European Commission

The European Commission's Knowledge Centre for Bioeconomy

Report on the Community of Practice Workshop:

Web-based workshop series in preparation of launch of the EU Bioeconomy Monitoring System

June 16, 17 & 30 2020

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The workshop took place on the 16, 17 & 30 June 2020,
Venue: web-based

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Background & purpose of the workshop

The European Bioeconomy Strategy, updated in 2018, promotes a sustainable and circular bioeconomy that contributes to the climate-neutrality of the EU, the implementation of a circular economy, and puts emphasis on sustainable food and farming systems as well as on forestry and bio-based sectors. These principles are contributing mainly to two Commission priorities for 2019-2024: the "European Green Deal" and "An economy that works for people". Under the first priority, a sustainable and circular bioeconomy should contribute effectively to the decarbonisation of industry and furthermore support, with concrete actions, clean technology through bio-based innovation. Under the second priority, the European Bioeconomy Strategy is meant to encourage local bio-based innovation as well as to facilitate the modernisation of EU industries. Primary producers should benefit from the bioeconomy, and social rights are also considered in the priority guidelines. The environmental, economic and social dimensions of sustainability are considered to be the underlying governing framework that should ultimately address the contribution of the European Bioeconomy to the UN's Sustainable Development Goals (SDGs).

The updated Strategy puts forward an Action Plan to drive a sustainable and circular bioeconomy that serves Europe's society, environment and economy. Within this plan the European Commission (EC) commits to build an EU-wide, internationally coherent, monitoring system to track economic, environmental and social progress towards a sustainable bioeconomy. The EC's Joint Research Centre is leading this Action in collaboration with other EC services and with inputs from experts in the relevant fields.

According to the Action Plan of the European Bioeconomy Strategy, the bioeconomy monitoring system should cover all three pillars of sustainability (economic, social and environment); be coherent with other monitoring systems, especially at Member States' (MS) level; build upon existing internationally-shared frameworks; monitor impacts of the Bioeconomy within and outside the EU; report indicators related to the physical state of relevant resources of the terrestrial and aquatic ecosystems and their services, of primary production sectors in the EU and all industrial sectors that rely on biological resources; present the information in a user-friendly way, through dashboards and other interactive visualisations in the EC Knowledge Centre for the Bioeconomy; and undergo periodic review.

To enable contribution of experts in relevant fields coming from within the Commission services but also from academia, MS, industry and other organisations in the development of the EU bioeconomy monitoring system, the EC Knowledge Centre for Bioeconomy has organised three workshops during the development phase. A first workshop of the Community of Practice on Bioeconomy was held in Brussels in November 2018, entitled "Setting the scene for monitoring the economic, environmental and social progress of the EU Bioeconomy" and focussed on existing monitoring approaches for the bioeconomy or related fields. A second workshop was held in Ispra in June 2019, entitled: "Shaping the EU Bioeconomy Monitoring System: a first discussion on indicators to include", where JRC researchers collected feedback from colleagues and external, thematic experts on the proposed approach and on the preliminary list of basic indicators, including available methods to aggregate basic indicators. At this third workshop, experts have discussed **the relevance and completeness of the selected indicators** and explored **synergies between the EU-wide monitoring system with other systems at national, regional and local level**.

Purpose of the workshop:

- To provide input for the finalisation of selected indicators, in preparation for presentation to the core services of the EC involved in the implementation of the Bioeconomy Strategy
- To understand and enhance the synergies and exchanges between the EU-wide monitoring system, regional, national and local levels

Structure and set-up of the workshop

The workshop was divided into three days. The first day was dedicated to EU-level monitoring and discussions, the second day focussed on regional and national level monitoring and the third day was a one-hour webinar to summarise the outcomes of the first two days.

In the first day, three presentations were given to describe three separate European scale monitoring systems. Following the presentations, participants were invited to break-away sessions focussed on indicators to represent the different objectives of the Bioeconomy Strategy..

In the second day, eight speakers set the scene for the discussion on links between regional and national-level monitoring and the EU Bioeconomy Monitoring System. The participants were then invited to a break-away group to further elaborate ideas on this theme.

On the third day, the JRC summarised the preliminary conclusions from the workshop discussions and participants had the opportunity to ask questions and provide additional inputs.

Content of the workshop

Plenary session, Day 1 (June 16)

Sarah Mubareka, welcomed the participants reminding that the workshop was organised in the framework of the Community of Practice on Bioeconomy, which entails that the participants were invited as individuals to share expertise in their field, and not as representatives of organisations. The goal is to build jointly and impartially the EU bioeconomy monitoring framework based on the best available knowledge.

After highlighting the first milestones in the process for building the Monitoring System (inter alia, a JRC Technical Report and peer-reviewed publication) and presenting the objectives of the workshop, the first session of plenary presentations started.

Justus Wesseler (Wageningen University and Research, Netherlands). Biomonitor

Justus Wesseler presented the approach followed in the Biomonitor Project to assess the contribution of the bioeconomy towards the objectives of the updated European Bioeconomy Strategy. The ultimate goal is to build a statistic and modelling framework to quantify the development of the EU Bioeconomy. The economic, environmental and social impacts of this development will be measured through indicators, which could be then linked to the standardization of bio-based products by the European Committee of Standardization.

The Biomonitor conceptual framework is structured along four inter-linked and circular areas of analysis: policies, strategies and legislation; driving forces; societal challenges; and the use of biological resources.

From a methodological point of view, the framework follows a mass balance and the Engel's law of economics by which the contribution of the sectors composing the bioeconomy to the overall economy will decline in relative terms over time. Uncertainties, opportunity costs, irreversibility and the finite nature of profits are also considered in the assessment.

Currently, the Biomonitor framework includes 84 indicators and sub-indicators (Figure 1) which are sector-correlated (NACE economic activities classification) and can be extended depending on the relative unit of measurement in which the indicators are expressed (i.e. intensive indicators, e.g. per capita, share, etc.).

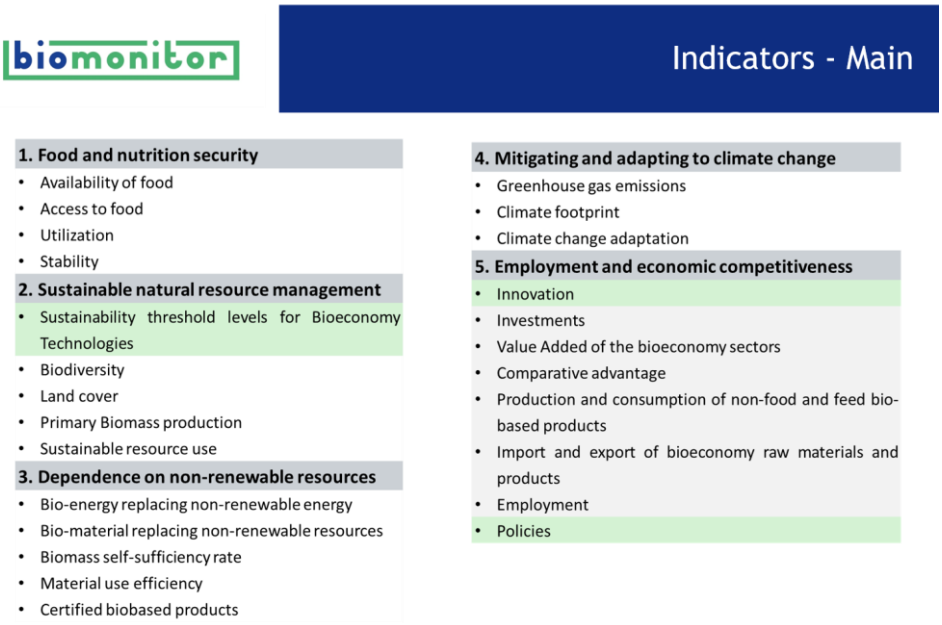


Figure 1. List of indicators included in the Biomonitor Monitoring Framework

Justus Wesseler presented a biomass flow analysis (Bio Flow Monitor) conducted for the chemical sector in The Netherlands, which is currently being developed for other countries as well as a time-series of value added based on Input-Output calculations. He stressed the importance of data availability and data analysis for these kinds of assessments.

The lessons learned from the Biomonitor exercise include the different indicator needs and requirements of bioeconomy stakeholders; the potential enlargement of basic indicators by the break down into time and geographical scales but also per capita, by unit produced, etc.; special focus on indicators related to innovation and entrepreneurship; differentiation between descriptive and prescriptive analysis; and the need for transparency in the methodology and data usage.

Uwe Fritsche (IINAS, Germany). Monitoring sustainability of bioenergy

Uwe Fritsche presented the work conducted by IEA Bioenergy with regards to sustainability assessment of bioenergy within the bioeconomy (not only in Europe but globally) and to the governance of sustainable biomass value chains. Various international organisations contribute to enabling such governance, like OECD, IRENA, FAO and many others, including the European Commission, which requires collaborative approaches supported by new and advanced indicators (in addition to the SDGs indicators).

The IEA Bioenergy Trask 45 is aiming to operationalise the sustainability of biomass while ensuring a sense of trust and a participatory process (including citizen engagement via citizen science tools). There is a need to assure that the financing of bioeconomy is actually sustainable for which certification is not enough. For that purpose, the IMMABS project (Indicators to measure, monitor and assess bioeconomy sustainability) seeks to generate a toolbox for a variety of assessment and monitoring scopes that may be of use in policymaking (e.g. DG DEVCO) and financing institutions (e.g. European Investment Bank). It is based on a set of "dominant" (core) indicators supported by proxies wherever data and methods are missing, possibly filled with citizen science data.

An example on indicators for assessing the sustainability of land in the SDGs was presented (Figure 2). It is composed by strategic and complementary indicators (which are region-specific) and for which correctness could be verified by citizens.

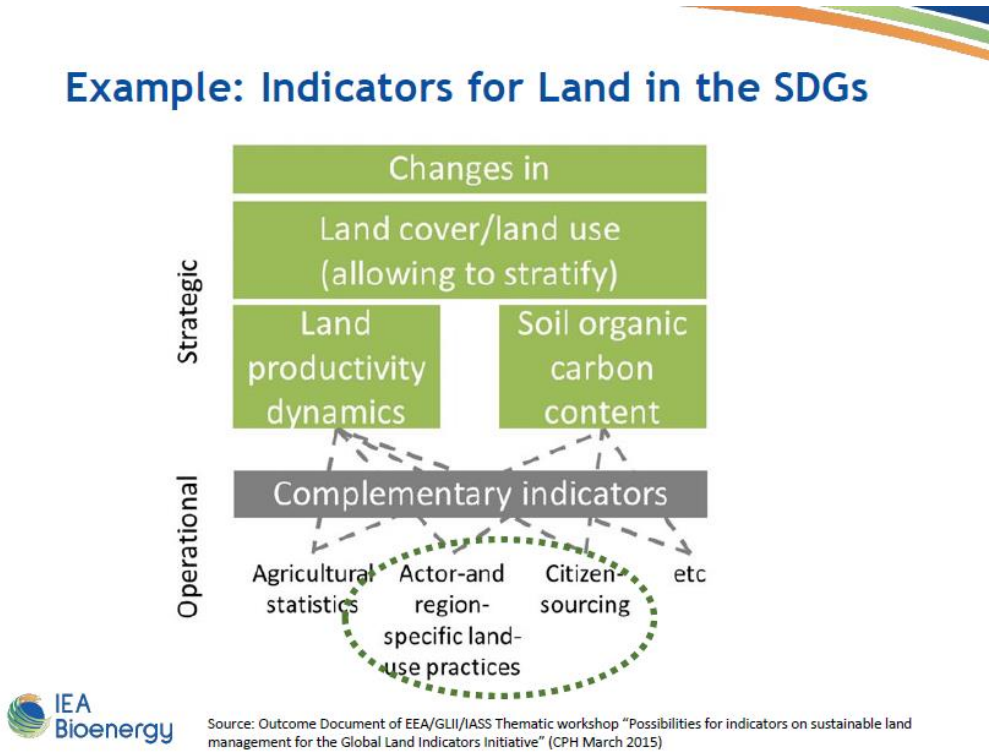


Figure 2: Indicators for Land in the SDGs

Jacopo Giuntoli (JRC). EU Bioeconomy Monitoring System

Jacopo Giuntoli presented the conceptual framework designed for the EU Bioeconomy Monitoring System to be populated with the basic indicators under discussion during the workshop. The Bioeconomy Strategy's objectives do not include operational criteria and therefore the monitoring system needed to be supported by two additional layers i) normative criteria and ii) key components. These additional layers disaggregate the system to an extent that allows its completion by basic indicators which may then be aggregated into system-level indicators to provide a meaningful message on the progress towards a sustainable and circular bioeconomy.

The 5 objectives (Figure 3) together with their normative criteria and key components were explained. They were inspired by similar exercises such as the ISBWG (International Sustainable Bioeconomy Working Group) and the MAES (Mapping and Assessment of Ecosystems and their Services) framework.

