

COUNCIL**Council****REPORT ON THE IMPLEMENTATION OF THE RECOMMENDATION OF
THE COUNCIL ON SUSTAINABILITY OF BIO-BASED PRODUCTS****(Note by the Secretary-General)**

JT03473000

1. This document presents, in its Annex, a report by the Committee on Scientific and Technological Policy (CSTP) on the implementation of the Recommendation of the Council on the Sustainability of Bio-based products [[OECD/LEGAL/0395](#)] (hereafter, the “Recommendation”) and conclusions regarding the instrument's continued relevance, dissemination, and whether it requires updating or revision.

Background

2. The Recommendation was adopted by the Council on 17 July 2012 [[C\(2012\)112](#) and its CORR1; [C/M\(2012\)9](#)] on the proposal of the CSTP. The Recommendation is predicated on the idea that the current and future magnitude of the economic, environmental and societal impacts of bio-based products are of such significance that they warrant strong, sustained and coherent action from governments, business and consumers to agree on harmonised frameworks for assessing their sustainability. Bio-based products are commercial or industrial goods (other than food or feed) composed in whole or in significant part of biological products, forestry materials, or renewable domestic agricultural materials, including plant, animal, or marine materials. These are products developed from biological materials, with the intent of replacing or enhancing products derived from nonrenewable resources. The term Bio-based Product encompasses bio-based chemicals, bio-based plastics, enzymes, bio-based materials, and bio-fuels. Food and feed are excluded.

3. The instrument provides guidance for the development and implementation of national frameworks for assessing the sustainability of bio-based products that take into consideration their environmental, economic and social impacts throughout the whole life cycle of bio-based products (cradle-to-grave).

4. Since 2012, the international landscape of sustainability and climate policy has moved on significantly assuming higher priority and visibility. The circular economy concept has been taken up to the extent that the Circularity Gap Reporting Initiative¹ delivers an annual global circularity metric that measures the state of the world economy and identifies key levers to transition to global circularity. To tackle climate change and its negative impacts, 197 countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015, and this came in to force a year later². The UN Sustainable Development Goals (SDGs) set out a path to a sustainable future. The European Union³ has elaborated a ‘green deal’, with the same goal in mind – of charting a future that is more sustainable.

5. In the Recommendation, the Council instructed the CSTP to monitor the implementation of the Recommendation and to report to Council thereon five years after its adoption and as appropriate thereafter.

Methodology

6. A survey questionnaire to assess progress was developed by the Secretariat and approved by the Working Party on biotechnology, nanotechnology and converging

¹ <https://www.circularity-gap.world/about>

² <https://www.un.org/en/climatechange/paris-agreement>

³ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

technologies (BNCT). It was then transformed into an online questionnaire for facilitating responses and analysis.

7. A link to the questionnaire was sent to all Adherents⁴. It was also sent to a range of subject experts for their input⁵. Responses were collected between February and August 2020. The analysis of the responses to the questionnaire was conducted by the Secretariat. Twenty-four Adherents⁶ and two non-Member non-Adherents⁷ responded to the questionnaire (hereafter, “Respondents”). The results were discussed with the Working Party.

8. To assess the continued relevance of the Recommendation, an analysis similar to the Likert analysis (Likert, 1932) was used. A return of ‘Obsolete’ was scored zero, a return of ‘Continued relevance but the Recommendation needs to be updated’ was scored one, and a return of ‘Continued relevance and no further action’ was scored two.

9. The questions for implementation were not subjective, requiring a ‘yes’ or ‘no’ response, followed by questions on how the implementation has been done that allowed Respondents to provide further information. The numbers of different types of instruments implemented by each country were summed for the overall Recommendation.

Process

10. BNCT delegates discussed the draft monitoring report at the 14-15 December 2020 Session of the BNCT and also provided comments to the Secretariat thereafter [[DSTI/STP/BNCT\(2020\)12](#)]. A revised draft was developed in light of these comments and BNCT Delegates were asked for another round of written comments by 29 January 2021 [[DSTI/STP/BNCT\(2020\)12/REV1](#)]. Minor comments were received and taken into account. The CSTP approved the final draft report as well as its transmission to the Council by written procedure on 5 March 2021 [[DSTI/STP/BNCT\(2020\)12/REV2](#)].

11. The Council is invited to note and declassify the report. Thereafter, a link to the report will be included in the public webpage of the Recommendation on the [online Compendium of OECD legal instruments](#).

Dissemination

12. Since its approval in 2012, there has been much interest in the Recommendation as countries have been formulating their national bioeconomy strategies. With a view to increasing the dissemination and impact of the Recommendation, the Secretariat has attended many international events to speak, to mentor, to moderate workshops and also BNCT has run its own workshops.

⁴ The Recommendation has 37 Adherents and no non-OECD Member Adherents.

⁵ International Sustainable Bioeconomy Working Group of the FAO; The German Bioeconomy Council and its International Advisory Council; EuropaBio; the World Bioeconomy Forum.

⁶ Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Israel, Italy, Japan, Korea, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Sweden, United Kingdom, United States.

⁷ Namibia and South Africa

Summary and conclusions

13. This review exercise has demonstrated a growing awareness regarding the need to develop the bioeconomy. Although Adherents may still have different interpretations of the bioeconomy, a high percentage of Respondents have started to actively pursue it. This should speed up the implementation of the Recommendation, as well as increase its relevance and impact, given that it proposes a standardised approach to building sustainability into bioeconomy frameworks.

14. The essential points for this exercise are:

- Overwhelmingly the Recommendation is still deemed relevant, with only one Respondent stating that it is obsolete.
- Most Respondents are implementing the Recommendation to varying degrees. Four of the 26 Respondents have implemented all ten of the specific recommendations.

15. Beyond this, the following key takeaways stood out from the review exercise:

- A significant number of Respondents consider that the definitions used in the Recommendation require updating.
- Engagement with non-Adherent non-OECD Member countries is very limited, representing the specific recommendation in the instrument with the lowest level of implementation, despite its crucial importance.
- There is a need to improve efforts to disseminate the Recommendation both internationally as well as across national levels of government.
- Defining and measuring sustainability is an absolute necessity in bioeconomy policy coherence.
- More work may be needed to determine how issues such as the emergence of the concept of circular economy, cascading use, the need for more emphasis on the demand-side (market-making) including public procurement, climate change, and the difficulty of comparing bio-based to non-bio-based and fossil equivalents.

16. In terms of dissemination, there has been much interest in the Recommendation since its approval by Council in 2012, as countries have been formulating their national bioeconomy strategies. National strategies mostly stress sustainability; thus there is an obvious connection to the Recommendation. With a view to further increasing the Recommendation's dissemination, the Secretariat has attended many international events to speak, to mentor, to moderate workshops and also BNCT has run its own workshops.

17. In terms of relevance, 77% of the returns state that the policy recommendations set out in the instrument are relevant and need no updates, and there is hardly any instance of 'obsolete'. Within the scores there are some anomalies. Some Respondents returned very high scores in terms of the total possible score and said that the Recommendation as a whole was still relevant although in need of some updating: exactly half of the Respondents said that the Recommendation as a whole needs no updating.

18. The lowest level of implementation by a considerable margin is for 'Non-member country collaboration'. This needs to be addressed. Many non-Adherent non-OECD Member countries have bioeconomy ambitions. To achieve the ambitious goals set out in many national strategies, governments need an effective and globally coordinated governance framework. This will require Adherents to engage much more with the many

non-Adherent non-OECD Member countries active in this area. Policy co-ordination and coherence needs to be achieved at the international level to ensure the harmonisation of policy objectives and requirements. Perhaps the greatest challenge is for the supply of sustainable biomass. Many Adherents are net importers of biomass and exporters of technology.

19. With the above in mind, there appear to be a number of areas in which further work to support the implementation, relevance, and impact of the Recommendation might be useful. It is proposed that the CSTP, through the BNCT, might assess the adequacy of the definitions used in the Recommendation and whether their revision could contribute to furthering harmonisation of policy making within and beyond the OECD Membership. These definitional issues might be explored in an upcoming June 2021 bioeconomy workshop hosted by the Italian government in Rome. In addition, it is proposed that Adherents focus on addressing the areas where implementation was revealed as low, in particular on engagement with non-Adherent non-OECD Members. To promote the impact and awareness of the Recommendation at a time when its relevance is as high as it has ever been, it is also proposed that Adherents, individually as well as through the CSTP and the Secretariat, work with relevant national and international organisations to facilitate broader dissemination of the Recommendation among relevant stakeholders to increase awareness and impact. In addition, in view of the responses of a number of Adherents, the CSTP, through the BNCT, may wish to consider further exploring issues such as the emergence of the concept of circular bioeconomy, cascading use, the need for more emphasis on the demand-side (market-making) including public procurement, climate change, and the difficulty of comparing bio-based to non-bio-based and fossil equivalents, and their relevance to the implementation of the Recommendation.

20. Beyond the specific next steps outlined above, it is proposed that the CSTP, through the BNCT, continue to review the implementation, relevance, and dissemination of the Recommendation and report again to the Council thereon in five years' time.

Proposed action

21. In the light of the preceding, the Secretary-General invites the Council to adopt the following draft conclusions:

THE COUNCIL

- a) noted document [C\(2021\)27](#), in particular the report set out in its Annex, and agreed to its declassification;
- b) encouraged Adherents to the Recommendation to continue their efforts to implement and disseminate the Recommendation and to address the main findings and challenges identified in the summary and conclusions section of the report;
- c) invited the Committee for Scientific and Technological Policy, through the Working Party on biotechnology, nanotechnology and converging technologies, to:
 - i. support Adherents in addressing the findings and challenges identified in the summary and conclusions section of the report;
 - ii. review whether and how the Recommendation may need to be revised and whether other actions should be taken to support its dissemination

and implementation and report to the Council thereon, as well as on the Recommendation's broader implementation, dissemination, and continued relevance, in no later than five years.

