability indicators, to be presented and discussed at a workshop co-hosted by Norway in fall 2021 and in other OECD countries during the coming year. The workshop features speakers and participants from OECD member states, FAO and the EU Commission to share and compare several of the most prominent worldwide national Bioeconomy strategies and policies to develop more effective international Bioeconomy governance mechanisms and framework monitoring systems. An OECD policy document on the topics discussed will be prepared.

DRAFT AGENDA

11.00 Opening section

Chairs: Laura D'Aprile, G20 EDM Chair, Head of Department, IT Ministry of Ecological Transition & Andrea Lenzi, President of the "Biosafety, Biotechnology and Life Sciences National Committee" (CNBBSV) of the IT Presidency of Council of Ministers, Rome.

- Prof. Roberto Cingolani, Minister, Ministry of the Ecological Transition
- Prof. Maria Cristina Messa, Minister, Ministry of the University and Research
- Dr. Antonio Bernardini, Italian Ambassador at OECD & Ministry for Foreign Affairs and International Cooperation
- Dr. Masamichi Kono, Deputy Secretary General, OECD
- Prof. Fabio Fava, Chair of "National Bioeconomy Coordination Board" (NBCB), CNBBSV, Italian Presidency of Council of Ministers

11.40 Session 1. Bioeconomy strategies in the different OECD Countries: comparison of their objectives, priorities, governance and implementation guidelines

Chairs: Fabio Fava, NBCB, IT Presidency of Council of Ministers & David Winickoff, OECD BNCT

Presentation of the main features of the Bioeconomy strategies existing in G20 and OECD Countries by: Dalia Lewi (Argentina); Gottfried Lamers (Austria), Bruno Nunes (Brazil), Sandy Marshall (Canada), Sari Tasa (Finland), Andrea Noske (Germany), Maeve Henchion & Patrick Barrett (Ireland), Fabio Fava (Italy), Takahiro Ohno (Japan), Thomas Malla (Norway), Ben Durham (South Africa) and Jay Fitzgerald (USA).

Comments from the G20 and OECD delegations.

13.30 Break

13.40 Session 2. Targets and monitoring tools, towards a common framework to monitor progress in the Bioeconomy

Chairs: Danilo Porro, Italian Ministry of University and Research & Françoise Roure, Ministry of Economy and Finance, France & OECD BNCT

13.45 Peter Wehrheim, European Commission (DG RTD). *Deployment of bioeconomies across Europe and co-creating it across policy areas*

14.00 Giovanni De Santi, European Commission (JRC). *Monitoring the sustainability of the EU Bioeconomy.*

14.15 Maurizio Martina, FAO, Deputy Director General: *The FAO initiative “Towards Sustainable Bioeconomy Guidelines (SBG)”*

14.30 Round table: *Monitoring tools and indicators currently applied in the different G20 and OECD Countries: a first comparative assessment with the identification of the most reliable ones. Speakers-* Gottfried Lamers (Austria), Anthony Imbrogno (Canada), Sari Tasa (Finland), Andrea Noske (Germany), Maeve Henchion & Patrick Barrett (Ireland), Lucia Gardossi (Italy), Takahiro Ohno (Japan), Ben Durham (South Africa) and Jay Fitzgerald (USA).

Comments from the G20 and OECD delegations

A short summary on the outcomes of the panel: Lucia Gardossi, Rapporteur

16.15 Ole J. Marvik, Norway OECD BNCT Delegate: *Carbon management; a potential policy framework integrating the Bioeconomy, carbon recycling and renewable energy.*

16.30 Conclusions and future actions

Chair: Prof. Andrea Lenzi

On. Giancarlo Giorgetti, Minister, Ministry of the Economical Development

Dr. Antonio Bernardini, Italian Ambassador at OECD

Prof. Fabio Fava, Chair of NBCB, CNBBSV, Presidency of Council of Minister