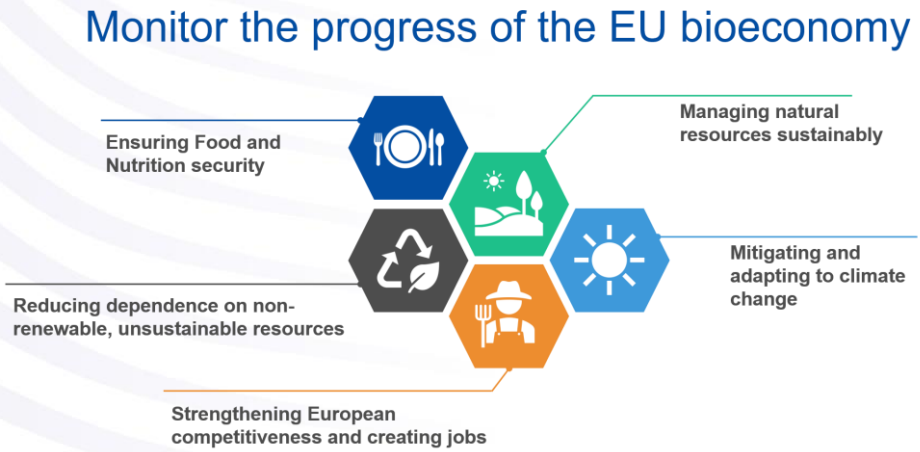


Figure 3. Objectives of the European Bioeconomy Strategy structuring the Monitoring Framework

The Monitoring System needs to be easily shared and used by the different stakeholders while capturing the holistic nature of the bioeconomy and covering all sectors in a balanced way. At the same time, the level of disaggregation of the indicators should allow the analysis of interlinkages, trade-offs and synergies. These requirements will eventually impact on the number of the selected indicators.

The framework was conceptualised so that it covers most of the SDGs and Green Deal objectives.

Q&A Session

The plenary presentations were followed by a Question and Answers session. The discussion was focused on:

- Indicators on climate footprint: modelling indicators assessing CO_2 emissions associated to the use of biomass via material flows (considering Carbon content of such materials). They are also linked to indicators on Carbon fertilisation as well as data on deadwood, which is being used as a proxy to assess biodiversity.
- External impacts are assessed by indicators on trade (imports) which should be complemented by indicators showing the impact on third countries. This impact is being quantified by product-LCA indicators to cover environmental impacts while social and economic impacts will be captured by other indicators and proxies.
- Impact from exports are not being comprehensively covered yet and should be further explored.
- The approach to follow in the process: releasing a wide range of indicators and leaving the decision makers to select the ones most suitable for their analysis vs. undergoing an expert analysis to release a small set of key composite indicators.

Parallel sessions, Day 1 (June 16)

Five parallel breakaway sessions, one for each objective of the Bioeconomy Strategy, took place. Each session was moderated by a JRC expert. During the registration phase, participants had been asked to choose two of the five objectives in which to participate. The five Strategy objectives are:

1. Ensuring Food and Nutrition Security
2. Managing Natural Resources Sustainably
3. Reducing dependence on non-renewable unsustainable resources
4. Mitigating and adapting to climate change
5. Strengthening European competitiveness and creating jobs

In this section, we report the main comments that were received by the JRC, both written and during the workshop. We then describe the actions taken with respect to these comments.

The overall comments revolved around concerns for the lack of a system-level view of the monitoring system in its current form. Indicators provide a detail view of specific aspects, but the bigger picture seems to be missing.

Ensuring Food and Nutrition Security

This session was moderated by Nicolas Robert and co-moderated by Javier Sanchez Lopez. Seventeen participants attended this session over two rounds. New indicators were proposed both during this session (as well as beforehand in writing).

Although the Strategy objective was said to be the most simple to assess, there were several comments particularly regarding (1) concerns about indicators on prices; (2) new value chains and new food products; (3) quality of food; (4) environmental impact (both domestic and abroad) of food production.

The list of indicators was subsequently modified, as described in the section below on “Outcomes of the workshop”.

Managing Natural Resources Sustainably

This session was moderated by Jose Barredo and co-moderated by Maria Teresa Borzacchiello. Fifteen participants attended this session over the two rounds. A summary was given of the material that had been received prior to the workshop. Many comments related to the comparability of the indicators across Member States, as well as the availability of such indicators. There were suggestions to merge or aggregate indicators. This particular group of indicators was the largest of all five Strategy Objectives with 82 indicators. Participating experts focused in particular on the fisheries and algae sectors. There were some split opinions, for example on the reliability of the land cover change indicators yet a recognition that this is an important indicator to monitor. The issue of linking with SDGs was also raised.

It was recognised that this objective of the Strategy is a complex one. Comments can be grouped into the following broad categories: (1) some concerns that the environmental impacts of the bioeconomy are not captured; (2) synergies with monitoring for CAP and at MS-level; (3) the significant resources required to monitor biodiversity; (4) the insufficient representation, via specific indicators, of soils which are fundamental to productivity. Other discussion points related to the overall picture these indicators are able to provide to assess the sustainability of the EU Bioeconomy.
Suggestions included to broaden the scope to life cycle assessment and footprint indicators using the German model as an example. This was followed up by the JRC through a telco with the University of Kassel, currently implementing this approach for Germany. JRC will follow the discussions in Germany on this approach. Some doubts emerged on the validity of some indicators and how they will be/ are measured: forest area that is not forested at some moments in time and deadwood because of different implications based on the latitude.

Again in this session, the issue of attribution of these indicators to bioeconomy was brought up.

The list of indicators was subsequently modified, as described in the section below on "Outcomes of the workshop".

Reducing dependence on non-renewable unsustainable resources

This session was moderated by Jacopo Giuntoli and co-moderated by Sarah Mubareka. Fourteen participants attended this session over the two rounds. In this session very few changes were proposed. Neither new indicators were proposed nor were any of the existing ones opposed. One possible new indicator emerged from the discussion on the quantification of residues from forests and agricultural land and the importance of this for bio-based industries (BBI) to be able to distinguish the uses of side-streams vs uses of dedicated crops. This concluded in the differentiation between biomass sources for the indicators related to products and energy from waste. Related to this, an interest in understanding how to improve efficiency along the value chain was expressed.

This session was very much focussed on the bigger picture of the monitoring system, with concerns being raised over the number of indicators to have in the system and how to proceed with the shortlisting; how to initiate MS-level harmonisation and compatibility with other monitoring systems. Again, an interest in the supply-chain level indicators came up as did the issue with the NACE classification not being bio-specific. Furthermore, although it was clear that the JRC list captures the bio-based component of solid municipal and household waste, it would be useful to consider the residues from the forests and agriculture sector. For forests this is already quantified, the difficulty is in quantifying the agricultural residues that are removed from the fields.

Subsequently the list of indicators was slightly modified, but several indicators were merged into parent indicators, thus simplifying the list. This is described in the section below on "Outcomes of the workshop".

Mitigating and adapting to climate change

This session was moderated by Marco Follador and co-moderated by Marios Avraamides. Twelve participants attended this session over the two rounds. In this session JRC described why the CAP indicators were so dominant, having been subject to previous discussions within the EC services (JRC, CLIMA and AGRI). Those indicators will be ready in 2021. The issue of management of agricultural land vs passive monitoring of the state of soils, for example, are important. Land management impacts are a part of the Objective 2 set of indicators under 'pressures'. Some doubts were raised on the relevance of forest fires as an indicator given the geographical relevance of this phenomenon. It was also suggested to look at pests or wind throw, which was taken on board, as described in the section below on "Outcomes of the workshop". It was suggested to refer to net removals in order to assess whether or not we are mitigating.

Strengthening European competitiveness and creating jobs

This session was moderated by Tévécia Ronzon and co-moderated by Lucia Parrino. The participants who attended this session went through the indicators one by one over the two sessions. Several were suggested to be discarded. An important source of information emerged for rural development: the FADN data for farmer income and income diversification.

It was recognised that although there are many gaps in this particular objective, it was important to identify wishful indicators. The Biomonitor project is foreseen to contribute to filling some of these gaps with JRC partners. The breakdown of these indicators by sector was repeated as being fundamental for many indicators in this objective. Indicators on Knowledge and Innovation in Bioeconomy fields were judged essentials but difficult to populate with data. As a follow-up of the workshop exchanges, contact has been made with the JRC authors of the Innovation scoreboard for which a match has been established between the International Patent Classification (IPC) and Societal Grand Challenges (SGCs), inter alia, the Bioeconomy.

Market mechanism and Resource competition were also assessed as difficult to inform with data.

Changes in the indicator set is further described in the section below on "Outcomes of the workshop".

Closing session, Day 1 (June 16)

Sarah Mubareka addressed the questions leading up the workshop regarding the procedure of the Monitoring Framework. She explained the process, from the framework design to the reporting, review and improvement of the system and highlighted that neither the procedure, nor the agents and responsible actors for the reporting phase have been yet decided. The next steps until the launch of the system (foreseen in November 2020), including the workshop follow-up and presentation of the system to the core EC services involved in the implementation of the Strategy were also presented. Experts were invited to provide feedback on the list of indicators if not done yet. It was explained that the JRC will report on the monitoring system at EU level but possibly in the future also at national level, in which case National Governments may be involved in the improvement of the system. The JRC will periodically release reports on the monitoring system every two years starting in 2021.

Outcomes of Day 1

As a result of the workshop, several adjustments have been made to the initial set of indicators. Of the original 220 indicators, 31 were dropped, 33 sub indicators were merged to 11 parent indicators, 4 were moved to different places in the framework and 7 (plus an additional 8 sub-indicators) were added for a current total number of indicators at 168.

Ensuring Food and Nutrition Security

There were originally 22 indicators for this objective, split into 2 normative criteria to describe the desired status related to this theme, further split into 7 key components that the JRC proposes to measure (figure 4).

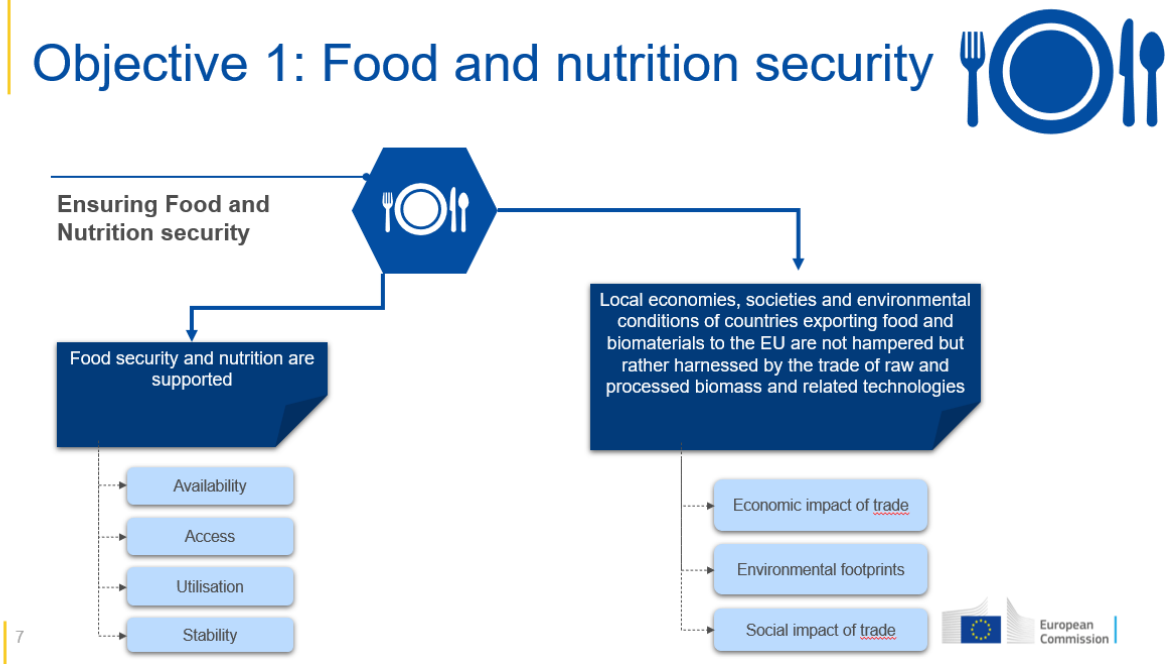


Figure 4. The normative criteria and key components related to the first objective of the Bioeconomy Strategy

Table 1 describes the original list of indicators as proposed by the JRC and the decisions taken for each of the indicators based on the workshop discussions.

Table 1. The indicators proposed by the JRC and the decision taken for each of the indicators based on the workshop discussions.

id	Name	Norm Crit	Key Comp	Decision on comments
1.1.a.1	Average dietary energy supply adequacy	Food security and nutrition are supported	Availability	Move to kc 1.1.c
1.1.a.2	Agricultural factor income per annual work unit (AWU)	Food security and nutrition are supported	Availability	Keep here even if related to rural income because used for SDG 02
1.1.a.3	Agricultural products	Food security and nutrition are supported	Availability	only focus on new products, 1.1.a.7-1.1.a.10 can replace this
1.1.a.4	Fish products	Food security and nutrition are supported	Availability	only focus on new products, 1.1.a.7-1.1.a.10 can replace this
1.1.a.5	Non-wood forest products	Food security and nutrition are supported	Availability	only focus on new products, 1.1.a.7-1.1.a.10 can replace this
1.1.a.6	New food products	Food security and nutrition are supported	Availability	https://ec.europa.eu/food/safety/novel_food_en
1.1.a.7	Total biomass supply for food purposes	Food security and nutrition are supported	Availability	add “including feed” in name (e.g. inputs)
1.1.a.8	Biomass of animal products directly consumed by humans	Food security and nutrition are supported	Availability	combine into one indicator; drop down menu to allow user to select
1.1.a.9	Biomass of fish products directly consumed by humans	Food security and nutrition are supported	Availability	combine into one indicator; drop down menu to allow user to select
1.1.a.10	Biomass of plant-based food directly consumed by humans including algae	Food security and nutrition are supported	Availability	combine into one indicator; drop down menu to allow user to select; algae not considered as a plant, create new subindicator for algae
1.1.b.1	Prevalence of moderate or severe food insecurity in the	Food security and nutrition are supported	Access	age=AllAge; units=%; choose series FIESMSI (=moderate and severe food insecurity)

	total population, yearly estimates			
1.1.b.2	Food price	Food security and nutrition are supported	Access	may be removed according to WS outcome
1.1.c.1	Prevalence of obesity in the adult population (18 years and older)	Food security and nutrition are supported	Utilisation	may be removed according to WS outcome
1.1.c.2	Daily calorie supply per capita by source	Food security and nutrition are supported	Utilisation	drop down list to allow users to select shares or totals to show dietary shifts (=new subindicator on shares)
1.1.c.3	Indicator concerning food quality, or food safety	Food security and nutrition are supported	Utilisation	Gap, maintain
1.1.d.1	Government support to agricultural research and development	Food security and nutrition are supported	Stability	input indicator
1.1.d.2	Fluctuation of Food prices (anomalies) / food price volatility	Food security and nutrition are supported	Stability	replace with purchasing price for food
1.1.d.3	Import dependency ratio of food (import/domestic production)	Food security and nutrition are supported	Stability	Gap, maintain
1.1.d.4	Value of food imports over total merchandise exports	Food security and nutrition are supported	Stability	
1.2.a.1	Economic impact of trade in exporting countries of food (to EU)	Local economies, societies and environmental conditions ..	Economic impact of trade in exporting countries of food (to EU)	Gap, maintain
1.2.b.1	Environmental footprints in exporting countries of food (to EU)	Local economies, societies and environmental conditions ..	Environmental footprints in exporting countries of food (to EU)	
1.2.c.1	Social impact of trade in exporting countries of food (to EU)	Local economies, societies and environmental conditions ..	Social impact of trade in exporting countries of food (to EU)	Gap, maintain

Table 2 describes the new indicators that were proposed during the workshop that are directly related to Objective 1 of the Bioeconomy Strategy, and the decision taken by the JRC.