Annex A. Report on the Implementation of the Recommendation of the Council on Sustainability of Bio-based products

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1. Background

1. The Recommendation of the Council on the Sustainability of Bio-based products [[OECD/LEGAL/0395](#)] (hereafter, the “Recommendation”) was developed by the Committee for Scientific and Technological Policy (CSTP) and adopted by the Council on 17 July 2012.
2. The Recommendation is predicated on the idea that the current and future magnitude of the economic, environmental and societal impacts of bio-based products are of such significance that they warrant strong, sustained and coherent action from governments, business and consumers to agree on harmonised frameworks for assessing the sustainability of bio-based products.
3. For the purposes of the instrument, “bio-based products” are defined as
commercial or industrial goods (other than food or feed) composed in whole or in significant part of biological products, forestry materials, or renewable domestic agricultural materials, including plant, animal, or marine materials. These are products developed from biological materials, with the intent of replacing or enhancing products derived from non-renewable resources. The term Bio-based Product encompasses bio-based chemicals, bio-based plastics, enzymes, bio-based materials, and bio-fuels. Food and feed are excluded (1, 2).
4. The Recommendation provides guidance for the development and implementation of the national frameworks for assessing the sustainability of bio-based products that take into consideration their environmental, economic and social impacts throughout the whole life cycle of bio-based products (cradle-to-grave).
5. The overall Recommendation contains 10 specific recommendations, which have been grouped in Table 1.

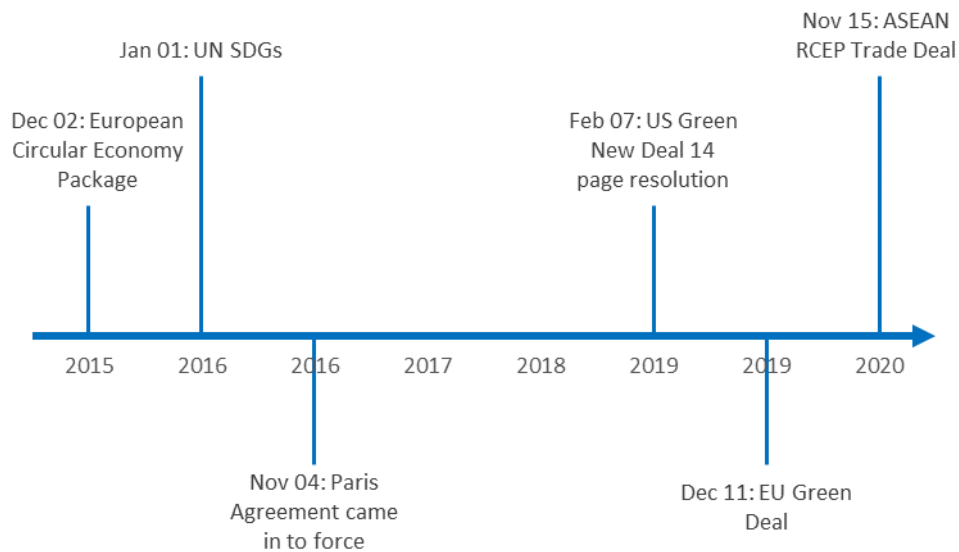
Table 1. The ten individual recommendations set out in the Recommendation.

<p>National frameworks</p> <p>1. Develop and implement national frameworks for assessing the sustainability of bio-based products that take into consideration their environmental, economic and social impacts throughout the whole life cycle of bio-based products (cradle-to-grave).</p> <p>2. Build consensus amongst relevant stakeholders in developing sustainability assessment frameworks for bio-based products.</p>
<p>Assessing sustainability: methodology and indicators</p> <p>3. Ensure the international consistency of approaches; use a life cycle approach to measure the sustainability of bio-based products, where possible; and compare with substitute non bio-based products.</p> <p>4. Facilitate the development and adoption of assessment methodologies for bio-based products that are science-based, broadly accepted, flexible and verifiable; these methodologies should allow for comparisons between various products and production options, including non-bio-based equivalents, in order to minimise the possibility of generating trade barriers.</p> <p>5. Facilitate the development and adoption of international sustainability indicators for bio-based products that are science-based, unambiguous and validated. These should take into account factors such as:</p> <ul style="list-style-type: none"> i. Energy balance, including non-renewable and renewable energy use. ii. All greenhouse gas reduction over product life cycles. iii. Bio-based content as an indicator of renewability. iv. Anticipated product life. v. Water and solvent use during the different stages of production, and impacts on biodiversity during feedstock production and subsequent processing. vi. Direct and indirect land used for feedstock production. vii. All aspects of end of product life. viii. Conventional as opposed to alternative bio-based production economics. ix. Impact on human and environmental health. <p>6. Develop and implement effective and efficient third party peer review of the sustainability assessments of bio-based products, as appropriate, and compare with non-bio-based products.</p>
<p>Transparency and public awareness</p> <p>7. Collect and make public appropriate data relevant to the sustainability assessment of bio-based products to enhance transparency and to facilitate the development of assessment methodologies for evidence-based decision-making.</p> <p>8. Promote awareness of the sustainability aspects of bio-based products and facilitate and encourage the timely provision of balanced and relevant information on the sustainability aspects of bio-based products.</p>
<p>Non-member country collaboration</p> <p>9. Enhance collaboration with non-Members and assist them in the development and implementation of principles for assessing the sustainability of bio-based products.</p>
<p>SME support</p> <p>10. Provide, through the public authorities of Members at various levels, support to SMEs involved in bio-based production and assessments of the sustainability of bio-based products.</p>

Source: Adapted from OECD (2012)

6. Since 2012 the international landscape of sustainability and climate policy has moved on significantly (Figure 1), assuming higher priority and visibility. The circular economy concept has been taken up to the extent that the Circularity Gap Reporting Initiative delivers an annual global circularity metric that measures the state of the world economy and identifies key levers to transition to global circularity. To tackle climate change and its negative impacts, 197 countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015, and this came in to force a year later. The UN Sustainable Development Goals (SDGs) set out a path to a sustainable future. The European Union has elaborated a ‘green deal’, with the same goal in mind - of charting a future that is more sustainable. More indirectly, on November 15, 2020, the ASEAN RCEP agreement was concluded, creating the largest trading bloc in the world.

Figure 1. Defining sustainability events since 2015



7. In the Recommendation, the Council instructed the CSTP to monitor the implementation of the Recommendation and to report to it thereon five years after its adoption and as appropriate thereafter. In line with this instruction, this document presents a report of the review of the Recommendation’s relevance and implementation and conclusions regarding its continued relevance, dissemination, and whether it requires updating or revision.

2. Methodology

8. A survey questionnaire was developed by the Secretariat and approved by the BNCT. It was then transformed into an online questionnaire for facilitating responses and analysis.

9. A link to the questionnaire was sent to all Adherents. It was also sent to a range of subject experts for their input⁸. Responses were collected between February and August 2020. The analysis of the responses to the questionnaire was conducted by the Secretariat. Twenty-four Adherents⁹ and two non-Member non-Adherents¹⁰ responded to the questionnaire (hereafter, “Respondents”). Table 2 lists Respondents and the specific organisation that completed the survey questionnaire. The Respondents were mostly from national governments and their agencies.

⁸ International Sustainable Bioeconomy Working Group of the FAO; The German Bioeconomy Council and its International Advisory Council; EuropaBio; the World Bioeconomy Forum

⁹ Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Israel, Italy, Japan, Korea, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Sweden, United Kingdom, United States.

¹⁰ Namibia and South Africa

Table 2. Organisations responding to the questionnaire.

Country	Respondent organisation	Respondent type
Belgium	Flemish Government, Department of Economy, Science and Innovation	Regional government
Canada	Agriculture and Agri-Food Canada	National government
Czech Republic	Ministry of Education, Youth and Sports, Department of Research and Development	National government
Denmark	Danish Agency for Science and Higher Education	National government
Estonia	Estonian Ministry of Rural Affairs	National government
Finland	Ministry of Agriculture and Forestry	National government
France	Ministère de l'Enseignement Supérieur, de la Recherche et de l'Innovation	National government
Germany	Project Management Agency Juelich	National government
Hungary	Bay Zoltan Nonprofit Ltd for Applied Research	Government-owned research organisation
Israel	Israel Innovation Authority	National government
Italy	Alma Mater Studiorum- University of Bologna, National Committee for Biosafety, Biotechnology and Life Sciences of the Italian Presidency of Council of Ministers	University, National government
Japan	Ministry of Economy, Trade and Industry	National government
Korea	Hongik University	University
Latvia	Latvian Ministry of Agriculture	National government
Lithuania	Ministry of the Economy and Innovation of the Republic of Lithuania	National government
Mexico	Consejo Nacional de Ciencia y Tecnología (CONACYT)	National government
Namibia	National Commission on Research, Science and Technology	National government
Netherlands	Netherlands Enterprise Agency (RVO)	Agency of national government
New Zealand	Scion	Government owned R&D organisation
Norway	Norwegian Ministry of Industry, Trade and Fisheries	National government
Poland	Minister Nauki i Szkolnictwa Wyzszego	National government
Portugal	Foundation for Science and Technology	National government
South Africa	Department of Science and Innovation	National government
Sweden	Chalmers University of Technology	University
United Kingdom	Department for Business, Energy and Industrial Strategy	National government
United States	Department of State	National government

10. To assess the continued relevance of the Recommendation, an approach, similar to the Likert analysis (Likert, 1932), was used. A return of 'Obsolete' was scored zero, a return of 'Continued relevance but the Recommendation needs to be updated' was scored one, and a return of 'Continued relevance and no further action' was scored two. The results are displayed on Table 4.

11. The questions for implementation were not subjective, requiring a 'yes' or 'no' response, followed by questions on how the implementation has been done that allowed Respondents to provide further information. The results from the yes or no responses are shown on Table 3. The numbers of different types of instruments implemented by each country were summed for the overall Recommendation, and are displayed per country as pie charts in Figure 2.

12. Various in-person events have been planned during which the results of this review project could be disseminated. During 2020 this will be limited to a series of virtual webinars planned for the work of the current Biennium to examine methodologies and indicators for a sustainable circular bioeconomy. The outcomes of this review will also

feed into a workshop in planning for June 2021 of the Presidency of Council of Ministers,¹¹ Rome. The current working title for the workshop is: “Bioeconomy in the OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective Bioeconomy governance mechanisms and monitoring systems.”

