Key results of the MonBio project: Improving monitoring of environmental aspects of the bioeconomy

“Weiterentwicklung des ‚Monitoringsystem Bioökonomie‘ unter besonderer Berücksichtigung von Aspekten des vorsorgenden Umweltschutzes“

March 2021 – June 2024

Aaron Best, Ecologic Institute

Berlin, 31 October 2024

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Science and Policy for a Sustainable World

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HELMHOLTZ Zentrum für Umweltforschung

Contents

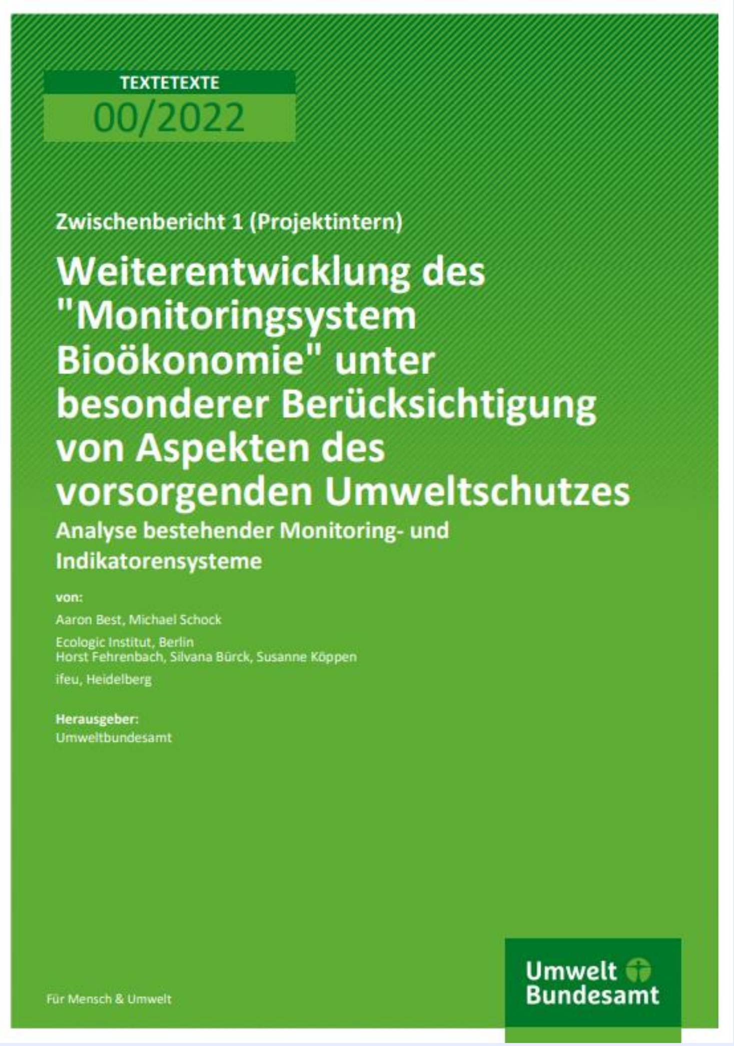
Project objectives

1. **Identify existing monitoring systems:** Gather the latest information and create a comprehensive and standardized overview of various monitoring initiatives (international, European, and national).
2. **Analyze indicators:** Evaluate indicators and monitoring systems in order to learn from existing approaches and practical experiences.
3. **Identify suitable indicators:** Find gaps in monitoring, identify indicators that could improve bioeconomy monitoring, and do a deeper analysis of promising environmental indicators for improving German bioeconomy monitoring.
4. **Recommend actions:** Make recommendations for the further development of bioeconomy monitoring and for the implementation of the bioeconomy strategy

Literature

Analysis of existing monitoring and indicator systems

- 50 reports/publications from 42 studies/projects were compiled
- 22 studies analyzed in detail using the questionnaire and summarized
- Internal project report - quick access to relevant details in the literature; basis for further analyses of selected indicators


TEXTETEXTE
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Zwischenbericht 1 (Projektintern)

Weiterentwicklung des "Monitoringsystem Bioökonomie" unter besonderer Berücksichtigung von Aspekten des vorsorgenden Umweltschutzes