Table 2. The indicators proposed by the workshop participants and the decision taken for each of the indicators by the JRC

Proposed indicator	**Decision**
Food purchasing power	ok included
Differentiate between fish from freshwater aquaculture, marine, shellfish for indicators "fish products", "biomass of fish products directly consumed by humans" and "biomass of plant-based food directly consumed by humans"	if data available, can be sub indicators of breakdown of 1.1.a.8-10
Same as above, but subcategorise if possible in cultured fish, shellfish and algae	if data available, can be sub indicators of breakdown of 1.1.a.8-10
Include aquaculture in "Government support to agricultural research and development"	input indicators will be dealt with separately
Protein per m2 (which I suppose can be calculated from yield, protein content and wet/dry ratio	complicated and not much added value
EU's self-sufficiency rate on protein for feed	ok included
%-share (or quantity) of novel protein rich products in total demand on protein for feed	Sub indicator as part of above indicator

Reflect the new value chains	ok, included
Food security: domestic and global demand can be catered? How will we deal with global demand?	we focus on EU, so global demand is not considered
Indicator on nutrition (not only calories)	proxy is 1.1.c.2 'Daily calorie supply per capita by source'
Break down into primary production sectors, for example daily calorie intake.	1.1.a.8-10 is by primary production
Feed Conversion Ratio: the quantity of feed required to produce a unit of animal protein (kind of feed and kind of animal protein are important here	ratio would be constant; better to use indicator related to inputs required (1.1.a.7)
Animal welfare	ok included
Biomass of algae products directly consumed by humans	ok included as sub indicator of 1.1.a.8-10

Thus in summary, for the first objective related to food and nutrition security:

- Four new indicators and seven new sub-indicators were taken on board;
- Six indicators were removed;
- Three indicators were merged to a single indicator;
- New total number of indicators: 18.

Managing Natural Resources Sustainably

There were originally 82 indicators for this objective, split into three normative criteria to describe the desired status related to this theme, further split into 9 key components JRC wishes to measure (figure 5).

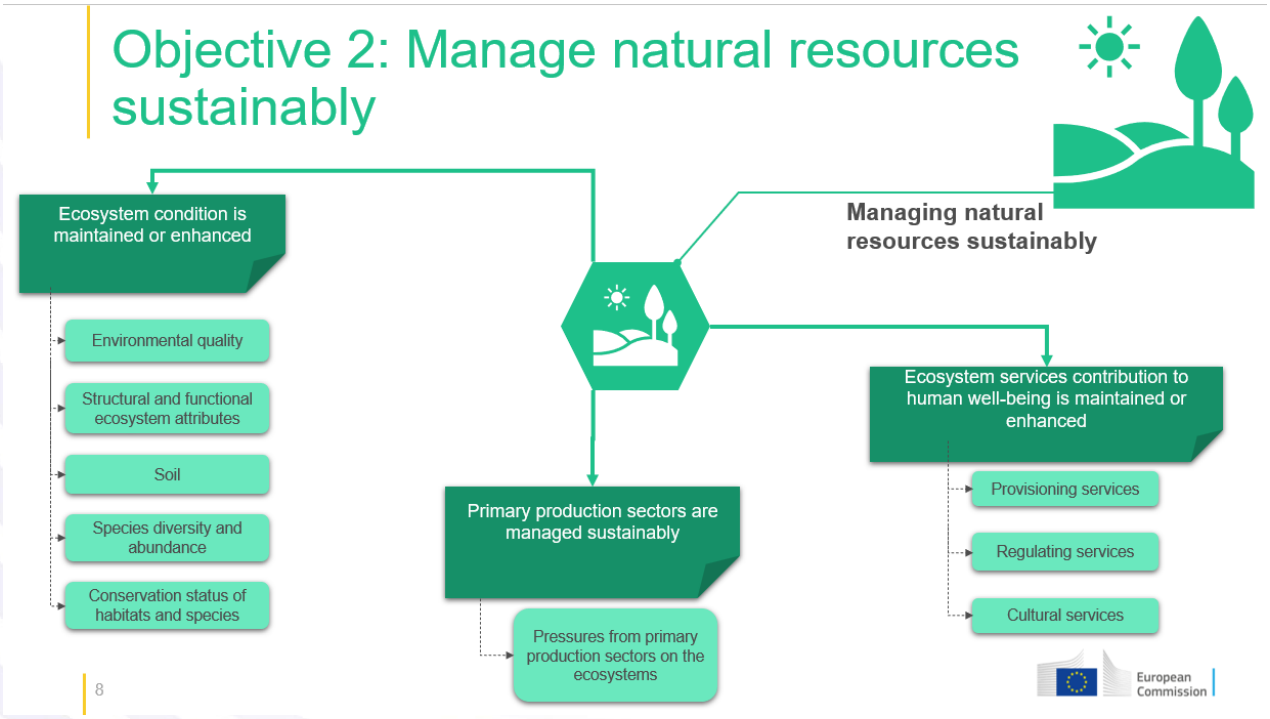


Figure 5. The normative criteria and key components related to the second objective of the Bioeconomy Strategy

Table 3 describes the original list of indicators as proposed by the JRC and the decisions taken for each of the indicators based on the workshop discussions.

Table 3. The indicators proposed by the JRC and the decision taken for each of the indicators based on the workshop discussions.

id	Name	Norm Crit	Key Comp	Decision on comments
2.1.a.1	Biochemical oxygen demand in rivers	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.2	Phosphate in rivers	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.3	Phosphorus in lakes	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.4	Nitrate in groundwater	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.5	Nitrate in rivers	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.6	Water Exploitation Index	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	move to objective 4: 4.1.b.3
2.1.a.7	Nutrients in transitional, coastal and marine waters	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.8	Chemical Status (composite indicator)	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	only 1 data point; change name to "CHEMICAL STATUS of groundwater, rivers, lakes, transitional and coastal waters"
2.1.a.9	Bathing water quality	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.a.10	Percentage of forest under management plan or equivalent	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	serious doubts of experts, about the message this is giving. May not be meaningful and certainly not comparable across MS
2.1.a.11	Critical load exceedance for nitrogen	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	to be replaced by AIR 004 (CSI 005): Exposure of Europe's ecosystems to acidification, eutrophication and ozone (suggested by EEA)
2.1.a.12	Exposure of forest area to ozone in EEA member countries	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	complicated to compute; not much added value and for forests, more relevant to develop under obj 4
2.1.a.13	Exceedance of air quality standards in urban areas	Ecosystem capacity to produce services is maintained or enhanced	Environmental quality	
2.1.b.1	Percentage area of urban green space (or percentage of natural area within the city boundaries)	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.2	Landscape fragmentation Index	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.3	Share of High Nature Value farmland in agricultural area	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.4	Share of organic farming in utilised agricultural area	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	start series from 2012 only, when all countries start to report.
2.1.b.5	Livestock density index	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.6	Forest fragmentation and connectivity index	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	although seems redundant with 2.1.b.2 this is about connectivity. and refers to forests only Rename indicator

				"CONNECTIVITY of forests"; sub indicator wildlife corridor of possible
2.1.b.7	Deadwood	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.8	Share of forest area	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	
2.1.b.9	Forest growing stock	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	Growing stock of forests and woodland, unit thousand cubic meters. If possible, choice in drop down menu: forests or forests&woodland
2.1.b.10	Ecological status of European waters	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	only 1 datapoint, BUT if we could recreate it as time series based on all other indicators above on nutrient load, it would be ideal.
2.1.b.11	Fish stock biomass	Ecosystem capacity to produce services is maintained or enhanced	Structural and functional ecosystem attributes	replace spawning and fish stock by index ; regionalisation by macro-regions; could rename to match JRC terminology "Conservation Status"
2.1.c.1	Soil organic carbon content	Ecosystem capacity to produce services is maintained or enhanced	Soil	Move to objective 4
2.1.d.1	Common farmland bird Index, EU aggregate	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	select species "common farmland species"; merge 2.1.d.1-2.1.d.3, use drop down list to differentiate
2.1.d.2	Common forest bird index, EU aggregate	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	select species "common forest species"; merge 2.1.d.1-2.1.d.3, use drop down list to differentiate
2.1.d.3	Grassland butterfly index, EU aggregate	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	merge 2.1.d.1-2.1.d.3, use drop down list to differentiate
2.1.d.4	Spawning Stock Biomass	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	JRC has analysed this data for CFP report; change to index , 100=2003; combine with 2.1.b.11
2.1.d.5	Age and size distribution of commercially-exploited fish species	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	if data will never be available, remove (Cecilia's comment) or make candidate for oblig. reporting?
2.1.d.6	Fish population abundance (Baltic sea)	Ecosystem capacity to produce services is maintained or enhanced	Species diversity and abundance	We only found data source for Baltic, are others available too? similar to 2.1.b.11. Could be replaced by EEA Status of marine fish and shellfish stocks in European seas? (row 60, "suggested.."
2.1.e.1	Surface of terrestrial sites designated under NATURA 2000	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	merge 2.1.e.1-2.1.e.4, use drop down list to differentiate; can replace 2.1.e.2 and 2.1.e.3. To differentiate between UAA and forests is more informative, but the problem is the indicator on forests is unFAIR
2.1.e.2	Share of forest area under Natura 2000	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	
2.1.e.3	Share of UAA under Natura 2000	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	merge 2.1.e.1-2.1.e.4, use drop down list to differentiate
2.1.e.4	Surface of marine sites designated under NATURA 2000	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	merge 2.1.e.1-2.1.e.4, use drop down list to differentiate

2.1.e.5	Conservation Status of European Habitats	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	
2.1.e.6	Conservation status of grassland	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	
2.1.e.7	Conservation Status of European Species	Ecosystem capacity to produce services is maintained or enhanced	Conservation status of habitats and species	only 1 data point in 2015 for all EU in EEA
2.2.a.1	Industrial roundwood removals	Primary production sectors are managed sustainably	Pressures from Forest Management	
2.2.a.2	Long term ratio of annual fellings (m3/ha/year) to net annual increment (m3/ha/year)	Primary production sectors are managed sustainably	Pressures from Forest Management	change name to match Eurostat name: "Share of fellings in NAI calculated over 5 year periods"
2.2.a.3	Fraction of primary residues remaining in forest	Primary production sectors are managed sustainably	Pressures from Forest Management	
2.2.a.4	Increase in Ecosystems extent: Forest and woodland	Primary production sectors are managed sustainably	Pressures from Forest Management	uncertainty high; focus on land take from valuable ecosystems, e.g. grassland.
2.2.a.5	Land take from forest	Primary production sectors are managed sustainably	Pressures from Forest Management	uncertainty is too high, to rely on CLC is not very robust
2.2.a.5	Fragmentation by roads and other linear features	Primary production sectors are managed sustainably	Pressures from Forest Management	2.1.b.6 measures all fragmentation, not only by roads. Roads are available form OSL but these do not include logging roads, which would be more interesting than just ordinary roads.
2.2.a.6	Fragmentation by forest cover loss	Primary production sectors are managed sustainably	Pressures from Forest Management	redundant
2.2.a.7	Critical load exceedance for nitrogen	Primary production sectors are managed sustainably	Pressures from Forest Management	not a pressure from forest management
2.2.a.8	Formation of tropospheric ozone (ground level ozone)	Primary production sectors are managed sustainably	Pressures from Forest Management	not a pressure from forest management
2.2.a.9	Number of annual introductions of invasive alien species in forests	Primary production sectors are managed sustainably	Pressures from Forest Management	EEA discontinued this measure; lost suggests this as an adaptation measure to be placed in Objective 4
2.2.a.10	Certified forests	Primary production sectors are managed sustainably	Pressures from Forest Management	cannot find data sources in websites
2.2.b.1	Contaminants	Primary production sectors are managed sustainably	Pressures from marine fisheries & aquaculture management	although these are pressures, they are not pressures of the fisheries sector per se; covered in status indicators
2.2.b.2	Nutrient discharge	Primary production sectors are managed sustainably	Pressures from marine fisheries & aquaculture management	could be a pressure from fisheries aquaculture, but no data is available
2.2.b.3	Fish catch	Primary production sectors are managed sustainably	Pressures from marine fisheries & aquaculture management	Revise name of indicator to match JRC terminology "exploitation level"
2.2.b.5	Fish mortality of commercially exploited fish and shellfish exceeding fishing mortality at maximum sustainable yield	Primary production sectors are managed sustainably	Pressures from marine fisheries & aquaculture management	
2.2.b.6	Number of annual introductions of invasive alien species in water	Primary production sectors are managed sustainably	Pressures from marine fisheries & aquaculture management	does not seem to be available at all
2.2.c.1	Change in Ecosystems extent: Rivers and lakes	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	uncertainty is too high, rivers and lakes grow and shrink