3. Process

13. BNCT delegates discussed the draft monitoring report at the 14-15 December 2020 Session of the BNCT (), and also provided further comments to the Secretariat thereafter [[DSTI/STP/BNCT\(2020\)12](#)]. A revised draft was developed in light of these comments and BNCT Delegates were asked for another round of written comments by 29 January 2021 [[DSTI/STP/BNCT\(2020\)12/REV1](#)]. Minor comments were received and taken into account. The CSTP approved the final draft report as well as its transmission to the Council by written procedure on 5 March 2021 [[DSTI/STP/BNCT\(2020\)12/REV2](#)].

14. The Council is invited to note and declassify the report. Thereafter, a link to the report will be included in the public webpage of the Recommendation on the [online Compendium of OECD legal instruments](#).

4. Dissemination

15. Since its approval in 2012, there has been much interest in the Recommendation as countries have been formulating their national bioeconomy strategies. With a view to increasing the dissemination and impact of the Recommendation, the Secretariat has attended many international events to speak, to mentor, to moderate workshops and also BNCT has run its own workshops. A selection of these is provided in Table 3 below.

¹¹ The Italian Presidency of Council of Ministers, in particular the President of the Council, Prof. Giuseppe Conte, relies on a strategic Committee on Biosafety, Biotechnology and Life Sciences which in turn hosts the “National Bioeconomy Coordination Body”, which is coordinating the Bioeconomy implementation in the country.

Table 3. A selection of events used for dissemination of the Recommendation.

Date	Event	Nature of dissemination
June 10-11, 2014	OECD workshop: Sustainable Biomass Drives the Next Bioeconomy, OECD HQ, Paris	An international workshop on biomass sustainability.
November 25-26, 2015	Global Bioeconomy Summit, Berlin	OECD workshop on "Bioeconomy Policy Analysis"
		Contributions to International Communique as a member of the International Advisory Council.
March 08, 2016	MCM workshop, Prague	Presentation entitled: "BNCT Three themes for Biennium 2015-2016 (including Biomass Sustainability).
March 14, 2016	CSTP Session, Paris	Presentation entitled: "BNCT Three themes for Biennium 2015-2016 (including Biomass Sustainability).
June 11, 2016	European Commission joint workshop	Presentation entitled: "Current and Future Work of OECD / BNCT on Bioeconomy"
June 24-25, 2016	Synenergene Forum, Amsterdam	Presentation entitled: "Biotechnology in a Sustainable Bioeconomy"
September 22-25, 2016	Italian Forum in Industrial Biotechnology and Bioeconomy, Vicenza	Presentation entitled: Bioeconomy Analysis at the OECD, 2015-2016
November 6-8, 2016	BioFuture Programme, of the Korean Federation of Science and Technology Societies (KOFST), Seoul	Presentation entitled: "The Bioeconomy, the Challenge of the Century for Policy Makers"
February 14, 2017	B-Debate, International Center for Scientific Debate, Barcelona	Presentation entitled: "Sustainable Bio-production, a Summary for Policy Makers"
March 20, 2017	BioEire, Next steps for the Irish bioeconomy: supply, demand, business and research considerations, Dublin	Presentation entitled: "The Bioeconomy: Current OECD Perspectives"
May 16, 2017	IEA workshop: The role of industrial biorefineries in a low-carbon economy, Gothenburg, Sweden	Presentation entitled: "Perspectives of Industrial Biorefineries in the Global Bioeconomy – Role of the Policy Framework to Support Implementation"
June 5-7, 2017	OECD side event at the World Circular Economy Forum.	Presentation entitled: "Recent OECD Work on the Bio- and Circular Economies"
October 24, 2017	CSTP Session, Paris	Presentation entitled: "Innovating a Circular Bioeconomy: Possibilities and Policy Challenges"
November 9, 2017	Ecomondo, Rimini	OECD workshop: "Successful industrial examples of Circular Bioeconomy in Italy"
January 31, 2018	European Commission workshop, Brussels	Presentation entitled: "Recent and Future Work on Bioeconomy at the OECD"
April 19-20, 2018	Global Bioeconomy Summit, Berlin	Session chair: Strategic Debate: "What will drive Bioeconomy-Innovation in the Future?"
		Contributions to International Communique as a member of the International Advisory Council.
May 22, 2018	1ª Conferência Nacional: Biomassa & Biorrefinarias, Lisbon	Presentation entitled: The Bioeconomy: A challenge for policy makers"
June 7-8, 2018	OECD workshop, Kraków	Workshop entitled: "Building a biomass innovation ecosystem in a circular bioeconomy in Poland"
November 6-8, 2018	Ecomondo, 2018, Rimini	Run two OECD workshops on Innovation Ecosystems and Sustainable Biorefining
May 23, 2019	IEA workshop: Governing sustainability in biomass supply chains for the bioeconomy, Utrecht.	Presentation entitled: "Governing Sustainability in Biomass Supply Chains for the Bioeconomy: some OECD perspectives"
October 3-4, 2019	Italian Forum in Industrial Biotechnology and Bioeconomy, Naples	Presentation entitled: "Industrial and innovation ecosystems in selected OECD countries"
November 26, 2019	Green Rio, Sao Paulo	Presentation entitled: "Enabling the Bioeconomy with Biotechnologies"
March 30-31, 2020	European Commission workshop, "Environmental sustainability and regional dimension of bio-based sectors:" (Virtual), Brussels	Intervention on: "International and European sustainability criteria and certification schemes of bio-based systems, innovative solutions, new business models and alternative value chains"

May 07, 2020	Bio-based Industries JU 2020 Info-Day, Riga (virtual)	Presentation entitled: "Sustainability of Bio-based Products: an OECD Perspective"
September 10, 2020	World BioEconomy Forum, Ruka (virtual)	Presentation entitled: "The Future of the Bioeconomy"
September 22-23, 2020	Workshop: III International Scientific Conference, Economic Sciences for Agribusiness and Rural Economy	Presentation entitled: "There is more than one interpretation of bioeconomy"

5. Implementation

16. The general trend of implementation of the 10 specific recommendations set out in the instrument is shown on Table 4. The levels of implementation of the recommendations are not very high for many Respondents. Only four of twenty-six Respondents reported implementation of all ten recommendations.

17. 'National frameworks' and 'Assessing sustainability: methodology and indicators' have very similar levels of implementation, with around half of the countries having actioned implementation. The greatest level of implementation has been for 'SME support'. The lowest level of implementation by a considerable margin is for 'Non-member country collaboration'.

Table 4. Implentation of the individual recommendations by Respondents.

Country	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Belgium	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes
Canada	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Czech Republic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Denmark	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No
Estonia	No	No	Yes	No	No	No	No	Yes	No	Yes
Finland	Yes	Yes	No	Yes	Yes	No	Yes	Yes		Yes
France	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Germany	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hungary	Yes	No	Yes	No	No	No	No	Yes	No	Yes
Israel	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No
Italy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Japan	No	No	No	No	No	Yes	No	No	No	No
Korea	No	No	No	No	No	No	No	No	No	No
Latvia	No	No	No	No	No	No	No	No	No	No
Lithuania										
Mexico	No	No	No	No	No	No	No	No	No	No
Netherlands	Yes	No	Yes	No	No	No	No	Yes	No	No
New Zealand	No	No	No	No	No	No	No	No	No	No
Norway	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Poland	Yes	Yes	No	No	No	No	No	Yes	No	No
Portugal	No	No	No	No	No	No	No	No	No	No
Sweden	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
United Kingdom	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes
United States	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Namibia	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes
South Africa	No	No	No	No	No	No	No	No	No	No

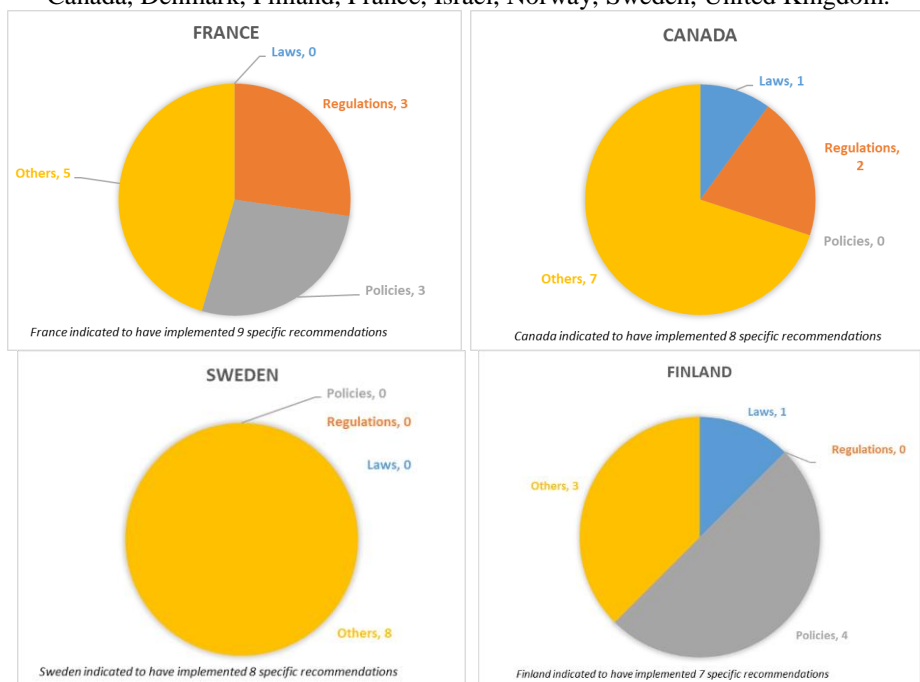
18. Figure 2 summarises the implementation instruments reported by the Respondents.