Analyse bestehender Monitoring- und Indikatorensysteme

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Umweltbundesamt

Für Mensch & Umwelt

Umwelt Bundesamt


Journal of Cleaner Production
Product Biodiversity Footprint – A novel approach to compare the impact of products on biodiversity combining Life Cycle Assessment and Ecology
biomonitor
D1.1: Framework for measuring the size and development of the bioeconomy
Date of document – 09/2019 (10/1)
TEXTE 45/2020
Nexus Ressourceneffizienz und Landnutzung – Ansätze zur mehrdimensionalen umweltpolitischen Bewertung der Ressourceneffizienz bei der Biomasse-bereitstellung
Abschlussbericht
Umwelt Bundesamt
Food and Agriculture Organization of the United Nations
ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT WORKING PAPER 77
BIOECONOMY
INDICATORS TO MONITOR AND EVALUATE THE SUSTAINABILITY OF BIOECONOMY
Overview and a proposed way forward
Forschungsbericht BWPLUS
Ein Konzept für einen Bioökonomie-Entwicklungsindex für Baden-Württemberg - BÖE-Index BW -
November 2018
THE GLOBAL BIOENERGY PARTNERSHIP SUSTAINABILITY INDICATORS FOR BIOENERGY
FIRST EDITION
GBEP Global Bioenergy Partnership
FSC
Forest Stewardship Council®
FSC® INTERNATIONAL STANDARD
FSC PRINCIPLES AND CRITERIA FOR FOREST STEWARDSHIP
FSC-STD-01-001 V5-2 EN
Monitoring the Bio-Economy
Assessing Local and Global Biomass Flows, Land-Use Change, Carbon Impacts and Future Land Resources
Chun Sheng Goh
INTERNATIONAL STANDARD ISO 13065
First edition 2015-09-15
Sustainability criteria for bioenergy
Critères de durabilité pour la bioénergie
sustainability MDPI
Monitoring Bioeconomy Transitions with Economic–Environmental and Innovation Indicators: Addressing Data Gaps in the Short Term


sustainability
Development of the Circular Bioeconomy: Drivers and Indicators
Forest Ecosystems
REVIEW
Open Access
Indicators and tools for assessing sustainability impacts of the forest bioeconomy
Jaakko Karvonen, Pradipta Halder, Jyrki Kangas and Pekka Leskinen
JRC SCIENTIFIC INFORMATION SYSTEMS AND DATABASES REPORT
Implementation of the EU Bioeconomy Monitoring System dashboards
Status and technical description as of December 2021
Synthesis on bioeconomy monitoring systems in the EU Member States
- Indicators for monitoring the progress of bioeconomy
Luke
sustainability
The Contribution of Sustainable Development Goals and Forest-Related Indicators to National Bioeconomy Progress Monitoring
sustainability
Conceptualization of an In
Assessing the Sustainabilit
THÜNEN
Setting up a bioeconomy monitoring:
Resource base and sustainability
Susanne Iost, Natalia Geng, Jörg Schweinle, Martin Banse, Simone Brüning, Dominik Jochem, Andrea Machmüller, Holger Weimar
Thünen Working Paper 149
SCP HOTSPOT ANALYSIS
HOT SPOT ANALYSIS TOOL FOR SUSTAINABLE CONSUMPTION AND PRODUCTION
to support science-based national policy frameworks
A GUIDE TO THE RSB STANDARD
Driving the development of the bio economy for a better world through certification, sustainability solutions, innovation and partnerships.
Trusted Solutions for a New World.
RSB
S2Biom
Delivery of sustainable supply of non-food biomass to support a "resource-efficient" Bioeconomy in Europe
S2Biom Project Grant Agreement n°608622
D5.4
Consistent Cross-Sectoral Sustainability Criteria & Indicators
Final Report
March 2015
BIOÖKONOMIE
ifo FORSCHUNGS-BERICHTE
Ermittlung wirtschaftlicher Kennzahlen und Indikatoren f
Monitoring des Voranschreite
Bioökonomie
ifo INSTITUT

Precautionary environmental protection: key aspects

- Environmentally sound biomass potentials
- Additional demand for biomass
- Changes in use and flows
- Biodiversity
- Environmental impacts of expansion
- Evaluation of the environmental benefits

Expert interviews

Topics frequently identified by experts as insufficiently covered by indicators

- **Biodiversity** / quality of ecosystems / species richness / landscape and habitat fragmentation
- **Biomass potential** - replacement of non-renewable materials/energy but at risk of exceeding biomass potential
- **Spatial resolution / accuracy** is required but difficult - link to specific land use - important but difficult to assess - Index intensity of use - problematic as the issue varies from place to place
- **Land use / Land use change** - indirect land use change
- **Impacts in exporting countries** - sustainability based on local conditions (including social issues: land rights)
- **Effects on planetary boundaries**
- **Bioenergy** – ensuring that only actual waste is diverted into bioenergy

Important question: what taxonomy?