				constantly and to rely on CLC is not very robust
2.2.c.2	Land take (from rivers and lakes and wetlands)	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	uncertainty is too high, rivers and lakes grow and shrink constantly and to rely on CLC is not very robust
2.2.c.3	Critical load exceedance for nitrogen	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	although these are pressures, they are not pressures of the fisheries sector per se; covered in status indicators
2.2.c.4	Gross nitrogen balance	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	although these are pressures, they are not pressures of the fisheries sector per se; covered in status indicators
2.2.c.5	Gross phosphorus balance	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	although these are pressures, they are not pressures of the fisheries sector per se; covered in status indicators
2.2.c.6	Number of annual introductions of invasive alien species in freshwater	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	If it is discontinued, we should not include
2.2.c.7	Size of the aquaculture production units	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	no data available for algae. For fish maybe but density would be more meaningful. Impact on land footprint.
2.2.c.8	Number of integrated multi-trophic aquaculture production units	Primary production sectors are managed sustainably	Pressures from freshwater fisheries & aquaculture management	positive, because multi-trophic therefore reducing environmental impact
2.1.d.1	Gross nitrogen balance	Primary production sectors are managed sustainably	Pressures from agroecosystems	not a pressure from management
2.2.d.2	Gross phosphorus balance	Primary production sectors are managed sustainably	Pressures from agroecosystems	not a pressure from management
2.2.d.3	Ammonia emissions from agriculture	Primary production sectors are managed sustainably	Pressures from agroecosystems	also in Obj. 4 under all emissions combined
2.2.d.4	Land take (from cropland/grassland)	Primary production sectors are managed sustainably	Pressures from agroecosystems	uncertainty is too high, to rely on CLC is not very robust
2.2.d.5	Change in Ecosystems extent: cropland & grassland	Primary production sectors are managed sustainably	Pressures from agroecosystems	uncertainty is too high
2.2.d.6	Number of annual introductions of invasive alien species	Primary production sectors are managed sustainably	Pressures from agroecosystems	
2.2.d.7	Intensification / extensification: high input farms / total farms	Primary production sectors are managed sustainably	Pressures from agroecosystems	add sector to indicator name
2.2.d.8	Loss of soil organic matter	Primary production sectors are managed sustainably	Pressures from agroecosystems	
2.2.d.9	Extent of other ecosystem (natural ecosystems)	Primary production sectors are managed sustainably	Pressures from agroecosystems	high uncertainty
2.2.d.10	Sales of pesticides	Primary production sectors are managed sustainably	Pressures from agroecosystems	
2.2.d.11	Soil erosion by water	Primary production sectors are managed sustainably	Pressures from agroecosystems	difficult to link to management
2.3.a.1	Biomass production from agriculture	Ecosystem services contribution to human well-being is maintained or enhanced	Provisioning services	combine into one indicator; add biomass production from waste
2.3.a.2	Biomass production from Forestry	Ecosystem services contribution to human	Provisioning services	combine into one indicator; add biomass production from waste

		well-being is maintained or enhanced		
2.3.a.3	Biomass production from fisheries and aquaculture	Ecosystem services contribution to human well-being is maintained or enhanced	Provisioning services	combine into one indicator; add biomass production from waste
2.3.a.4	Biomass production from algae	Ecosystem services contribution to human well-being is maintained or enhanced	Provisioning services	combine into one indicator; add biomass production from waste
2.3.b.1	Flood regulation	Ecosystem services contribution to human well-being is maintained or enhanced	Regulating services	drop down selection for INCA - Flood Control, ES Flow, Demand, Potential, unmet demand, monetary values - 2006-2012
2.3.b.2	Air quality	Ecosystem services contribution to human well-being is maintained or enhanced	Regulating services	
2.3.c.1	Aesthetics considerations of nature	Ecosystem services contribution to human well-being is maintained or enhanced	Cultural services	
2.3.c.2	Unmet demand of recreation services / Access	Ecosystem services contribution to human well-being is maintained or enhanced	Cultural services	drop down selection for INCA - Recreation, ES Flow, Demand, Potential - 2000-2006-2012. Change name of indicator accordingly
2.3.c.3	Net ecosystem productivity	Ecosystem services contribution to human well-being is maintained or enhanced	Cultural services	

Table 4. The indicators proposed by the workshop participants and the decision taken for each of the indicators by the JRC

Proposed indicator	**Decision**
Wildlife corridors	Not sure if we know which are the corridors used by wildlife, if yes, can be sub indicator of 2.1.b.6
Threatened tree species in forests	ok to include
"human appropriated net primary production" proportion primary production used by humans	Corresponds to long term ratio of annual fellings (m3/ha/year) to net annual increment (m3/ha/year)

Thus in summary, for the second objective related to sustainable management:

- One new indicators and one new sub-indicator were taken on board;
- Twenty indicators were removed;
- Thirteen indicators are pending decision whether or not to remove
- Eleven indicators were merged into three indicators;
- New total number of indicators: 52

Reducing dependence on non-renewable unsustainable resources, whether sourced domestically or from abroad

There were originally 45 indicators for this objective, split into six normative criteria to describe the desired status related to this theme, further split into 12 key components JRC wishes to measure (figure 6).

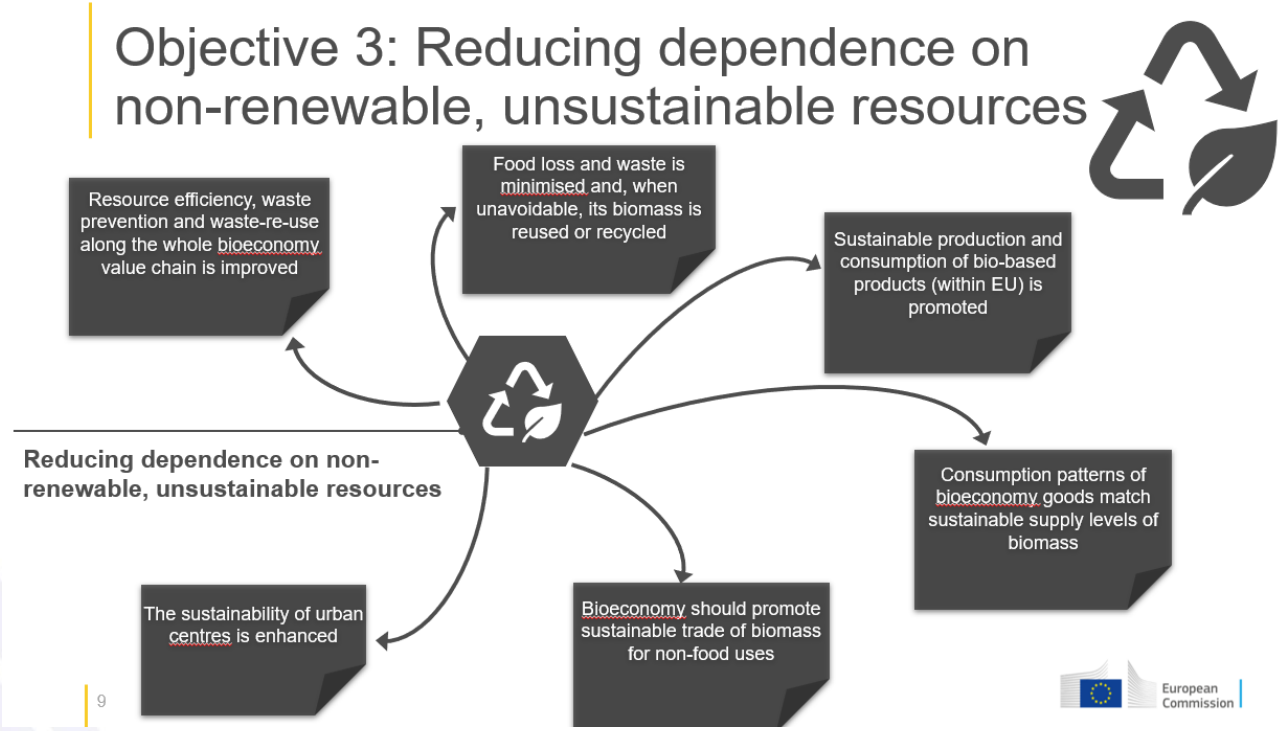


Figure 6. The normative criteria related to the third objective of the Bioeconomy Strategy

Table 5 describes the original list of indicators as proposed by the JRC and the decisions taken for each of the indicators based on the workshop discussions.

Table 5. The indicators proposed by the JRC and the decision taken for each of the indicators based on the workshop discussions.

id	Name	Norm Crit	Key Comp	Decision on comments
3.1.a.1	Domestic Material Consumption (Biomass)	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Resource efficiency (Material footprint)	env_ac_mfa
3.1.a.2	Material Footprint (Biomass)	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Resource efficiency (Material footprint)	in xls sheet filter, tab='country data'; unit= 'tonnes/cap'; indicator id='854' (biomass)
3.1.a.3	Land footprint IN EU of EU consumption (for non-food&feed)	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Resource efficiency (Material footprint)	
3.1.b.1	Energy productivity	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Energy efficiency	provides a picture of the degree of decoupling of energy use from growth in GDP
3.1.b.2	Share of renewable energy in gross final energy consumption	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Energy efficiency	

3.1.b.3	Share of renewable energy in gross final energy consumption of bio based industries or bioenergy industries	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Energy efficiency	
3.1.c.1	Cascading factor of wood resources	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	indicator unique to JRC; we have three estimates of primary sources. One is the reported value from JFSQ (FAOSTAT), the other two are estimates we got from the declared uses (a minimum and a maximum value, both larger than the reported value). So we cannot provide just one factor, but we need to provide at least two estimates of this factor (a range where the true value is expected to lay).
3.1.c.2	Circular material rate	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	
3.1.c.3	Final Energy Consumption from renewable municipal waste	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	
3.1.c.4	Recycling rate of bio-waste	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	
3.1.c.5	Energy from biomass waste or residues	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	indicator unique to JRC, reproducible.
3.1.c.6	Products from biomass waste or residues	Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved	Biogenic waste prevention, re-use/recycling, and recovery	
3.2.a.1	Food loss index	Food loss and waste is minimised and, when unavoidable, its biomass is reused or recycled	Food loss and waste minimization	JRC is working on this, wait for results. From FAO we only have 1 year of data (2016)
3.2.a.2	Food Waste Index	Food loss and waste is minimised and, when unavoidable, its biomass is reused or recycled	Food loss and waste minimization	JRC is working on this, wait for results
3.2.a.3	JRC Food waste indicator	Food loss and waste is minimised and, when unavoidable, its biomass is reused or recycled	Food loss and waste minimization	
3.3.a.1	Environmental impacts based on product-based LCA and basket of representative products of the bioeconomy	Bioeconomy should promote sustainable production and consumption of biomass and bio-based products (within EU)	Bio-based products environmental impacts	
3.4.a.1	Import dependency of wood resources	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Consumption and demand for biomass and bio-based products	

3.4.a.2	Import dependency of biofuels	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Consumption and demand for biomass and bio-based products	
3.4.a.3	Import dependency of bioenergy	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Consumption and demand for biomass and bio-based products	
3.4.a.4	Total biomass consumed for energy	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Consumption and demand for biomass and bio-based products	indicator unique to JRC; combine 3.4.a.4 & 3.4.a.5 into one indicator; drop down menu to allow user to select
3.4.a.5	Total biomass consumed for materials	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Consumption and demand for biomass and bio-based products	indicator unique to JRC; combine 3.4.a.4 & 3.4.a.5 into one indicator; drop down menu to allow user to select
3.4.b.1	Bioethanol and pure biogasoline (indigenous) production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	merge 3.4.b.1, 3.4.b.2, 3.4.b.4 (all liquid biofuels) & have drop down menu [nrg_inf_lbpc]
3.4.b.2	Pure biodiesels (indigenous) production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	merge 3.4.b.1, 3.4.b.2, 3.4.b.4 (all liquid biofuels) & have drop down menu [nrg_inf_lbpc]
3.4.b.3	Biogasses (indigenous) production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	table is tricky, shows commodity on row and take geo requests one at a time
3.4.b.4	Pure bio jet kerosene and other liquid biofuels (indigenous) production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	merge 3.4.b.1, 3.4.b.2, 3.4.b.4 (all liquid biofuels) & have drop down menu [nrg_inf_lbpc]
3.4.b.5	Wood fuels production (wood used for energy)	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	indicator unique to JRC; combine 3.4.b.5 & 3.4.b.6 into one indicator; drop down menu to allow user to select
3.4.b.6	Wood-products (non-energy) production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	indicator unique to JRC; combine 3.4.b.5 & 3.4.b.6 into one indicator; drop down menu to allow user to select
3.4.b.7	Bio-based plastics production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	qualify by changing name "mass of"?
3.4.b.8	Bio-based textiles production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	qualify by changing name "mass of"?
3.4.b.9	Bio-based chemicals production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	qualify by changing name "mass of"?
3.4.b.10	Advanced biofuels production	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Production of bio-based products	