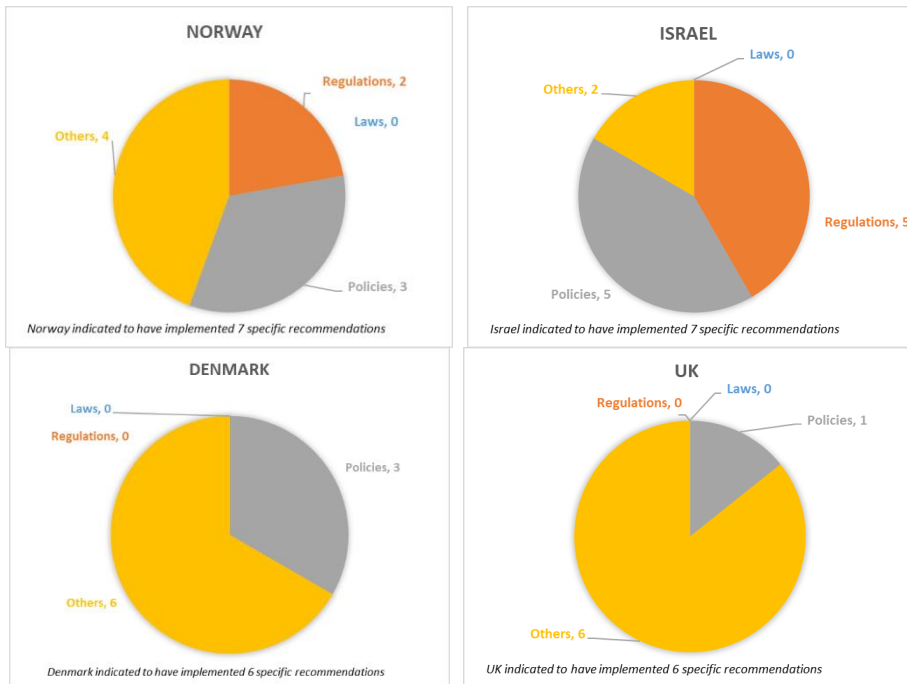
Figure 2. Implementation instruments by Respondent

Methods used by Respondents that implemented 10 specific recommendations:
Czech Republic, Germany, Italy, United States.

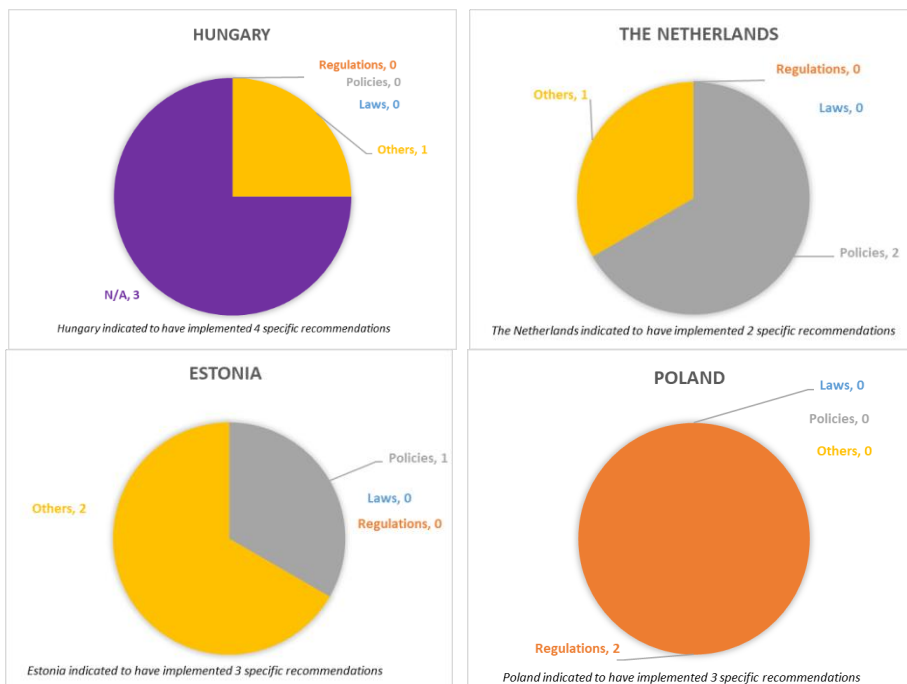


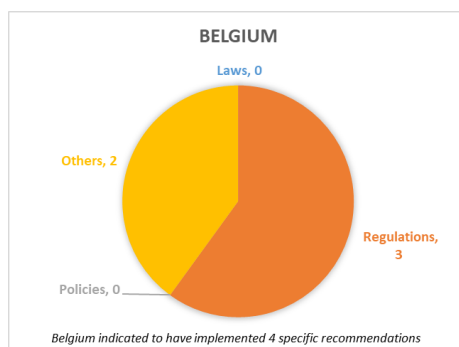
Methods used by Respondents that implemented 6-9 specific recommendations:
Canada, Denmark, Finland, France, Israel, Norway, Sweden, United Kingdom.





Methods used by Respondents that implemented 1-5 specific recommendations:
Belgium, Estonia, Hungary, Japan, Netherlands, Poland.





Source: Survey questionnaire.

19. It is also worth noting at the outset that most Respondents have put in place national bioeconomy strategies or an equivalent (Table 5).

Table 5. National bioeconomy strategies of countries responding to the questionnaire.

Country	National Bioeconomy Strategy or similar	Year
Belgium (Flanders)	Bio-economy in Flanders: The vision and Strategy of the Government of Flanders for a Sustainable and Competitive Bioeconomy in 2030. (Regional, not national).	2014
Canada	Canadas Bioeconomy Strategy. Leveraging our Strengths for a Sustainable Future. (Note that this has not yet been accepted by the federal government).	2019
Czech Republic	Under development.	
Denmark	Denmark as growth hub for a sustainable bioeconomy. (Not a national strategy, but a statement by the National Bioeconomy Panel).	2014
Estonia	No known bioeconomy strategy.	
Finland	The Finnish Bio-economy Strategy.	2014
France	A Bio-economy Strategy for France.	2017
Germany	National Policy Strategy on Bioeconomy. National Bioeconomy Strategy.	2013 2020
Hungary	No known bioeconomy strategy.	
Israel	No known national bioeconomy strategy.	
Italy	Bio-economy in Italy. Bioeconomy in Italy: A new bioeconomy strategy for a sustainable Italy.	2016 2019
Japan	Basic Plan of Biomass Utilisation. The Bioeconomy Strategy 2019.	2010 2019
Korea	No known national bioeconomy strategy.	
Latvia	Latvian Bioeconomy Strategy 2030.	2017
Lithuania	No known national bioeconomy strategy.	
Mexico	No known national bioeconomy strategy.	
Namibia	National Programme on Research, Science, Technology and Innovation. (Bioeconomy related, not specific).	2015
Netherlands	Framework Memorandum for a Bio-based Economy. (Policy paper, not a national strategy).	2012
New Zealand	No known national bioeconomy strategy.	
Norway	Familiar Resources, Undreamt of Possibilities: the Government Bioeconomy Strategy.	2016
Poland	Under development.	
Portugal	Under development.	
South Africa	The Bio-economy Strategy.	2013
Sweden	Swedish Research and Innovation Strategy for a Biobased Economy.	2012
United Kingdom	Growing the Bioeconomy. Improving lives and strengthening our economy: A national bioeconomy strategy to 2030.	2018
United States	National bio-economy blueprint.	2012

5.1. Implementation of the individual recommendations

Specific recommendation 1: Develop and implement national frameworks for assessing the sustainability of bio-based products that take into consideration their environmental, economic and social impacts throughout the whole life cycle of bio-based products (cradle-to-grave).

Percent of Respondents implementing: 60%

20. Respondents described implementation through various strategic national policy areas. Of course, the obvious route is through the national bioeconomy strategy (where appropriate). Other important routes to implementation include: the circular economy

national plans; smart specialisation strategies; renewable energy plans; resource and waste strategies, and; how countries are tackling biomass at the level of policy. The connection to the circular economy makes sense in European Union member states as recent documents from the European Commission describe an integration of the bioeconomy with the circular economy.

21. Renewable energy plans involve biofuels and bioenergy, often into the medium term. Many countries have mandates and/or targets for biofuels and bioenergy as part of the renewable energy mix. Biomass plans may consider how to safeguard the sustainable supply of biomass for non-food use as there is a potential conflict in the use of biomass for food and other purposes. Thus implementation is also closely associated with agricultural policy.

22. Implementation through waste strategies is an important area of policy now and into the future as there are some important waste sources that can act as feedstocks for bio-based production (Box 1). These include solid (organic i.e. carbon-containing) domestic waste and waste industrial gases containing one carbon atom i.e. C1 gases such as carbon dioxide and carbon monoxide.

Box 1. The role of the bio-based industry in the EU Green Deal

In the Green Deal objectives, bio-based materials can meet 60% of material needs, and they can reduce the overall environmental footprint of material use. Bioenergy will play a significant role in energy systems decarbonisation and green mobility (e.g. air transport). A range of environmental and economic benefits are recognised as part of the European path to sustainability and a circular economy

Biorefining is recognised as a sustainable route to turning food waste into products

In the European Union, annual production of food waste is of the order of 30 million tonnes and increasing. There is the potential for 190 biorefineries with repayment of investment in less than 15 years.

Future support hinges on sustainability

There are many challenges for bio-based product sustainability in Europe:

- Many aspects of bio-based industry operation is regulated by existing law (e.g. GMO regulation, Renewable Energy Directive II).
- Impacts are not regulated or are partially regulated e.g. GHG emissions (except for biofuels), land use change, ecosystem degradation.
- Development of metrics is incomplete (indicators, criteria), there are requirements for standards and benchmarks, and policy instruments (e.g. regulation, incentives).
- Life-cycle perspective is important, but also impacts that LCA does not capture well (e.g. sustainability of biomass sourcing).
- Use of the existing instruments: certification schemes, PEF LCA method, sustainable finance taxonomy.

Source: Misiga (2020). Presentation at the BNCT webinar “Carbon management policies; global practices in sustainability indicators and assessment”, October 15, 2020.

23. The United States described a specific instrument to address this recommendation—the BioPreferred Program of the United States Department of Agriculture (USDA), for which a method for assessing bio-based content was developed and implemented (Box 3).

24. The Netherlands is developing a broad sustainability framework on biomass as the Netherlands is a net importer of biomass – thus the sustainability issues are very much beyond its borders. Aspects that are taken into account are criteria for sustainability of production and availability of biomass.

Specific recommendation 2: Build consensus amongst relevant stakeholders in developing sustainability assessment frameworks for bio-based products.