EU Bioeconomy Monitoring System

Highlighted categories are those that have indicator data in the *EU Bioeconomy Monitoring System* (as of 2023).

1 Ensuring Food and Nutrition Security
- 1.1 Food security and nutrition are supported
  - 1.1.a Availability
  - 1.1.b Access
  - 1.1.c Utilisation
  - 1.1.d Stability

2 Managing Natural Resources Sustainably
- 2.1 Ecosystem capacity to produce services is maintained or enhanced
  - 2.1.a Environmental quality
  - 2.1.b Structural and functional ecosystem attributes
  - 2.1.d Species diversity and abundance
  - 2.1.e Conservation status of habitats and species
- 2.2 Primary production sectors are managed sustainably
  - 2.2.a Pressures from Forest Management
  - 2.2.b Pressures from marine fisheries & aquaculture management
  - 2.2.d Pressures from agroecosystems
- 2.3 Ecosystem services contribution to human well-being is maintained or enhanced
  - 2.3.a Provisioning services

3 Reducing dependence on non-renewable unsustainable resources, whether sourced domestically or from abroad
- 3.1 Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved
  - 3.1.a Resource efficiency (Material footprint)
  - 3.1.b Energy efficiency
  - 3.1.c Biogenic waste prevention, re-use/recycling, and recovery
- 3.2 Food loss and waste is minimised and, when unavoidable, its biomass is reused or recycled
  - 3.2.a Food loss and waste minimization
- 3.4 Consumption patterns of bioeconomy goods match sustainable supply levels of biomass
  - 3.4.a Consumption and demand for biomass and bio-based products
  - 3.4.c Reduced dependence on non-renewable resources

4 Mitigating and adapting to climate change
- 4.1 Climate change mitigation and adaptation are pursued
  - 4.1.a Climate change mitigation
  - 4.1.b Climate change adaptation

5 Strengthening European competitiveness and creating jobs
- 5.1 Economic development is fostered
  - 5.1.a Contribution of bioeconomy to economic development
  - 5.1.b Value of raw and processed biomass, value added in bioeconomy sectors
- 5.2 Inclusive economic growth is strengthened
  - 5.2.a Employment in bioeconomy
- 5.6 Demand and supply-side market mechanisms and policy coherence between supply and demand of food and non-food goods are enhanced
  - 5.6.b Resource competition among sectors of the bioeconomy and Biomass demand for new value chains

EU Bioeconomy Monitoring System

Good practices of the EU BMS

- **Comprehensive taxonomy** – 1 Objective, 1.1 Normative criteria, 1.1.1 Components → *Logic, clarity*
- **Several types of indicators** – basic indicators, derived indicators, system-level indicators, composite indicators, headline indicators
  → *Various uses and scales*
- **Inclusion of components without indicators**
  → *Transparency regarding open gaps*
- **Annual overview of all EU BMS indicators -** „published", „data available", „data gap", „in development", „to be deleted“
  → *Transparency regarding status*
- **Reference to several political frameworks** – UN SDGs, Green Deal
  → *Relevance, Synergies*
- **Coordination with other monitoring systems**
  → *Comparability, efficiency, systemic approaches*

Indicator screening

(potential to fill gaps)

Blue text: Taxonomy of the EU Bioeconomy Monitoring System

2 Managing Natural Resources Sustainably

Irreversibility risk identifier (a label on issues where irreversibility is a factor)
Detailed spatial maps, showing land use types, intensities, and land use change
Planetary boundaries

2.1 Ecosystem capacity to produce services is maintained or enhanced

2.1.a Environmental quality

Area of land (ha) restored from a degraded state (e.g. contaminated, salinated, eroded)