3.4.c.1	Transport energy from biofuels	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	RES-T in line 34 of source file; 3.4.c.1, 3.4.c.2, 3.4.c.3 can be merged
3.4.c.2	Total electricity from biomass	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	RES-E in line 16 of source file; 3.4.c.1, 3.4.c.2, 3.4.c.3 can be merged
3.4.c.3	Total heat from biomass	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	RES-H&C in line 44 of source file; 3.4.c.1, 3.4.c.2, 3.4.c.3 can be merged. Add to name "..& cooling"
3.4.c.4	Final consumption of fossil sources in EU (solid, gaseous, liquid)	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	if we have this data we create a new indicator by summing all energy consumed, be it fossil or renewable -based.
3.4.c.5	Wood-based constructions	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	change name to "share of"
3.4.c.6	Bio-based plastics	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	change name to "share of"
3.4.c.7	Bio-based textiles	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	change name to "share of"
3.4.c.8	Bio-based chemicals	Consumption patterns of bioeconomy goods match sustainable supply levels of biomass	Reduced dependence on non-renewable resources	change name to "share of"
3.5.a.1	Economic impact of trade in exporting countries of non-food (to EU)	Local economies of countries exporting non-food commodities to the EU are not hampered but rather harnessed by the trade of raw and processed biomass and related technologies	Economic impact of trade in exporting countries of non-food (to EU)	
3.5.b.1	Environmental footprints in exporting countries of non-food (to EU)	Local economies of countries exporting non-food commodities to the EU are not hampered but rather harnessed by the trade of raw and processed biomass and related technologies	Environmental footprints in exporting countries of non-food (to EU)	
3.5.c.1	Social impact of trade in exporting countries of non-food (to EU)	Local economies of countries exporting non-food commodities to the EU are not hampered but rather harnessed by the trade of raw and processed biomass and related technologies	Social impact of trade in exporting countries of non-food (to EU)	
3.6.a.1	Self-assessed satisfaction with recreational and green areas	The sustainability of urban centres is enhanced	Enhanced well-being and health of urban dwellers	
3.6.a.2	Self-assessed satisfaction with living environment	The sustainability of urban centres is enhanced	Enhanced well-being and health of urban dwellers	

3.6.a.3	Self-assessed overall life satisfaction	The sustainability of urban centres is enhanced	Enhanced well-being and health of urban dwellers	

No new indicators were proposed for this objective.

Thus in summary, for the third objective related to reducing dependencies on non-renewables:

- No new indicators were proposed;
- No indicators were removed;
- Sixteen indicators were merged into six indicators;
- New total number of indicators: 32

Climate change mitigation and adaptation are pursued

There were originally 21 indicators for this objective, split into 2 normative criteria to describe the desired status related to this theme, further split into 3 key components JRC wishes to measure (figure 7).

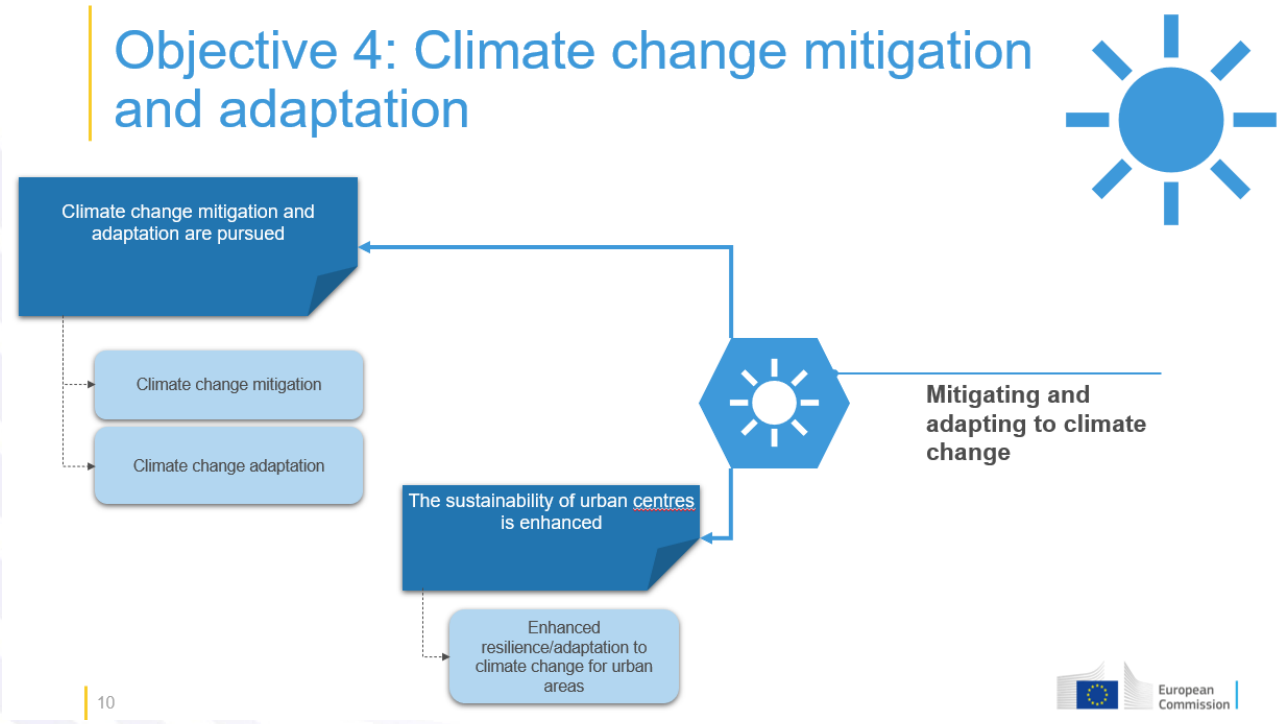


Figure 7. The normative criteria related to the fourth objective of the Bioeconomy Strategy

Table 6 describes the original list of indicators as proposed by the JRC and the decisions taken for each of the indicators based on the workshop discussions.

Table 6. The indicators proposed by the JRC and the decision taken for each of the indicators based on the workshop discussions.

id	Name	Norm Crit	Key Comp	Decision on comments
4.1.a.1	net GHG emissions (emissions and removals) from bioenergy (absolute and relative vs. total sector emissions)	Climate change mitigation and adaptation are pursued	Climate change mitigation	to be computed by JRC
4.1.a.2	net GHG emissions (emissions and removals) from BBI (absolute and relative vs. total industrial emissions)	Climate change mitigation and adaptation are pursued	Climate change mitigation	to be computed by JRC
4.1.a.3	net GHG emissions (emissions and removals) from agriculture	Climate change mitigation and adaptation are pursued	Climate change mitigation	combine 4.1.a.3 & 4.1.a.6 into one indicator ; drop down menu to allow user to select
4.1.a.4	net GHG emissions (emissions and removals) from bio-waste (absolute and relative vs. total waste emissions)	Climate change mitigation and adaptation are pursued	Climate change mitigation	to be computed by JRC
4.1.a.5	GHG emissions from fishing and aquaculture	Climate change mitigation and adaptation are pursued	Climate change mitigation	
4.1.a.6	net GHG emissions (emissions and removals) from LULUCF	Climate change mitigation and adaptation are pursued	Climate change mitigation	
4.1.a.7	Financial support to bio-based sectors (climate action)	Climate change mitigation and adaptation are pursued	Climate change mitigation	input indicator
4.1.b.1	Climate change indices (country level precipitation and temp)	Climate change mitigation and adaptation are pursued	Climate change adaptation	Not immediate. Requires JRC technical help to decipher
4.1.b.2	Crop yield (3 main crops)	Climate change mitigation and adaptation are pursued	Climate change adaptation	[apro_csph1 $ harvest production in eu standard humidity (1000 t) / apro_csph1 $ area cultivation/harvested/production (1000ha)] - allow user to choose crop (there are 4: pulses, vegetables, grassl, permCrops)
4.1.b.3	Water abstraction (WEI)	Climate change mitigation and adaptation are pursued	Climate change adaptation	
4.1.b.4	Soil moisture (seasonal average)	Climate change mitigation and adaptation are pursued	Climate change adaptation	
4.1.b.5	Soil erosion	Climate change mitigation and adaptation are pursued	Climate change adaptation	
4.1.b.6	Share of farmers with CAP risk management tools (insurance)	Climate change mitigation and adaptation are pursued	Climate change adaptation	specify in name "Adaptation in agriculture:..."
4.1.b.7	Share of agricultural land under commitments to improve adaptation (ha)	Climate change mitigation and adaptation are pursued	Climate change adaptation	specify in name "Adaptation in agriculture:..."
4.1.b.8	Sustainable water use: share of irrigated land under commitments to improve water balance	Climate change mitigation and adaptation are pursued	Climate change adaptation	

4.1.b.9	Adaptation in forest: # fire instances	Climate change mitigation and adaptation are pursued	Climate change adaptation	not easy to find data in EFFIS
4.1.b.10	Adaptation in fishery: Potential catch	Climate change mitigation and adaptation are pursued	Climate change adaptation	
4.1.b.11	MS Preparedeness - Year of adoption of NAS/NAP:	Climate change mitigation and adaptation are pursued	Climate change adaptation	
4.2.b.12	International Transboundaries effects - loss in GDP	Climate change mitigation and adaptation are pursued	Climate change adaptation	Data in PESETA reports
4.2.a.1	City preparedeness - # cities signatories of COM - Adaptation	The sustainability of urban centres is enhanced	Enhanced resilience/adaptation to climate change for urban areas	
4.2.a.2	Investments in urban adaptation through nature-based infrastructures or EBA	The sustainability of urban centres is enhanced	Enhanced resilience/adaptation to climate change for urban areas	

Table 7. The indicators proposed by the workshop participants and the decision taken for each of the indicators by the JRC

Proposed indicator	**Decision**
Burnt area	ok to include
Emissions from non-EU fishing vessels	To verify data availability
Damages due to storm events in forest	Very relevant, could also apply to agri. Data in NFI? Ok to add
Refer to practices too, e.g. no-till or carbon farming. May be available under CAP or use RS as a basis	Will follow CAP indicators; objective 2 contains 'pressures' indicators from the different primary production sectors
GHG by land use	GHG for each sector is already planned to be reported. Only LULUCF and agri sectors have available data. JRC has to further test their approach to dissociate the BBI sectors, hopefully by 2021 we will have it
NET GHG emissions for all sectors	Could be an aggregate indicator in the future, for now we leave disaggregated
Degree of specialisation by primary producers	There is an indicator related to this in Objective 5 under rural income diversification but it is true that we may see it as a resilience indicator to CC.
Adaptation in fisheries to include aquaculture as well	This can be a sub-indicator if data is found

Thus in summary, for the second objective related to climate change:

- Two new indicators and one new sub indicator were taken on board; and one was moved from objective 2 to this one
- No indicators were removed;
- no indicators were merged;
- New total number of indicators: 24

Strengthening European competitiveness and creating jobs

There were originally 50 indicators for this objective, split into 6 normative criteria to describe the desired status related to this theme, further split into 18 key components JRC wishes to measure (figure 8).

Figure 8. The normative criteria related to the fifth objective of the Bioeconomy Strategy

Table 8 describes the original list of indicators as proposed by the JRC and the decisions taken for each of the indicators based on the workshop discussions.

Table 8. The indicators proposed by the JRC and the decision taken for each of the indicators based on the workshop discussions.

id	Name	Norm Crit	Key Comp	Decision on comments
5.1.a.1	Contribution of the Bioeconomy to GDP	Economic development is fostered	Contribution of bioeconomy to economic development	Need to normalise by GDP. Need source link for GDP data
5.1.a.2	Value Added per sector / Bioeconomy value added	Economic development is fostered	Contribution of bioeconomy to economic development	filter 'attribute =Value added at factor cost'; drop down to select for each sector, divide by sum of all sectors (to be computed)
5.1.a.3	GVA to turnover ratio	Economic development is fostered	Contribution of bioeconomy to economic development	Need to normalise value added by GVA. Need source link for GVA data
5.1.a.4	Economic productivity (GVA/unit of biomass)	Economic development is fostered	Contribution of bioeconomy to economic development	
5.1.a.5	Gross value added per person employed in bioeconomy	Economic development is fostered	Contribution of bioeconomy to economic development	need to compute: ['attribute =Value added at factor cost' / 'attribute =Number of persons employed']
5.1.b.1	Turnover in bioeconomy per sector	Economic development is fostered	Value of raw and processed biomass, value	filter 'attribute =Turnover'; drop down to select for each sector and sum of all sectors (to be computed)

			added in bioeconomy sectors	
5.1.b.2	Value-added per sector	Economic development is fostered	Value of raw and processed biomass, value added in bioeconomy sectors	filter 'attribute =Value added at factor cost'; drop down to select for each sector, and sum of all sectors (to be computed)
5.1.c.1	Export value	Economic development is fostered	Exports of EU food and non-food biomass, processed goods and/or related technologies	
5.1.c.2	Trade balance (net export)	Economic development is fostered	Exports of EU food and non-food biomass, processed goods and/or related technologies	JRC working on this through Biomonitor
5.1.d.1	Terms-of-Trade of biomass (export/import)	Economic development is fostered	Comparative advantage	
5.1.d.2	Revealed comparative advantage of biomass (Balassa index)	Economic development is fostered	Comparative advantage	
5.1.d.3	Number of enterprises in bioeconomy	Economic development is fostered	Comparative advantage	
5.1.d.4	Bioeconomy SME birth & death rates	Economic development is fostered	Comparative advantage	
5.2.a.1	Persons employed per bioeconomy sectors	Inclusive economic growth is strengthened	Employment in bioeconomy	need to compute: 'attribute =Number of persons employed'
5.2.b.1	Occupation health and safety	Inclusive economic growth is strengthened	Working conditions related to bioeconomy	
5.2.b.2	Cancer occurrences due to the use of pesticides	Inclusive economic growth is strengthened	Working conditions related to bioeconomy	impossible to establish link, remove this indicator
5.2.c.1	Employment by age in bioeconomy sectors	Inclusive economic growth is strengthened	Equality & inclusiveness in bioeconomy sectors	income may be better (check CAP conditions)
5.2.c.2	Employment by educational level in bioeconomy sectors	Inclusive economic growth is strengthened	Equality & inclusiveness in bioeconomy sectors	income may be better (check CAP conditions)
5.2.c.3	Employment by gender in bioeconomy sectors	Inclusive economic growth is strengthened	Equality & inclusiveness in bioeconomy sectors	less relevant than income by gender but data may be easier to obtain
5.2.c.4	Income by gender by sector	Inclusive economic growth is strengthened	Equality & inclusiveness in bioeconomy sectors	Priority over employment indicator but data may not be available