Percent of Respondents implementing: 56%

25. The responses given bore strong relation to specific recommendation 1, logically as both are related to developing sustainability national frameworks. However, the responses highlighted the multi-dimensional policy aspects involving agriculture, industry and trade, environment, waste, R&I and national bioeconomy strategies. Denmark has a specific bioeconomy panel for consensus building, and Germany has a specific advisory body for the federal government (Box 2). Conferences and workshops, engagement with non-governmental organisations (NGOs) are among the general methods to bring stakeholders together and share experiences and interests. The United Kingdom emphasised waste and plastics stakeholder fora.

26. It has to be understood that this is a long and ongoing process, where research, building up national and international datasets, common practices and benchmarking are all necessary and require public bodies.

Box 2. Instruments to build consensus and the policy framework

Denmark's National Bioeconomy Panel

The National Bioeconomy Panel was set up in 2013 under the auspices of the Ministry of Environment and the Ministry for Industry, Business and Financial Affairs. In 2017, the panel was relaunched with a reduced number of panel members and with a stronger focus on industry.

The panel's central task is to draw attention to opportunities for specific measures in promotion of the bioeconomy. Such measures – ranging from agriculture to fisheries, from processing to consumption – should foster a sustainable bioeconomy, in which resources and products are, to a much greater extent than today, used for the benefit of the environment, climate, growth and employment.

By establishing the National Bioeconomy Panel, the government concentrated an important agenda in a single joint forum attended by representatives with experience and expertise from the entire value chain, ranging from NGOs and researchers to authorities and product development officers in major Danish companies.

The German Bioeconomy Council

The German Bioeconomy Council is the advisory body to the German Federal Government on bioeconomy. Its role is the implementation of the German bioeconomy research and policy strategies. In policy it is responsible for setting up the framework conditions within which the bioeconomy will operate. Since 2015 it has organised a three events called the Global Bioeconomy Summit in Berlin that attracts stakeholders from many countries, and this has clear alignment to specific recommendation 9.

Specific recommendation 3: Ensure the international consistency of approaches; use a life cycle approach (LCA) to measure the sustainability of bio-based products, where possible; and compare with substitute non bio-based products.

Percent of Respondents implementing: 56%

27. LCA is used in other sectors so it is a familiar tool in many countries. For example, in the Netherlands LCA is used in the building sector to assess the sustainability of products. Participation in technical committees such as ISO and integration of LCA methodologies into product comparison is essential to international consistency. However, it also had to be cautioned that LCAs are used by universities and research institutions in some countries without a harmonised approach provided by regulations or other law.

28. The US BioPreferred Program has coordinated with counterparts in other countries to use ASTM D6866-20 as the bio-based content test method to try and broker international harmonisation. The international dimension is also inherent to the European Union: the Joint Research Centre (JRC) is working specifically on how to use the life cycle approach for assessing the environmental impacts of bio-based products in Europe.

Specific recommendation 4: Facilitate the development and adoption of assessment methodologies for bio-based products that are science-based, broadly accepted, flexible and verifiable; these methodologies should allow for comparisons between various

products and production options, including non-bio-based equivalents, in order to minimise the possibility of generating trade barriers.

Percent of Respondents implementing: 56%

29. This is a specific recommendation that requires government-funded research projects and programmes. For example, the Czech Republic cited specifically how the National Agency for Agricultural Research focuses on the use of natural resources and the bioeconomy. Canada is supporting the development of a life cycle inventory (LCI) database and associated life cycle assessment (LCA) guidelines.

30. The requirements of the specific recommendation are inherent to national bioeconomy strategies e.g. France's bioeconomy strategy and action plan take into account the need to assure the sustainability of bio-based products.

31. An important aspect is that the problem is not only in developing the assessment methods but also implementing them in practice.

32. A particular strength of the USDA BioPreferred Program is the use of a science-based protocol to determine the bio-based content of products (Box 3).

Box 3. The USDA BioPreferred Program

Science-based assessment of renewable carbon content

In 2002, the US Farm Bill created the BioPreferred programme to “spur economic development, create new jobs and provide new markets for farm commodities. It was expanded in the 2008, 2014, and 2018 Farm Bills. The increased development, purchase, and use of bio-based products reduces the nation’s reliance on petroleum, increases the use of renewable agricultural resources, and contributes to reducing adverse environmental and health impacts.” The BioPreferred programme has two components: a federal procurement mandate for bio-based products and a certification/voluntary labelling initiative for bio-based products. The mandatory purchasing component requires that federal agencies buy bio-based products from categories identified by USDA with bio-based content minimum levels. These include lubricants, inks, cleaning and construction products, and exclude food, feed and fuel.

Bio-based content is assessed using the American Society for Testing and Materials (ASTM) D6866-20 test method that uses radiocarbon analysis (<https://www.astm.org/Standards/D6866.htm>). The method calculates the ratio of a product's ‘new’ organic carbon (such as from agricultural materials) to total organic carbon (‘new’ and ‘old’, or petroleum-based carbon). Thus bio-based content can be expressed as a percentage.

USDA also offers bio-based product manufacturers a voluntary certification and labelling initiative – third-party testing results quantify the products’ ‘new carbon’ content as derived from plants and other renewable agricultural, marine, and forestry materials. Currently USDA has designated 139 product categories of bio-based products for federal purchasing. Manufacturers can voluntarily list their “qualifying” products in the USDA BioPreferred catalogue. Right now, there are about 16 000 products listed in the catalogue.

Specific recommendation 5: Facilitate the development and adoption of international sustainability indicators for bio-based products that are science-based, unambiguous and validated. .

Percent of Respondents implementing: 40%

33. Given the centrality and detail of this specific recommendation, the responses were, relative to some of the others, rather brief and non-specific. They focussed on national and international cooperation (the OECD was mentioned as a forum for developing new knowledge – see Box 4).

Box 4. Sustainability indicators and international organisations

The OECD

Mostly sponsored by the government of the Netherlands, the OECD held a workshop on June 10-11, 2014 on measuring biomass sustainability (“Sustainable biomass drives the next bioeconomy”). Several of the observations then were repeated during two BNCT webinars on October 15 and 22, 2020, entitled “Carbon management policies: global practices in sustainability indicators and assessment”. There is no international agreement on the indicators to measure sustainability of bio-based products or, more generally, renewable carbon.

The first of the 2020 webinars was a general event, with inputs from major stakeholders, such as the United States Department of Agriculture, the European Commission, the United Nations Food and Agriculture Organisation. As a balance to the large policymaker views, there were also comments from industry, spanning a multinational technology end-user to an innovative small company at the forefront of carbon capture through biotechnology.

The second webinar followed a similar structure but focussed on three of the most important value chains of the sustainability transition: aviation fuel, plastics and feed. The stakeholder mix was enriched by academic views on sustainability measurement, followed by policymaker and industry comments. It became clear from these two events that, while there has been progress since our work in 2014, there is still much to do in this area, especially as renewable carbon assumes greater political importance.

The overarching purpose of these webinars was to inform the Programme of Work and Budget for Biennium 2021-2022 for the BNCT to move the world forward on this topic that is critical to the move for a sustainable recovery post-COVID-19.

The Food and Agriculture Organization of the United Nations (FAO)

The FAO has conducted a major project Towards Sustainable Bioeconomy Guidelines (SBG), funded by the German Ministry for Food and Agriculture (BMEL). The ultimate aim of FAO’s work on sustainability indicators is to provide technical assistance to countries and stakeholders in developing and monitoring sustainable bioeconomy (Bracco et al., 2019). This is probably the most advanced work anywhere on sustainability assessment. Crucially, it considers the three sustainability dimensions (social, economic and environmental) while also proposing a limited set of core indicators, to keep the monitoring feasible and cost-effective. Such an approach is essential for the large number of SMEs with limited resources.

Specific recommendation 6: Develop and implement effective and efficient third party peer review of the sustainability assessments of bio-based products, as appropriate, and compare with non-bio-based products.

Percent of Respondents implementing: 36%

34. Likewise, the descriptions of implementation of specific recommendation 6 lack detail, and there is no perceptible theme to the responses. “Third party” ranged through ISO, independent bioeconomy panels, research funding of sustainability assessment, consumer associations, labelling guidelines. The main objective of the CEN (European Standardization Institute) Technical Committee 411 is to develop standards for bio-based products covering horizontal aspects. This includes a consistent terminology for bio-based products, sampling, bio-based content, application of, and correlation towards, LCA and sustainability of biomass used, and guidance on the use of existing standards for the end-of-life options.

Specific recommendation 7: Collect and make public appropriate data relevant to the sustainability assessment of bio-based products to enhance transparency and to facilitate the development of assessment methodologies for evidence-based decision-making.

Percent of Respondents implementing: 48%

35. Transparency is a key word in this specific recommendation. The United Kingdom government has conducted a call for evidence in autumn 2019 to better understand the demand, benefit, and implications for developing standards for bio-based and biodegradable plastics. This is very relevant as public opinion of bio-based products is likely to be focussed on the plastics issues, which are currently of high political priority. Publicly funded groups should play a key role in coordinating action and should be in a unique position to collate, share and publish information. That is not to say that the private sector does not have roles to play; Canada mentions industry-led metrics development. An example of enhanced public consultation is provided by the transition from Biomass Towns to Biomass Industrial Cities in Japan (Box 5).

Box 5. The Biomass Towns and Biomass Industrial Cities initiatives of Japan

In the Biomass Towns concept, biomass materials are envisaged to be used by different constituencies of a town rather like the utilisation of waste materials in a waste exchange i.e. a ‘waste’ material from one constituent is a feedstock for another. In the context of biomass towns the ‘constituencies’ include factories, restaurants, households, farms and forests. They are augmented by biomass conversion facilities such as electricity and heating plants, ethanol plants and composting facilities. By 2011, 318 out of some 1 700 municipalities had developed their Biomass Town plans.

Some Biomass Towns succeeded in regional revitalisation through increase of employment and decrease in waste disposal costs. However, uptake of the plan was by no means complete, and several causes were identified, including a need for more, and more effective, communication with local stakeholders and communities. With lessons learned, the Biomass Industrial City initiative was launched in 2013. Like the Biomass Towns initiative, the vision is to create industry utilising local biomass and building a local circular economy, and to stimulate rural development.