5.2.c.5	Income distribution along bioeconomy value chains	Inclusive economic growth is strengthened	Equality & inclusiveness in bioeconomy sectors	
5.3.a.1	Distance to logistics hubs (territorial dimension)	Resilience of the rural, coastal and urban economy is enhanced	Physical infrastructure (accessibility, services)	may be replaced by Biomonitor MISTICS
5.3.a.2	Average distance to forest road?	Resilience of the rural, coastal and urban economy is enhanced	Physical infrastructure (accessibility, services)	Irrelevant, delete
5.3.b.1	Price volatility	Resilience of the rural, coastal and urban economy is enhanced	Financial stability (household; region)	price volatility of what? better to replace with purchasing power. Delete
5.3.c.1	Bioeconomy investments in rural and coastal areas	Resilience of the rural, coastal and urban economy is enhanced	Bioeconomy investments in rural & coastal areas	input indicator
5.3.c.2	Number of bioeconomy businesses developed with policy support	Resilience of the rural, coastal and urban economy is enhanced	Bioeconomy investments in rural & coastal areas	input indicator
5.3.d.1	Transformation of biomass at farm (or coop) level	Resilience of the rural, coastal and urban economy is enhanced	Rural income diversification	
5.3.d.2	Income diversification in rural areas, by farmer age for production and transformation at farm or coop level.	Resilience of the rural, coastal and urban economy is enhanced	Rural income diversification	
5.3.d.3	Income diversification of rural and coastal biomass producers (other than agriculture)	Resilience of the rural, coastal and urban economy is enhanced	Rural income diversification	DG AGRI wanted this
5.3.e.1	Fish & seafood landing income	Resilience of the rural, coastal and urban economy is enhanced	Income of primary producers	merge 5.3.e.1, 5.3.e.2, 5.3.e.3 to "income in primary production sectors (by sector)"
5.3.e.2	Income of agricultural household holdings	Resilience of the rural, coastal and urban	Income of primary producers	merge 5.3.e.1, 5.3.e.2, 5.3.e.3 to "income in primary production sectors (by sector)"

		economy is enhanced		
5.3.e.3	Forest income	Resilience of the rural, coastal and urban economy is enhanced	Income of primary producers	merge 5.3.e.1, 5.3.e.2, 5.3.e.3 to "income in primary production sectors (by sector)"
5.4.a.1	Adoption of new bioeconomy technology by primary producers for both production and transformation levels	Existing knowledge is adequately valued and proven sound technologies are fostered	Existing knowledge on bioeconomy technologies	
5.4.a.2	Rolling-out of pilot projects	Existing knowledge is adequately valued and proven sound technologies are fostered	Existing knowledge on bioeconomy technologies	Contact BBI-JU
5.4.a.3	Investment in TRL8-9 bio-based products	Existing knowledge is adequately valued and proven sound technologies are fostered	Existing knowledge on bioeconomy technologies	input indicator
5.5.a.1	% persons employed with 3º education in bioeconomy sectors	Knowledge generation and innovation are promoted	Knowledge generation/ (high level) education	
5.5.a.2	Changes in University curricula (number)	Knowledge generation and innovation are promoted	Knowledge generation/ (high level) education	
5.5.a.3	Investment in higher education related to bioeconomy	Knowledge generation and innovation are promoted	Knowledge generation/ (high level) education	
5.5.b.1	Number of patents by bioeconomy sectors	Knowledge generation and innovation are promoted	Research and innovation	ESTAT working on this too, keep in touch with Eckhard. See match IPC classes with Bioeconomy on page 104 of the JRC report
5.5.b.2	Investment in research and innovation (1000 eur)	Knowledge generation and innovation are promoted	Research and innovation	
5.5.b.3	Open innovation	Knowledge generation and innovation are promoted	Research and innovation	
5.5.b.4	New products produced from primary sources	Knowledge generation and	Research and innovation	

		innovation are promoted		
5.5.b.5	Number of research outputs in the field of bioeconomy	Knowledge generation and innovation are promoted	Research and innovation	
5.5.b.6	Innovation hurdle for different industries	Knowledge generation and innovation are promoted	Research and innovation	too unclear, need at least a proxy
5.6.a.1	Market or consumers acceptance	Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced	Market mechanisms (e.g. prices, consumer awareness)	could be replaced by 5.6.a.2 as proxy
5.6.a.2	Number of labelled or certified bio-based products	Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced	Market mechanisms (e.g. prices, consumer awareness)	
5.6.b.1	Volume of labelled/certified bio-based products sold	Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced	Consumer behaviour	in workshop people preferred number to volume, mainly because of complexity of obtaining data. Delete.
5.6.c.1	Share biomass uses by primary sector	Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced	Resource competition among sectors of the bioeconomy and Biomass demand for new value chains	compute shares (drop down list)
5.6.c.2	Producer prices per primary production sector	Demand and supply-side market mechanisms	Resource competition among sectors of the bioeconomy	

		and policy coherence between supply and demand of food and non-food goods are enhanced	and Biomass demand for new value chains	
5.6.c.3	Food index calculated on a standard food basket	Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced	Resource competition among sectors of the bioeconomy and Biomass demand for new value chains	move to Obj1, food purchasing power because it exists in FAO

Table 8. The indicators proposed by the workshop participants and the decision taken for each of the indicators by the JRC

Proposed indicator	**Decision**
how many people are taking sick leave	Difficult to link to bioeconomy sectors.

Thus in summary, for the second objective related to climate change:

- No new indicators were taken on board;
- Five indicators were removed including one moved to Objective 1;
- Three indicators were merged to one indicator;
- New total number of indicators: 42

Plenary session, Day 2 (June 17)

Robert M'Barek from JRC opened the second day of the workshop, presenting the different views of the national bioeconomies that would be explained, and highlighted the importance of building an EU-wide monitoring system compatible with other monitoring systems at different scales (global, regional, national and local level).

Alexandros Theodoridis (Forschungszentrum Jülich, Germany) SCAR-BSW mandate and monitoring

Mr. Theodoridis presented the work conducted by the Bioeconomy Strategic Working Group (BSW) of the Standing Committee for Agricultural Research (SCAR) and explained its role as advisor for national research programmes. Considering a wide concept for the bioeconomy, the BSW covers topics such as how to produce more biological resources sustainably with lower inputs, the biomass availability at different scales, biomass logistical issues, the implementation of national policy strategies and its impacts on primary sectors, and many others.

The BSW provides a platform for information exchange and mutual learning between MS and the EC and supports MSs to design and implement their bioeconomy strategies by delivering specific recommendations and strategic advice.

The role of the BSW in the monitoring system is to help the European Commission in designing the framework and bring in the perspective from the different MS. It will also help in building on existing national systems and avoid duplicate work.

BSW commissioned to the Natural Resources Institute in Finland (Luke) a study on monitoring systems at MS level, presented by the following speaker.

Markus Lier (Natural Resources Institute (LUKE), Finland) Coordination of national-level monitoring - Montbioeco

Mr. Lier gave a presentation on the MontBioeco project, conducted in 2017-2018, which aimed at screening, comparing and synthesising bioeconomy monitoring systems in the EU MS. The analysis was based on a desktop research and surveys directed to sectoral stakeholders, ministries and research institutions. Markus Lier presented different initiatives carried out (e.g. the bioeconomy in different countries dashboard) to identify the status of national and regional strategies, their objectives and the existence of indicators for their monitoring. The study showed that the bioeconomies across MS and regions not always include the same sectors (Figure 9).

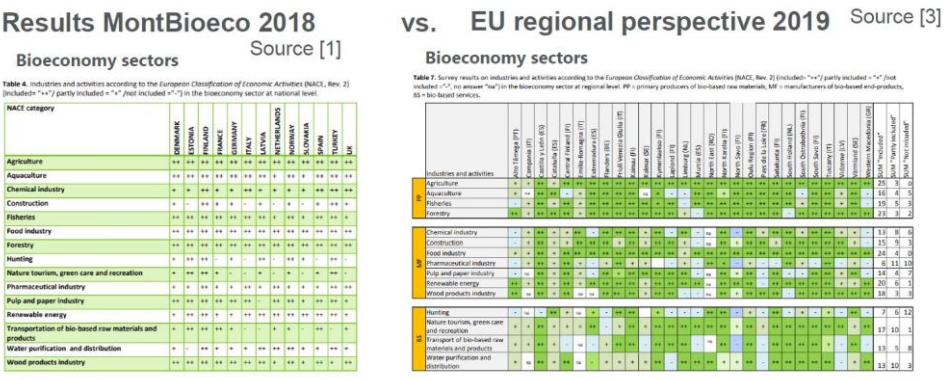


Figure 9. Sectors included in the different national and regional bioeconomies

The study also identified the 30 most suitable key indicators for each objective of the European Bioeconomy Strategy (Figure 10).

EU bioeconomy strategy objective	Identified most suitable key indicators
Creating jobs and maintaining competitiveness	Number of employed persons in rural and urban areas
	Value added
	Contribution to the GDP
	Investment in research and innovation
	Exports
	+ Import (identified by the correspondents after the online-survey)
Reducing dependence on non-renewable resources	Production of renewable energy *and* Production of biofuels and biogas *combined*
	Material and waste recycling and recovery rates
	Material replacing non-renewable resources
	Public financial support and private
	Investment in research and innovation
Mitigating and adapting climate change	Carbon sequestration
	Forest carbon emissions/sinks
	Greenhouse gas emissions from agriculture
	Water area carbon emissions/sinks
	Public financial support and private investments
	Investment in research and innovation
Ensuring food security	Domestic food supply of food commodities in terms of production, import/ stock change
	Agricultural products
	Fish products
	Non-wood forest products
	New food products
	Public financial support and private
	Investment in research and innovation
Managing natural resources sustainably	Land cover
	Resource availability
	Sustainable resource use
	Environmental protection
	Public financial support and private investments for ecosystem services
	+ Investment in research and innovation (identified by the correspondents after the online-survey)

Figure 10. Key indicators identified in the MontBioeco project

Some lessons learnt and conclusions drawn during the project included the need for using standardised statistics and indicators as well as the necessity for several rounds of validation and feedback to test the feasibility of the indicators proposed. It is important to set the focus group of the monitoring system (researchers, policymakers, citizens, etc.) so that the selected indicators adapt to the different needs and ensure that it does not overlap with other indicator set at other geographical scale (e.g. Finland).

Barna Kovács (Permanent Representation of Hungary to the European Union, BIOEAST Secretary General) Monitoring in Eastern European countries

The presentation by Mr. Kovács addressed the perspective and state of the bioeconomy in the Central-Eastern European (CEE) countries (11 MSs) framed in the BIOEAST initiative and supported by the H2020 CSA BIOEASTsUP project. While Latvia has already developed a national bioeconomy strategy and Estonia decided not to have a dedicated strategy, all other CEE countries do not have a policy roadmap yet. The BIOEAST initiative provides a supporting platform for bioeconomy governance. In this context, innovation and research as well as data showing costs, trade-offs and synergies are required to ensure a competitive and sustainable development on the bioeconomy.

The indicators which are being monitored in those countries are still sector-specific based on national statistics. They focus on an economic approach with sustainability still to be addressed. What the EU monitoring system could bring to the monitoring of BIOEAST countries relates to a quantification of ecosystem services and public goods, externalities of the new business models, as well as the comparability across sectors (including non bio-based).

Niels Gøtke (Danish Agency for Science, Technology and Innovation) Danish Monitoring

Policy developments on the bioeconomy started in Denmark already in 2005-2007. These developments were renewed in 2018 by an Action Plan set up by the Danish Bioeconomy Panel (involving experts from industry, farmers' associations, universities and ministries). The panel has a monitoring role to suggest new initiatives to be deployed as e.g. development of new proteins sources and sustainable building blocks. Currently the focus in Denmark is on climate change and sustainability issues. Denmark is also embarked in the Nordic bioeconomy initiative, launched in 2018.

Niels Gøtke explained the needs for a monitoring system, inter alia, a common methodology with solid data (possibly from national statistics bureaus and Eurostat) that allows comparability across MSs. For this purpose, the Farm Accountancy Data Network (FADN) could serve as inspiration for the EU monitoring system. He highlighted that Denmark started working on bioeconomy indicators without reaching a concrete output. He suggested to build a monitoring system with few indicators, with an economic focus, targeting mainly policymakers.

Anne Vehviläinen (Ministry of Agriculture and Forestry, Natural Resources Department, Finland) Finnish Monitoring

Finland was, together with Germany, the first MS in developing a dedicated bioeconomy strategy in 2014, which included a plan to develop criteria and indicators. The implementation of that strategy was overlooked by the Inter-ministerial secretariat and involved 3 Ministries (agriculture and forestry, economic affairs and employment and environment). The country is preparing a new national strategy where the indicators will be again analysed.

The set of indicators set in the 2014 strategy has been produced and collected annually by the National Institute of Statistics and looks not only to economic data (inter alia output, value added, investments and exports) but also biomass uses and resource efficiency as well as ecosystem services.

Ms. Anne Vehviläinen listed the needs and requirements for bioeconomy indicators which include usefulness for high level decision purposes and allocation of resources; large number of sector-specific indicators and the flexibility to change with the operating environment. They should rely on national statistics and consider the SDGs' framework. Lastly, she underlined that in Finland, the funding for the collection of indicators is a limiting factor.

Susanne Iost (Thünen Institut, Germany) German Monitoring

A new report on the monitoring of the German bioeconomy had just been published. The system presented covers three different dimensions but Ms. Iost focused her presentation on the 1st dimension dealing with the resource base and sustainability and its conceptual framework.

The data collection relies on official statistics by sector and data on material flows, which could then serve as a basis for sustainability assessments with LCA-based approaches. The framework could not consider for the time being the changes brought by the new national bioeconomy strategy for Germany (2020) as e.g. the inclusion of bio-based services due to, inter alia, low data availability. It thus focuses on biomass production and processing data.

For the sustainability assessment the monitoring system bases the analysis in 27 SDG-based indicators. The study analysed whether the indicators could be assigned to the bioeconomy and if the data was available for their quantification. Some of the indicators listed dealt with SDG 6 (nitrate in groundwater), SDG 7 (share of energy consumption form biomass), SDG 8 (value added, employment, etc.) and SDG 13 (GHG emissions).

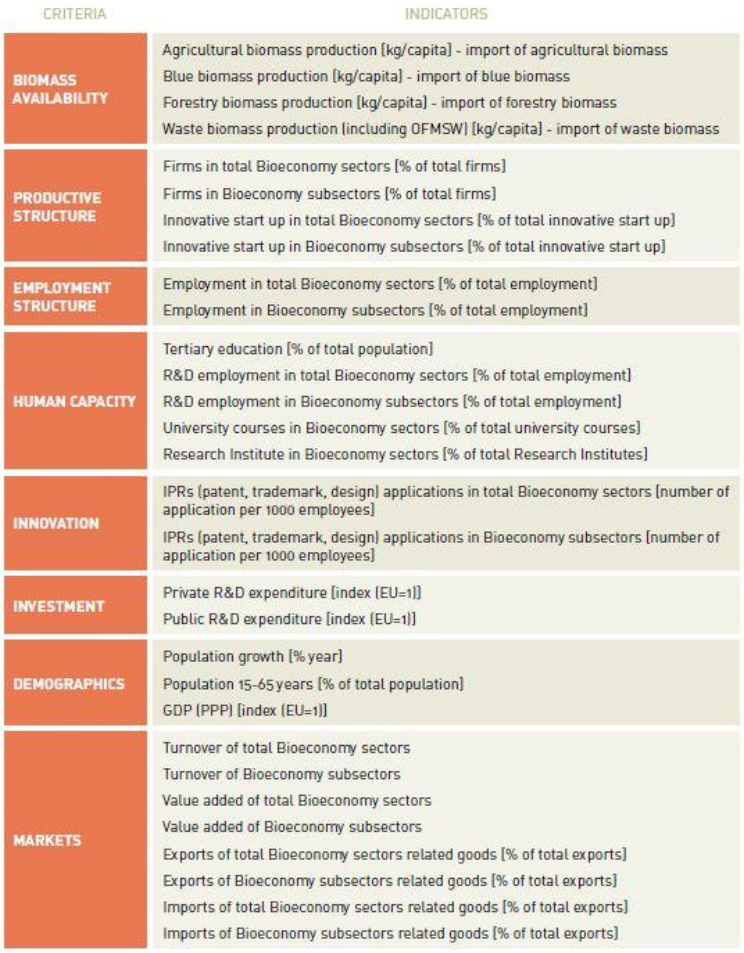
Lastly, she suggested setting clearly the goals of the monitoring system to facilitate the selection of indicators and working together with national institutes and agencies to collect useful data that are currently missing.

Fabio Fava (University Bologna, Italy) Italian Monitoring

Prof. Fava focused his presentation on the revised Italian bioeconomy strategy, BIT II (2019) and how to monitor its progress. Italy has a National Bioeconomy Coordination body (NBCB) in the frame of the National Committee Biosafety, Biotechnology and Life Science (CNBBSV) of the Italian Presidency of Council of Ministers with the mandate to interconnect the national and regional Bioeconomy actions/initiatives by promoting the implementation of circular Bioeconomy in the whole country. It is made up by representatives of four Ministries (Ministry Agriculture, Food, Forestry Policies; Ministry Education, University, Research; Ministry Economic Development; Ministry Environment, Land, Sea), the Agency for territorial cohesion, the Conference of 21 Regions and autonomous Provinces, and the National Technology Clusters (public/private partnerships) on Agrifood, Biobased Industry (Green Chemistry) and Bluegrowth. The NBCB is working at the implementation of the strategy BIT II and the finalization of the related Implementation Action Plan. One of

the main priorities is to interconnect the national bioeconomy sectors creating longer and better locally routed value chains on the whole Italian territory .

With this aim, the Italian strategy sets up a set of specific indicators (≈30) structured along different criteria (Figure 11). Yet, the indicators will be revised and improved to make them more effective, robust and harmonised so that the monitoring is more comprehensive and tailored to the Italian novel products and territories. Therefore, Fabio Fava highlighted the Italian interest and the full availability of NBCB to collaborate with JRC in the design and implementation of the EU monitoring System.



CRITERIA	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 subsectors [% of total firms] Innovative start up in total Bioeconomy sectors [% of total innovative start up] Innovative start up in Bioeconomy subsectors [% of total innovative start up]
EMPLOYMENT STRUCTURE	Employment in total Bioeconomy sectors [% of total employment] Employment in Bioeconomy subsectors [% of total employment]
HUMAN CAPACITY	Tertiary education [% of total population] R&D employment in total Bioeconomy sectors [% of total employment] R&D employment in Bioeconomy subsectors [% of total employment] University courses in Bioeconomy sectors [% of total university courses] Research Institute in Bioeconomy sectors [% of total Research Institutes]
INNOVATION	IPRs (patent, trademark, design) applications in total Bioeconomy sectors [number of application per 1000 employees] IPRs (patent, trademark, design) applications in Bioeconomy subsectors [number of application per 1000 employees]
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 subsectors Value added of total Bioeconomy sectors Value added of Bioeconomy subsectors Exports of total Bioeconomy sectors related goods [% of total exports] Exports of Bioeconomy subsectors related goods [% of total exports] Imports of total Bioeconomy sectors related goods [% of total exports] Imports of Bioeconomy subsectors related goods [% of total exports]

Figure 11. Set of indicators established in the Italian Bioeconomy Strategy (BIT II)

Jesús Escudero (INIA, Spain) Spanish Monitoring

The presentation by Jesús Escudero covered the Spanish bioeconomy Strategy released in 2015, providing an overview of the state of the bioeconomy in that country and the set of indicators (≈20) established in the 2018 Action Plan and followed by the Ministry of Agriculture and the National Statistics Institute (Figure 12).

Indicators. BioE Strategy, Ministry of Agriculture, National Institute of Statistics

1. GDP (%) affected by Bioeconomy
2. Companies (No) in biomass production & processing for energy
3. Companies (No) for bioproducts generation
4. Total investment (€) in biotech sector, public & private
5. Research companies (No) in biotech sector
6. Research (No) centres in biotech sector
7. Biotech companies operating in bioeconomy sector
8. Jobs (No) in bioeconomy sector
9. Exports (€) in bioeconomy sector
10. Annual production (€) in bioeconomy sector
11. Capital gross formation in bioeconomy
12. Projects (No) funded in bioeconomy
13. R&D&I public investment (€) in bioeconomy
14. Communication strategies (No) in bioeconomy
15. Land use (Ha) for cultivation
16. Biomass Produced (T)
17. Residues generated (T) by bioeconomy sectors and treatment
18. Annual reduction (%) in carbon emission
19. Research publications and citations (No) in scientific journals
20. Intellectual and industrial property files (No) in bioeconomy

Figure 12. Indicators to monitor the progress of the Bioeconomy in Spain

He also addressed a few issues to be solved in the Spanish context such as the undertaking of the agreed Action Plans, the activation of the Spanish Bioeconomy Observatory and the deployment of the commitments among the Spanish Ministries (Agriculture, Science and Environment). It was underlined that more detailed Specific, Measurable, Achievable, Relevant and Time-bound (SMART) indicators are needed to fine-tune the monitoring of the Spanish bioeconomy and to provide science-based evidence for policymaking.

Parallel sessions, Day 2 (June 17)

Participants were divided into four different breakaway groups ensuring balanced number of participants from MS. The sessions were co-moderated by experts from the JRC. In this section we group the discussions into recurring themes that appeared throughout the afternoon among the different groups.

Each parallel session was initiated with a poll: *"How do you think the EU Bioeconomy Monitoring framework could be most useful":*

(a) To guide the development of local or national-level monitoring

(b) For useful insights/data for local or national-level monitoring

(c) Neither of the above

The motivation behind this poll was to allow the JRC to get a feeling of where to invest in the future. If the first choice predominates, the understanding is that a majority of investment and effort should be put into the framework concepts, such as developing theoretical bases for understanding the whole picture through analyses of trade-offs and synergies. If the second choice predominates, a majority of investment should be made in harmonising indicators across countries, sectors and the value chain.

For all sessions combined, 53% of participants chose a; 34% chose b; 3% chose c and 10% did not vote.

The discussions that ensued were related to the poll, with the participants explaining their choices. The discussions can be clustered into four main arguments:

- A dominance of a: using the EU model to structure National monitoring with MS-specific indicators. Exchange of information among MS to inform one another. Thus, even though indicators would remain specific to each country, the completeness of the framework itself would ensure a good overview across all three pillars of sustainability. Furthermore, the danger in maintaining lopsided monitoring systems is that interpretations will also be biased. Thus, a well-rounded monitoring system can ensure that even gaps are highlighted. In this case the national idiosyncrasies would be maintained while ensuring a good coverage of the main facets to monitor.
- A dominance of b: using data gathered at EU level for national level monitoring. A proposal to focus on a harmonisation of indicators themselves. If indicators are harmonised that true comparison between MS can be made. This would require significant effort in terms of first agreeing on the taxonomy, then on the indicators to harmonise, and finally on collecting the data if needed. National statistical offices would have to be on board.
- National level monitoring is reflected in the EU level monitoring system. The EU-level monitoring misses the very fine details that are perceived at national level. Without this input the EU system will never reflect the fine points of the bioeconomy, e.g. very local value chains will be missed at EU level.
- EU level monitoring is more coarse, but better than nothing. In this argument, EU level monitoring can fill gaps in national monitoring systems where there is no national-level monitoring.

Exchange of information

The exchange between MS would allow for a broadening of vision, thus possibly resulting in revisions towards more ample monitoring systems.

Closing session, Day 2 (June 17)

During the closing session three main questions and points of discussion arose:

- Evolution of national strategies and approaches to be fostered, as e.g. the uptake of circularity approaches in the revised German strategy.
- The importance of setting a clear understanding of the scope to co-design a common monitoring system.
- The reporting of the monitoring system (the analysis of the indicators) conducted by the JRC every two years will be at European level while the indicators to be provided in the interactive dashboards will be presented at national level and, potentially in the long-term, at regional and local level, if feasible.

Outcomes of Day 2 (June 17)

The four main synergies between EU and national-level monitoring brought forward by workshop participants were: 1) EU-level monitoring provides a model for a holistic and balanced view of bioeconomy sustainability, which MS may use for their own monitoring; 2) EU monitoring should be leveraged to propose and further develop harmonised approaches to monitoring; 3) The EU monitoring system should publish national level monitoring side-by-side to allow for cross-comparability; 4) EU level monitoring is developed with the EU in mind but the data can be used to fill the gaps in national level reporting.

All of these synergistic approaches are relevant and have been considered by the JRC as ways forward to improve the symbiosis between EU and national level monitoring. In the 2021-2022 Work Programme of the JRC under preparation, the EU-level bioeconomy monitoring has been partially reformulated given the outcomes of these results in the following way: Firstly, a research component of the work at the JRC will focus on the system's level and holistic view of monitoring bioeconomy both for the EU and in an international context with the FAO. The objective of this component is to capture the predominant elements related to the sustainability of the bioeconomy and to monitor those, as well as trade-offs and synergies. Furthermore, as described in the closing words of the workshop on June 20 (Figure 13), the JRC will collaborate closely with other EC services to derive 'input' indicators. These are indicators that are the main drivers to the state and pressure indicators that are currently in the system. In this way the concepts of policy-coherence are also captured. A natural place to start is with the indicators that have already been identified to monitor the implementation of the actions in the European Bioeconomy Strategy Action Plan.