Particularly in the utilisation of unused biomass such as forest residues and waste-derived biomass such as livestock manure, it can be seen that local stakeholders (including

forest owners, forestry associations, farmers, regional agricultural cooperatives, plant manufacturers and operating companies) have started to work collaboratively i.e. collective action has started to build value chains.

One of the major premises for project implementation was consensus building by conducting briefing sessions at a local level. In activities like burning biomass for electricity or heat generation and treating wastes for methane fermentation, it was considered essential to understand local residents and to gain their trust. In the Biomass Industrial City/Region schemes, municipalities are positioned as the main formulators of the plan. They then coordinate with local farmers, plant manufacturers, local residents and other relevant stakeholders in the planning process in a voluntary manner.

Specific recommendation 8: Promote awareness of the sustainability aspects of bio-based products and facilitate and encourage the timely provision of balanced and relevant information on the sustainability aspects of bio-based products.

Percent of Respondents implementing: 64%

36. Closely related to specific recommendation 7, the responses are similarly related. One novel approach in Italy is to invite citizens and all those interested in the topic to express their views via the national task force on bioeconomy website and national events on bioeconomy-related topics. Traditional methods such as, conferences, seminars, information campaigns and labelling will assume more importance.

Specific recommendation 9: Enhance collaboration with non-Members and assist them in the development and implementation of principles for assessing the sustainability of bio-based products.

Percent of Respondents implementing: 20%

37. By a considerable margin this was the least implemented of the specific recommendations (19 out of 26 countries declare no implementation). Of those that have, they emphasise the importance of international collaboration. Germany is intensifying international collaboration as a strategic goal of the German Bioeconomy Strategy. Italy has actions to promote the bioeconomy in the Mediterranean area. The International Bioeconomy Forum is a platform to guide international cooperation on key research and innovation priorities and horizontal activities that are crucial for the development of a global, sustainable bioeconomy (Box 6).

Box 6. The International Bioeconomy Forum

Canada co-chairs the International Bioeconomy Forum (IBF) with the European Commission. The IBF provides a flexible multilateral mechanism where global research and innovation partners can discuss, coordinate and act on common challenges in the bioeconomy. IBF activities on bioeconomy indicators are led by the Food and Agriculture Organization of the United Nations, in partnership with the European Commission's Joint Research Centre. To ensure compatibility with the international arena, the JRC is following the International Sustainable Bioeconomy Working Group (ISBWG) structure of 10 aspirational principles and 24 criteria.

IBF members are Argentina, Canada, China, India, New Zealand, South Africa, the United States and the European Commission. Observers are Australia, Korea, the BIOEAST

Initiative, the Food and Agriculture Organization of the United Nations, the Standing Committee on Agricultural Research and the Inter-American Institute for Cooperation on Agriculture.

Source: <https://www.agr.gc.ca/eng/scientific-collaboration-and-research-in-agriculture/international-engagement/international-bioeconomy-forum/?id=1552307410662>

Specific recommendation 10: Provide, through the public authorities of Members at various levels, support to SMEs involved in bio-based production and assessments of the sustainability of bio-based products.

Percent of Respondents implementing: 56%

38. Implementation was through broad and specific methods. In particular France emphasised SME support, and a key mechanism is through the Industries et Agro-ressources (IAR) bioeconomy cluster (Box 7). Governments should realise that there are some attributes of bioeconomy SMEs that need particular attention. Many of these SMEs are likely to be rurally based (close to the feedstocks). They require multi-disciplinarity, which is difficult to achieve in the smaller SMEs. Therefore government funding programmes for the bioeconomy should be cognisant of these special circumstances.

39. Transnational and regional programmes should also aim to support SMEs. One of the key European ‘regions’ for the bioeconomy is the Danube region, representing Austria, Bulgaria, Croatia, Czech Republic, Germany, Romania, Serbia, the Slovak Republic and Slovenia. Another important government mechanism for support to SMEs can be through collaboration with primary research institutes, mentioned by Sweden.

Box 7. Bioeconomy clusters promote regional sustainability and assist SMEs.

Bioeconomy clusters have been a feature of European bioeconomy policy, many expressing sustainability as part of the remit. Within the mission is to promote SMEs within their regions. The regional dimension to these clusters aligns with the distributed manufacturing paradigm and sustainability. Several examples are given.

Industries & Agro-Ressources (IAR), France

The Industries & Agro-Ressources (IAR) bioeconomy cluster in France has 340 members, of which 139 are SMEs. Located in the Champagne- Ardenne and Picardy regions of France, it unites stakeholders from research, education, industry and agriculture in France around a shared goal: to optimise the added value from the exploitation of biomass. It has regional roots where biorefining has been particularly successful, it also has a global mission by integrating external know-how through international strategic alliances. A classic task of a regional cluster, IAR assembles stakeholders from the whole value chain around a shared innovation problem.

The cluster has been involved in R&I projects to a value of around EUR 1.5 billion. It has responded to the special challenges of fund raising for the shift from demonstration to commercialisation within SMEs by creating IAR-Invest. It offers an inclusive service for innovative companies to: increase their visibility with private investors, especially the venture capital community; and to arrange interaction with multiple stakeholders to

improve the prospects for securing investments e.g. funds, banks, regional councils, incubators and financial institutions.

CINBIOS and FISCH (Catalisti), Flanders

The sector of chemical industry and life sciences is the largest and most R&D intensive sector in Flanders. CINBIOS is a partnership between cluster organisations and associations of industrial biotechnology and bioeconomy, founded in 2009. It promotes collaboration and networking and facilitates new projects involving research and industry actors. It is a joint initiative of FlandersBio, Ghent Bioeconomy Valley and Essenscia Vlaanderen, which is financially supported by the Flemish government through IWT Vlaanderen.

Flanders Innovation hub for Sustainable Chemistry (FISCH) was a sustainable chemistry cluster. The FISCH portfolio had a number of research and demonstration projects on biological materials (plants, algae). It was created to facilitate the transition of the Flemish chemical industry towards more sustainability. Now Catalisti, part of the mission is to find and initiate new innovation projects aimed at sustainable business opportunities.

BE-BASIC and Bio-based Delta, Netherlands

The BE-BASIC consortium (Bio-Based Ecologically Balanced Sustainable Industrial Chemistry) based in Delft was formed in 2010 and places emphasis on scale-up, an open innovation model and engagement with the financial sector. This initiative includes a R&D budget exceeding EUR 120 million. The Ministry of Economic Affairs, Agriculture and Innovation as part of the Economic Structure Enhancement Fund (FES), funds half and the other half comes from industry and knowledge institutions. Now the BE-BASIC Foundation, the mission and ambition is: *“To build a sustainable bio-based economy the food, chemical, energy and materials industry need to switch from fossil fuels to biomass. This requires new technologies and insight in the sustainability issues that come along with this transition.”*

Bio-based Delta is based in the Southwest of the Netherlands and combines entrepreneurs, knowledge institutes and governments in Zeeland, Zuid-Holland and Brabant to work together towards a bio-based economy. The region has large agricultural, horticulture and chemical sectors, and an advantageous geographic location along the Antwerp-Rotterdam axis. Now the Circular Biobased Delta foundation exists with the mission to accelerate the green transition towards a circular bio-based economy in the Delta region of the Netherlands.

CLIB2021, Germany

Born from the German Federal BioIndustry 2021 competition CLIB2021 was awarded the first prize, winning EUR 20 million. Headquartered in Düsseldorf, the home region of CLIB2021 is North Rhine-Westphalia (NRW), home to 30% of the German chemical industry and 50% of European start-ups in industrial biotechnology. It provides multiple services to spin-outs and SMEs, such as technology transfer, access to infrastructure, investors and production sites as well as business support and legal advice and IP advice. The core activity is to initiate R&D consortia, but it brings together academic and industrial active in research, development, production and commercialisation – all crucial elements of the industrial value chain. CLIB is in regular dialogue with ministries responsible for bioeconomy from NRW, Germany as well as the EU.

6. Summary and conclusions

40. Key takeaways from the present review exercise are that:
- Overwhelmingly the Recommendation is still deemed relevant, with only one Respondent stating that it is obsolete.
 - A significant number of Respondents consider that the definitions used in the Recommendation require updating.
 - Most Respondents are implementing the Recommendation to varying degrees. Four of the 26 Respondents have implemented all ten of the specific recommendations.
 - Engagement with non-Adherent non-OECD Member countries is very limited, representing the specific recommendation in the instrument with the lowest level of implementation, despite its crucial importance.
 - There is a need to improve efforts to disseminate the Recommendation both internationally as well as across national levels of government.
 - Defining and measuring sustainability is an absolute necessity in bioeconomy policy coherence.
 - More work may be needed to determine how issues such as the emergence of the concept of circular economy, cascading use, the need for more emphasis on the demand-side (market-making) including public procurement, climate change, and the difficulty of comparing bio-based to non-bio-based and fossil equivalents.

6.1. Bioeconomy implementation is slow and out of step with national bioeconomy strategies

41. The level of implementation of the Recommendation bears a relation to the implementation of bioeconomy policies writ large, which aim to promote the bio-based economy. A central challenge for the implementation of national bioeconomies for policy makers is balancing supply- and demand-side measures across very diverse sectors, involving industrial manufacturing, agriculture, forestry, marine resources and waste management.

42. Since 2012, when the United States and the European Union published bioeconomy strategies, around 50 countries have published national strategies or other documents similarly describing progress towards a bioeconomy (Figure 4). The level of implementation across Respondents revealed in the present exercise may be a result of how long each country has had a national bioeconomy strategy.

43. Bioeconomy strategies are bold statements about a more sustainable future but they are short on policy detail. However, they should set the framework for more concrete policy actions. The deployment of the bioeconomy is slow for several reasons (Meyer, 2017), despite much political attention. National governments widely regard the development of a modern bioeconomy as a central strategy to promote their economies and to ensure sustainable development worldwide. It is clear that despite the efforts of many countries to implement a bioeconomy, much work remains to be done. It can be predicted that the

Recommendation will be relevant for years to come as governments wrestle with the difficulties of implementation.

Figure 3. Around 50 countries have bioeconomy strategies or similar programmatic documents.



Source: updated from OECD (2018) to reflect late-2020.

44. The least implemented of the specific recommendations set out in the instrument was number nine, which concerns engagement with non-Adherent non-OECD Member countries. As can be seen from Figure 4, many countries outside the group of Adherents to the Recommendation (currently only OECD Members) have bioeconomy ambitions. To achieve the ambitious goals set out in many national strategies, governments need an effective and globally coordinated governance framework (Dietz et al., 2018). This will require Adherents to engage much more with the many non-member countries. Policy coordination and coherence needs to be achieved at the international level to ensure the harmonisation of policy objectives and requirements. Perhaps the greatest challenge is for the supply of sustainable biomass. Many OECD Adherents are net importers of biomass and exporters of technology. To prevent predictable problems of over-exploitation of biomass, the international dimension should be a high priority for Adherent governments.

6.2. There is still impetus for the bioeconomy

45. There are recent national and transnational documents that suggest that the impetus for the bioeconomy is not waning, even if deployment is slow. For example, in the United States expansion is such that there is a perceived need for a greater level of organised coordination. This is because of the dispersal of life sciences and biotechnologies across many different sectors and government departments. In the United States, in 2020 it was recommended that the Executive Office of the President should establish a government-wide strategic coordinating body for the bioeconomy, presided over by senior White House leadership (National Academies of Sciences, Engineering, and Medicine, 2020).

46. The European Union bioeconomy strategy was one of the earliest. It is significant then that the European Commission has chosen to update the strategy (European Commission, 2018). In this document the European Commission makes official the importance of the bioeconomy to the European economy, reaffirming that it has a turnover value of EUR 2.3 trillion and that it accounts for 8.2% of the European Union's workforce, placing the bioeconomy as "a central element to the functioning and success of the EU economy". A significant update is to bring the bioeconomy and the circular economy into the same orbit, with a sustainable bioeconomy as "the renewable segment of the circular economy".

47. Having done around two decades of work on biomass utilisation, Japan had not actually produced a national bioeconomy strategy. Thus the arrival of one in 2019 is evidence that Japan sees the bioeconomy as part of the future of the country. The strategy emphasises the use of biotechnologies in the bioeconomy, as do the strategies of the United Kingdom and the United States.

6.3. Dissemination

48. The COVID-19 crisis has heralded many calls for a more sustainable society to emerge from the crisis including from the IEA (IEA, 2020) and the OECD (OECD, 2020). As has come to be expected, many such documents barely mention the bioeconomy or ignore it completely, despite the necessity of biotechnology for the eradication of the disease (Heywood and Macintyre, 2020). This lack of attention to the bioeconomy for a sustainable future is out of step with its importance as identified by the European Commission (above). In this situation, dissemination of the Recommendation internationally as well as across national levels of government is more important than ever.

49. There has been much interest in the Recommendation since its approval by Council in 2012, as countries have been formulating their national bioeconomy strategies. National strategies mostly stress sustainability; thus there is an obvious connection to the Recommendation. With a view to further increasing the Recommendation's dissemination, the Secretariat has attended many international events to speak, to mentor, to moderate workshops and also BNCT has run its own workshops. The report outlines a selection of key events in this regard in Table 2.

50. Despite these efforts, the present report highlights the importance of disseminating the Recommendation more broadly, both internationally as well as domestically across levels of government. In light of this, it is proposed that Adherents, individually as well as through the CSTP and the Secretariat, work with relevant national and international organisations to facilitate broader dissemination of the Recommendation among relevant stakeholders to increase awareness and impact.

6.4. A need for coherence

51. This exercise has highlighted a patchiness in the deployment of the bioeconomy. While there is overwhelming agreement that the Recommendation is still relevant (only one Respondent from 26 thinks the Recommendation to be obsolete), only four Respondents have implemented all ten specific recommendations. The absence of an internationally agreed definition of bioeconomy may be one reason for the lack of coherence in deployment although it will be only one of several. The United States made a call to create a process with Adherents to update these definitions. This may bring

rationalisation of the different views among Adherents that would help create further harmonisation of policy making within and beyond the OECD Membership.

52. A uniting definition of bioeconomy would make it easier to measure the bioeconomy. As governments have been spending taxpayers' money on the bioeconomy, there is now an imperative to be able to measure the benefits to the economy overall, and to be able to compare progress with other countries. Carlson (2016) detailed the difficulties in estimating the contribution of biotechnologies to the economy of the United States. As the bioeconomy is now much more than biotechnology, these difficulties are amplified.

53. Directly relevant to the Recommendation, measuring sustainability is still elusive. Work of the BNCT in the Biennium 2021-2022 is set to address the issue, although the topic is complex and highly politically charged. In the absence of measurement, there is a very large risk of greenwashing and companies using sustainability as a marketing tool. Thus defining and measuring sustainability (Bosch et al., 2015) is an absolute necessity in bioeconomy policy coherence.

54. Another aspect of policy coherence is policy diversity. The bioeconomy is a transition phenomenon that requires whole-of-government attention. Policy crosses boundaries of, amongst others, innovation, taxation, environmental, industrial, energy, waste management and agricultural policy. Hence the previous remarks on the need for policy coordination.

6.5. A framework for sustainable bioeconomy policy

55. The OECD has previously called for “innovative policy frameworks” for the bioeconomy to move forward to meet global challenges (OECD, 2009). These have been elusive. Other OECD work (OECD, 2011) has indicated that a balance of supply- and demand-side measures is needed to bring a technology forward. Governments are more prone to avoiding demand-side action for various reasons. Demand-side policies are particularly dependent on internationally agreed criteria in order to mitigate expected national rivalry during the global bioeconomy transition.

56. Marvik and Philp (2020) have proposed a policy framework that contains a temporal level of policy deployment (Figure 5). A policy mix does not imply a temporal strategy and a progression path for policy makers, i.e. it lacks any conception of a sequence of policy implementation. Marvik and Philp refined the approach by describing the mix of specific and general measures in a sequence from ideas to market, familiar to innovation policy makers. The approach may give policy makers a broader idea of how to construct a strategy that will connect and coordinate supply- and demand-side drivers to achieve a stronger and more robust effect on the economic system. For demand-side policies, temporal aspects such as the duration of market intervention, are particularly important: too long can lead to market distortion and too short may not enable the desired effect.

Figure 4. Bioeconomy policy in an innovation policy framework.

OBJECTIVES			
Stimulating availability of bio-resources	Strengthen skills and technology base	Trigger investments in new manufacturing	Increased sustainability and value creation
VALUE CHAIN SPECIFIC POLICIES			
Resource regulations and permits	Targeted R&D grant programmes	Public technology scale-up and pilot facilities	Product standards and norms
Transportation and logistics infrastructure	Specific education and training programmes	Financial support for first-in-kind (flagship) projects	Price subsidies and product tax policies
Feedstock specific trade regulations	Technology cluster and network support	Targeted government investments programmes	Product mandates and bans policies
GENERIC POLICIES			
Biomass sustainability assessment studies	Broad scope R&D grant programmes	Start-up and SME support	Sustainability labels and their communication
Governance and regulation efficiency	Tax incentives for applied R&D	Industry-oriented educating programmes	Public awareness and acceptance campaigns
Waste management policies	Stimulate international partnerships	Techno-economic feasibility studies	Tax on CO ₂ emissions
International trade agreements	Exchange programmes and apprenticeship	Private investment stimulating policies	Public procurement of bio-based products

Source: Adapted from Marvik and Philp (2020).

57. Table 6 illustrates some examples of national and international policy instruments.

Table 6. Bioeconomy policy instruments from around the world.

Type of policy	Examples
Biomass sustainability	Biomass Nippon Strategy (Japan); Biomass Commercialisation Strategy (Japan); Fundamental Law for Promotion of Biomass Utilization (Japan); Agro-ecological Zoning for Sugarcane Initiative (Brazil); Billion Ton Study (United States); Proposed International Biomass Dispute Settlement Facility (Netherlands); Research, Innovation and Competitiveness Strategy of the Energy Union (EURICS) (European Union)
R&D subsidy	Many dedicated and non-dedicated programmes in different countries to support industrial biotechnology and engineering biology research; Top Sectors Chemicals (Netherlands); Innovation Contract Bio-based Economy (Netherlands); Horizon 2020 (European Union); <i>Investissement d'Avenir</i> (France); BioNets programme (Finland), BIOSTRATEG (Poland); Strategy for Promotion of Industrial Biotechnology (Korea); Swedish Research and Innovation Strategy for a Bio-based Economy (Sweden)

Biorefinery financing: pilot, demonstration and flagship	Bio-based Industries Joint Undertaking (BBI JU) (European Union); Flagships of the BBI JU, such as FIRST2RUN (coordination Italy), AgriChemWhey (coordination Ireland); BIOMOTIVE (coordination Poland); InnovFin (European Investment Bank and European Commission); Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (United States); Centre for Process Innovation (CPI) (United Kingdom); the Norwegian BioCentre, NBioC (Norway), Biotep (Norway)
Novel and hybrid investment instruments	UK Green Investment Bank (United Kingdom); <i>La Banque publique d'investissement</i> (Bpifrance) (France); Green Bond Principles (International); International Biorefinery Competition (Finland)
Indirect incentives	Qualifying Renewable Chemical Production or Investment Tax Credit Act of 2015 / S. 2271 Renewable Chemicals Act (2015) (United States)
Technology and regional clusters	CLIB 2021 (Germany); IAR (France); BE-Basic (Netherlands); Bio-Vale (UK); SPRING (Italy); CINBIOS (Belgium); IBioC (Scotland), Bioeconomy Cluster (Slovakia);
International clusters	BIG-C (BioInnovation Growth mega-cluster) (Belgium, Germany, Netherlands); Bio Base NWE (Belgium, Germany, Ireland, Netherlands, United Kingdom); BSR STARS S3 (Nordic and Baltic states)
SME support	COSME (Competitiveness of Enterprises and SMEs) (European Union)
Mandates and targets	Renewable Fuels Standard (United States); Renewable Energy Directive (European Union)
Public procurement	USDA BioPreferred Program (United States); InnProBio, the Forum for Bio-Based Innovation in Public Procurement (European Union)
Carbon and emissions incentives	Climate Change and Emissions Management Fund (CCEMF) (Canada)
Standards and certification	Compostability DIN EN 13432 (Europe); Biodegradability ASTM D6400 (United States); The European Commission has issued four mandates to the European Committee for Standardization (CEN) on bio-based products including: elaboration of a standardisation programme for bio-based products; bio-polymers and bio-lubricants, bio-solvents and bio-surfactants, and; development of horizontal standards for bio-based products
Metrics, indicators, definitions, terminology	Bioeconomy Observatory (European Union); Fraunhofer ISI Business Unit Bioeconomy and Life Sciences (Germany);
Labelling	USDA BioPreferred Program (United States); Vincotte (Belgium), PEFC sustainable forestry (International);
Governance and regulation	Preservation, Management and Utilization of Marine Bioresources Act (Korea); Toxic Substances Control Act (United States); Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (European Union); The UK Synthetic Biology Roadmap (United Kingdom); Biorefineries Roadmap (Germany)
Skills and education	Two-year Post-MSc programme Designer in Bioprocess Engineering (Netherlands); NSF- Integrative Graduate Education and Research Traineeship (IGERT) (United States); US National Science Foundation Center for Biorenewable Chemicals (United States); Higher National Diploma (HND) in industrial biotechnology (Scotland); Master Biocirce (Italy); Master of Biotechnology and Bioinformatics (Australia); Specialist training facilities (NIBRT) (Ireland); edX MOOC in industrial biotechnology (Netherlands and Brazil); SynBio4All (France)
Communication and raising awareness	USDA BioPreferred Program (United States)