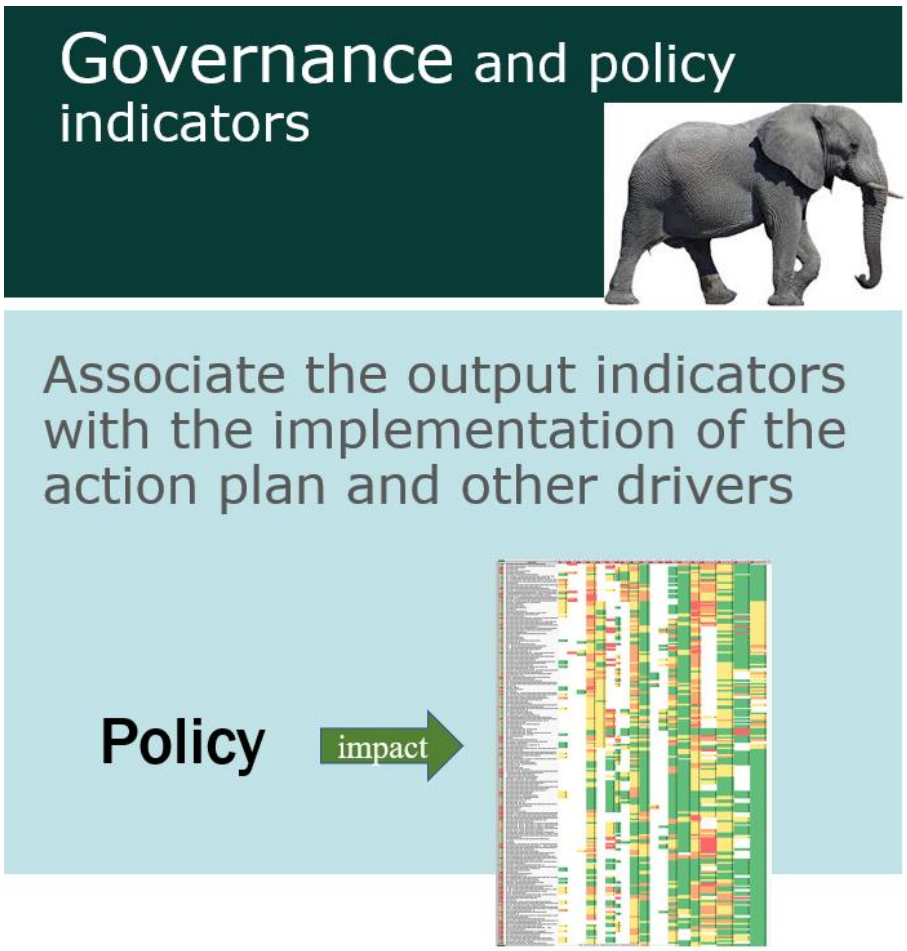


Figure 13. Associating state and pressure indicators with drivers (governance)

Secondly, the efforts to harmonise indicators across the EU for key aspects such as biomass availability and uses and employment and value added in bioeconomy sectors will continue in our work for the coming years. This work will partially continue within the context of the Biomass Mandate[1] and with close collaboration with DG RTD. The launch of a high-level Member State Forum led by RTD may result in guidance from MS on the prioritisation of the EU-level harmonisation efforts.

Thirdly, the JRC is evaluating the possibility for the EU-level monitoring system to contain 'case studies' or best practices at very local level. With this approach, the EU monitoring system may not cover all national level statistics for all facets of sustainability, but rather would focus on the innovation component (Objective 5). This is only in the feasibility study phase and no concrete plans have been made yet.

Finally, given that some participants expressed the need to fill gaps in their national level monitoring system, the JRC will pledge to provide the full data and metadata to facilitate re-use.

Summary of outcomes of the workshop

The main outcomes of this workshop were

1) Re-evaluation of list of indicators;

2) Proposals on way-forward to ensure synergies between the EU-level and national, regional and local level monitoring;

3) Clarifications on procedural aspects of the EU Bioeconomy Monitoring System, such as milestones and quality assessment of indicators;

4) Re-affirmation of partnership between JRC and other EC services as well as with other relevant monitoring initiatives in the EU (Biomonitor, Bioeast, SCAR, LUKE, IEA Bioenergy, MS, National Forest Inventories).

Evaluation of the workshop

During the three days (16, 17 and 30 June 2020), the workshop was attended in total by 61 different experts, 54% of which were from external organisations and 46% from the European Commission. The breakdown of participants along the three days is shown in Figure 14.

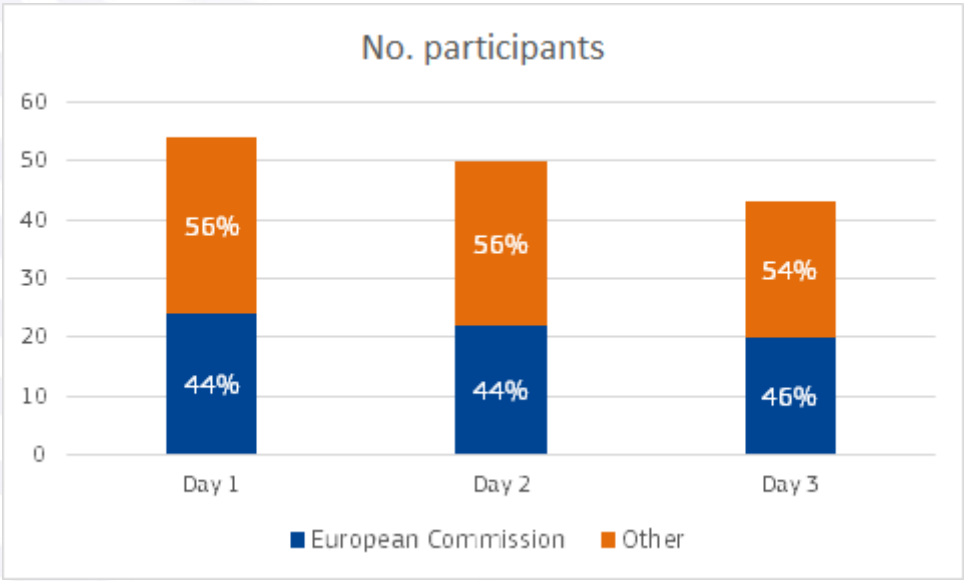


Figure 14. Breakdown of participants during the three days of the workshop and their affiliation

[1] https://ec.europa.eu/knowledge4policy/projects-activities/jrc-biomass-assessment-study_en

At the end of the event, participants were invited to give their feedback on the organisation and outcomes of the workshop through a JRC standard online survey. Different aspects of the workshop (e.g. agenda, speakers, documentation, facilities and services, assistance before the event and overall outcome of the event) were assessed in a scale from 1 (completely disagree) to 5 (completely agree). The average mark obtained for each question is shown in Figure 15. Overall, the feedback was positive. Items with an average score below 4, were related to the time allocated for questions and discussion, the interactive tools used during the workshop and the preference for physical meetings. Actually, the most recurring comment obtained from the questionnaires regarded the short time allocated to both plenary and break-out discussions and some participants suggested to extend the discussion given the savings in travelling time.

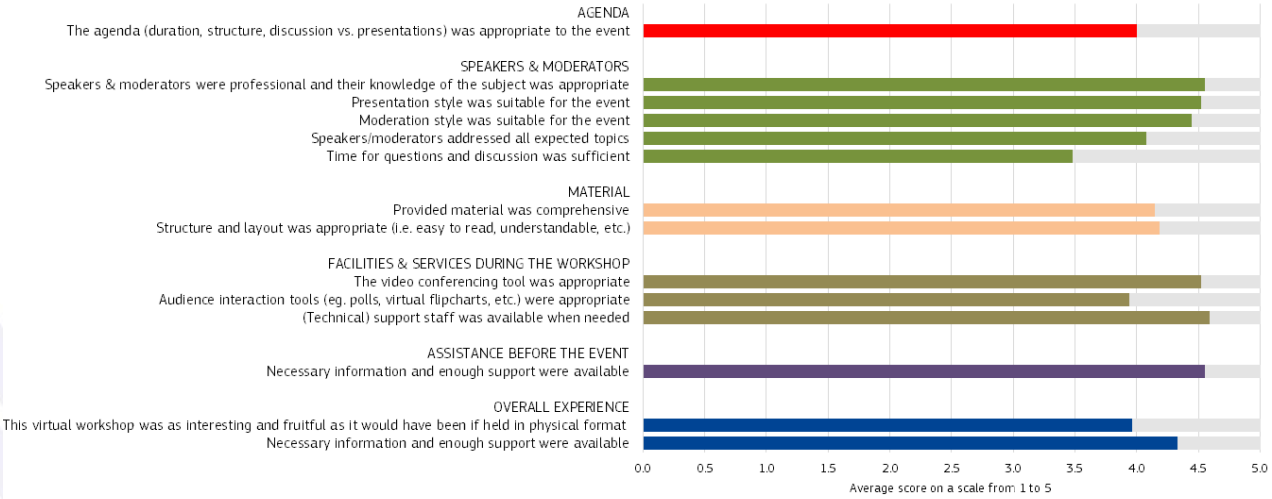


Figure 15. Assessment of different aspects of the workshop by the attendees in a scale from 1 to 5

Most of the additional comments were of appreciation for the workshop. However, other remarks provided for improvement included:

- An agenda too focused on presentations
- The need for a better explanation of goals in break-out sessions in day 1
- Preference for physical meetings
- Doubts on how the outputs of the workshop would be actually taken on board for the monitoring framework.

Annex 1

Tuesday 16 June 2020
14h30 – 16h45

14:30 – 14:40 **Welcome**
Introduction to workshop, format, expected outcomes
Sarah Mubareka (JRC)

Session 1: EU-wide Bioeconomy Monitoring Systems

14:40 – 15:10 **Presentations on EU-wide monitoring initiatives for the Bioeconomy**

Session objective:

- To understand and learn from the different EU-wide approaches

Justus Wesseler (Wageningen University and Research, Netherlands)
Biomonitor (10 min)
Uwe Fritsche (IINAS, Germany)
Monitoring sustainability of bioenergy (10 min)
Jacopo Giuntoli (JRC)
EU Bioeconomy Monitoring System (10 min)

15:10-15:30 Q & A in panel

15:30 - 16:00 **BE Strategy Objective-specific session on indicators, Round 1 (30')**
16:00 – 16:30 **BE Strategy Objective-specific session on indicators, Round 2 (30')**

Session objectives:

- Primary objective: Get consensus on indicators; discuss controversial indicators, ideas to fill gaps
- Secondary objective: Get ideas for headline indicators

There will be five parallel breakaway sessions, one per EU Bioeconomy Strategy Objective. Each session will be moderated by an expert:

6. *Ensuring Food and Nutrition Security (**Nicolas Robert**, Javier Sanchez Lopez, JRC)*
7. *Managing Natural Resources Sustainably (**Jose Barredo**, Maria Teresa Borzacchiello, JRC)*
8. *Reducing dependence on non-renewable unsustainable resources (**Jacopo Giuntoli**, Sarah Mubareka, JRC)*
9. *Mitigating and adapting to climate change (**Marco Follador**, Marios Avraamides, JRC)*
10. *Strengthening European competitiveness and creating jobs (**Tévécia Ronzon**, Lucia Parrino, JRC)*

- ✓ *Each participant should choose two sessions to follow at the time of registration (or may remain in the same session for both rounds)*
- ✓ *In these sessions, we will discuss specific indicators and indicator gaps*
- ✓ *The list of indicators will be circulated before the meeting*
- ✓ *Participants are asked to provide their comments before the meeting*

16:30 – 16:45 **Back in plenum, next steps explained and closing of Day 1**
Sarah Mubareka (JRC)

Wednesday 17 June 2020
14h30-16h30

14:30 – 14:40 **Welcome**
Introduction to workshop, format, expected outcomes
Robert M'Barek (JRC)

Session 2: Regional, national and local level monitoring

14:40 – 15:40 **Regional, national and local monitoring of bioeconomy**

Session objective:

- To understand and learn from different national-level approaches

Alexandros Theodoridis (Forschungszentrum Jülich, Germany) *SCAR-BSW mandate and monitoring* (5-7')
Markus Lier (Natural Resources Institute (LUKE), Finland) *Coordination of national-level monitoring - Montbioeco* (5-7')
Barna Kovács (Permanent Representation of Hungary to the European Union, BIOEAST Secretary General) *Monitoring in Eastern European countries* (5-7')
Niels Gøtke (Danish Agency for Science, Technology and Innovation)
Danish Monitoring (5-7')
Anne Vehviläinen (Ministry of Agriculture and Forestry, Natural Resources Department, Finland) *Finnish Monitoring* (5-7')
Susan Iost (Thünen Institut, Germany) *German Monitoring* (5-7')
Fabio Fava (University Bologna & CNBBSV, Italian Presidency of Council of Ministers, Italy) *Italian Monitoring (5-7')*
Jesús Escudero (INIA, Spain) *Spanish Monitoring (5-7')*

15:40 – 16:10 **Break out session***: Local, national and EU level monitoring system coherence*

Session objective:

- To understand the priorities of monitoring systems at local, national and regional levels
- To identify synergies and differences between monitoring at different geographical scales

Moderators:
1. ***Nicolas Robert**, Javier Sanchez Lopez, JRC*
2. ***Sarah Mubareka**, Maria Teresa Borzacchiello, JRC*
3. ***Marco Follador**, Marios Avraamides, JRC*
4. ***Tévécia Ronzon**, Lucia Parrino, JRC*

Leading questions:

1. *Could the EU Bioeconomy Monitoring framework guide the development of local or national-level monitoring systems?*
2. *Could the EU Bioeconomy Monitoring framework be used for local or national-level monitoring?*

16:10-16:30 **Back in plenum Closing of Day 2** *Robert M'Barek (JRC)*
Closing workshop and next steps *Sarah Mubareka (JRC)*

Tuesday 30 June 2020
14h30 – 15h30

Summary and conclusions of the June 16 & 17 workshop