6.6. Continuing relevance

58. In terms of relevance, Table 7, which sets out Respondents views on the ongoing relevance of the Recommendation, is mostly green (77% of the total) and there is hardly any instance of 'obsolete'. Within the scores there are some anomalies. While some Respondents rated the specific recommendations in the instrument as high for relevance, they rated the instrument as a whole as still relevant but in need of updating. This is borne out by numbers: only 50% of the returns said that no updates were needed, while across the ten individual recommendations 77% of returns said no updates. These responses may reflect the fact that while many Respondents did not consider that the specific recommendations in the instrument required updating, a larger number felt that the definitions in the instrument may do. This element is explored further below.

59. It is noteworthy that the main reasons to advocate updates are:

- The Recommendation does not reflect the concept of circular economy. It pre-dated the most important documents on the circular economy concept, including the first European Union circular economy action plan. Another comment was that the Recommendation does not take enough account of the use of residuals, such as agricultural or forestry, or the cascading use of biomass (for an explanation of cascading use, see Keegan et al., 2013). Cascading use and the circular economy are intimately linked as cascading use makes more efficient use of resources that may otherwise be wasted.
- There needs to be more emphasis on the demand-side (market-making), especially public procurement.
- Climate change should be reflected.
- Comparison to non-bio-based and fossil equivalents is burdensome as finding the relevant data for these is not straightforward.

60. Both Japan and Korea returned that all of the specific recommendations, and therefore the instrument as a whole, need updating. Both countries have very low levels of implementation. Certainly the national bioeconomy strategy of Japan is very new, published in 2019, although its biomass policies go back to the beginning of the century e.g. the Biomass Nippon Strategy of 2002.

61. At the end of the exercise, the specific recommendation that was felt to require updates most is number 1. This is important as progress is predicated on national frameworks. The various national bioeconomy strategies that have been produced do not set out how a sustainable bioeconomy is to be achieved through specific policy interventions. The publication of some 50 national strategies or similar documents (Figure 4) is a significant achievement. Now is time for their implementation guided by policy frameworks.

Table 7. Relevance of the Recommendation overall and of the 10 individual specific recommendations contained therein.

Country	RO	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	SUM
Belgium	2	1	1	0	2	0	2	1	2	2	2	15
Canada	2	2	2	2	2	2	2	2	2	2	2	22
Czech Republic	2	2	2	2	2	2	2	2	2	2	2	22
Denmark	1	2	2	2	2	2	2	2	2	2	2	21
Estonia	2	2	2	2	2	2	2	2	2	2	2	22
Finland	2	2	2	2	2	2	2	2	2	2	2	22
France	1	1	2	2	2	2	2	2	2	2	2	20
Germany	1	2	1	2	2	2	2	2	2	2	2	20
Hungary	2	2	2	2	2	2	2	2	2	2	2	22
Israel	1	1	2	2	2	2	2	1	2	2	2	19
Italy	1	1	2	2	2	2	2	1	2	2	2	19
Japan	1	1	1	1	1	1	1	1	1	1	1	11
Korea	1	1	1	1	1	1	1	1	1	1	1	11
Latvia	2	2	2	2	2	2	2	2	2	2	2	22
Lithuania	1											1
Mexico	0	1	0	2	0	0	2	2	0	0	0	7
Netherlands	2	1	2	1	2	2	2	2	2	2	2	20
New Zealand	2	2	2	2	2	2	2	2	2	2	2	22
Norway	2	2	2	2	2	2	2	2	2	2	2	22

Poland	2	2	2	2	2	2	2	2	2	2	2	22
Portugal	1	1	2	2	2	2	2	2	2	2	2	20
Sweden	1	1	2	2	2	1	2	2	2	2	2	19
United Kingdom	2	2	2	1	2	2	2	2	2	1	2	20
United States	1	2	2	1	1	2	1	2	2	2	2	18
Namibia	2	2	2	2	2	2	2	2	2	2	2	22
South Africa	1	2	1	2	2	2	2	2	2	2	2	20
SUM	38	35	32	33	34	32	36	39	34	34	34	

Note: 0 = obsolete, 1 = relevant, needs updates, 2 = relevant, needs no further action. RO means ‘overall recommendation’. Capital R followed by a number refers to the individual recommendation.

Source: Survey questionnaire.

62. As most countries say “relevant / needs no further action”, there is little impetus to changes in this specific recommendation. However, some countries have not implemented some or all of the recommendations (see Table 4). It may be a worthwhile exercise to try to correlate responses that call for updates of the Recommendation with responses of no implementation. Perhaps countries have not implemented because they feel that the individual specific recommendations or the Recommendation as a whole need changes to accommodate their goals for the bioeconomy.

6.7. Relevance of the definitions of bioeconomy and bio-based products

63. There is a clearer justification for updating the definition of bioeconomy, not only from this exercise but from experience over the last decade. A small group of nations are indeed building their bioeconomy plans based on biotechnology, most notably the United Kingdom and the United States. However, for many countries the bioeconomy is being interpreted much more broadly. Consider that the European Union definition of bioeconomy does not contain the word ‘biotechnology’ at all, and yet the estimates of bioeconomy in Europe suggest that it constitutes well over 10% of Europe’s GDP. Indeed, while exactly half of the Respondents said that the overall Recommendation is still relevant and needs no updates, there was a much larger call for changes to the definitions. Only 9 of the 26 Respondents (about 35%) said that the two definitions – on “bioeconomy” and bio-based products”, respectively – have continued relevance with no further actions, with 16 saying that the definitions were still relevant but needed updates.

64. There were some conflicting views on the need for updating the two definitions. The use of the term biotechnology has divided Respondents on the definition of bioeconomy. One response suggested that using biotechnology in the definition reduces the clarity of the definition; biotechnology describes a multitude of different techniques and technologies. On the other hand, some countries put biotechnology at the forefront of their bioeconomies e.g. the United States. One country considered that the use of the term industrial biotechnology made the bioeconomy definition too narrow.

65. Across society at large, many are unfamiliar with the concept of ‘bio-based’ and with both its positive and negative connotations (Sijtsema et al., 2016). An interesting distinction between bioeconomy and bio-based products was made by Italy: this distinction allows separating primary (and traditional) sectors from more high added-value sectors. Another suggestion was that food and feed should not be excluded, given how the bioeconomy has been interpreted since 2012. The use of ‘domestic’ carries the risk that it could unintentionally leave out valid bio-based products that happen to include imported material.

66. There was a suggestion that the substitution approach (bio-based substituting fossil) is outdated. Certainly, it is noted that making the comparison in terms of the sustainability of bio- and fossil-derived products remains difficult for technical and regulatory reasons (Wu and Maravelias, 2019).

67. As a generalisation several Respondents felt that updates to the definitions should be made due to policy and events that have occurred since the Recommendation was published. There have been landmark documents on waste management, digitalisation, the circular economy and climate change that could be better reflected in the definitions. The definition of bioeconomy could be rewritten to make more emphasis on economic, social and environmental contributions.

6.8. Next steps

68. With the above summary and conclusions in mind, there appear to be a number of areas in which further work to support the implementation, relevance, and impact of the Recommendation would be important. As such, it is proposed that the CSTP, through the BNCT, assess the adequacy of the definitions used in the Recommendation and whether their revision could contribute to furthering harmonisation of policy making within and beyond the OECD Membership. In addition, it is proposed that Adherents focus on addressing the areas where implementation was revealed as low, in particular on engagement with non-Adherent non-OECD Members. To promote the impact and awareness of the Recommendation at a time when its relevance is as high as it has ever been, it is also proposed that Adherents, individually as well as through the CSTP and the Secretariat, work with relevant national and international organisations to facilitate broader dissemination of the Recommendation among relevant stakeholders to increase awareness and impact. In addition, in view of the responses of a number of Adherents, the CSTP, through the BNCT, may wish to consider further exploring issues such as the emergence of the concept of circular economy, cascading use, the need for more emphasis on the demand-side (market-making) including public procurement, climate change, and the difficulty of comparing bio-based to non-bio-based and fossil equivalents, and their relevance to the implementation of the Recommendation.

69. Following the completion of and with a view to leveraging the results of this review exercise, various in-person events have been planned during which the results could be disseminated. During 2020 this was limited to a series of virtual webinars planned for the work of the current Biennium to examine methodologies and indicators for a sustainable circular bioeconomy. The results will be part of a workshop in planning for June 2021 of the Presidency of Council of Ministers, Rome. The current working title for the workshop is: “Bioeconomy in the OECD countries: sharing and comparing the existing national strategies and policies for co-designing more effective Bioeconomy governance mechanisms and monitoring systems.”

70. Beyond the specific next steps outlined above, it is proposed that the CSTP, through the BNCT, continue to review the implementation, relevance, and dissemination of the Recommendation and report again to the Council thereon in five years’ time.

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