2.1.b Structural and functional ecosystem attributes

2.1.b.2,Landscape fragmentation index,index,data available (no DE data; Nov 2022)
2.1.b.6,Forest fragmentation and connectivity index,percent,data available (no DE data; Nov 2022)
2.1.b.8,Share of forest area,percent tot land area,data available (no DE data; Nov 2022)

2.1.d Species diversity and abundance

Biodiversity footprint (Symobio)
Biodiversity footprint (Chaudhry & Brooks 2018)
Biodiversity Value Increment (BVI) oder Inputs an N, Pestizide etc. von Produkten

2.1.e Conservation status of habitats and species

2.2 Primary production sectors are managed sustainably

Certification, taking into account landscape conditions

2.2.a Pressures from Forest Management

2.2.a.3,Change in ecosystems extent: Forest and woodland,hectares,data available (no DE data; Nov 2022)
2.2.a.4,Land use / land cover type taken over by forest,hectares,data available (no DE data; Nov 2022)

2.2.d Pressures from agroecosystems

2.2.d.2,Land use / land cover type taken over by agricultural land,hectares,data available (no DE data; Nov 2022)
2.2.d.3,Change in ecosystems extent: cropland & grassland,hectares,data available (no DE data; Nov 2022)

2.3 Ecosystem services contribution to human well-being is maintained or enhanced

2.3.b Regulating services

2.3.b.2,Air quality,[no units identified],no known data

2.3.c Cultural services

Indicator screening

(potential to fill gaps)

Blue text: Taxonomy of the EU Bioeconomy Monitoring System

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

LCA for substitution effects (esp. system change)

3.1 Resource efficiency, waste prevention and waste-re-use along the whole bioeconomy value chain is improved

3.1.a Resource efficiency (Material footprint)

3.1.a.3,Land footprint in EU of EU consumption (for non-food&feed),[no units identified],no known data

(focus of analysis: connection to bases for decisionmaking (thresholds, targets, etc.)

3.1.c Biogenic waste prevention, re-use/recycling, and recovery

Waste and residues - Circularity factor (Anteil primärer und sekundärer Biomasse)

3.4 Consumption patterns of bioeconomy goods match sustainable supply levels of biomass

Sustainable potentials, Identification of biomass potentials in line with nature recovery and biodiversity

Sankey diagrams to visually communicate biomass flows coupled with biomass potentials

4 Mitigating and adapting to climate change

4.1 Climate change mitigation and adaptation are pursued

4.1.a Climate change mitigation

CO_2-Opportunity costs (Nature recovery opportunity costs)

% of biomass obtained from land with high carbon stock (e.g. peatland or wetland)

Carbon intensity as measured through Life cycle GHG emissions (gr eq. CO2 / product unit)

4.1.a.1,net GHG emissions (emissions and removals) from bioenergy (absolute and relative vs. total sector emissions),tCO2e and %,data may be available

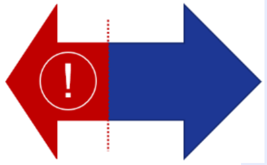
4.1.a.2,net GHG emissions (emissions and removals) from BBI (absolute and relative vs. total industrial emissions),tCO2e and %,data may be available

4.1.a.4,net GHG emissions (emissions and removals) from bio-waste (absolute and relative vs. total waste emissions),tCO2e and %,data may be available

4.1.a.5,GHG emissions from fishing and aquaculture,1000 tCO2e,no known data

High-potential indicators to fill identified gaps

1. **CO_2 opportunity costs** - compares the officially reported CO_2 reduction potentials of bioeconomy activities (e.g. biofuels) with alternative approaches and explicitly includes renaturation as an alternative in the analysis. ***Units:*** *Tonne CO_2-eq. or land use in hectares.*
2. **Integrated Sankey diagrams (coherent comparisons of sustainable production capacities and utilisation)** - combines Sankey diagrams of material flows by biomass category with representations of sustainable production. Where no capacity calculation is available, this is indicated in the diagram. Capacity ranges can be used to communicate uncertainties or disagreements. ***Units:*** *Various (e.g. tonne of dry matter).*
3. **Irreversibility risk label -** a label that draws attention to irreversibility risks. This label could be used in conjunction with other indicators to ensure that a higher level of precaution is applied when setting targets.



Sankey+

Sustainability

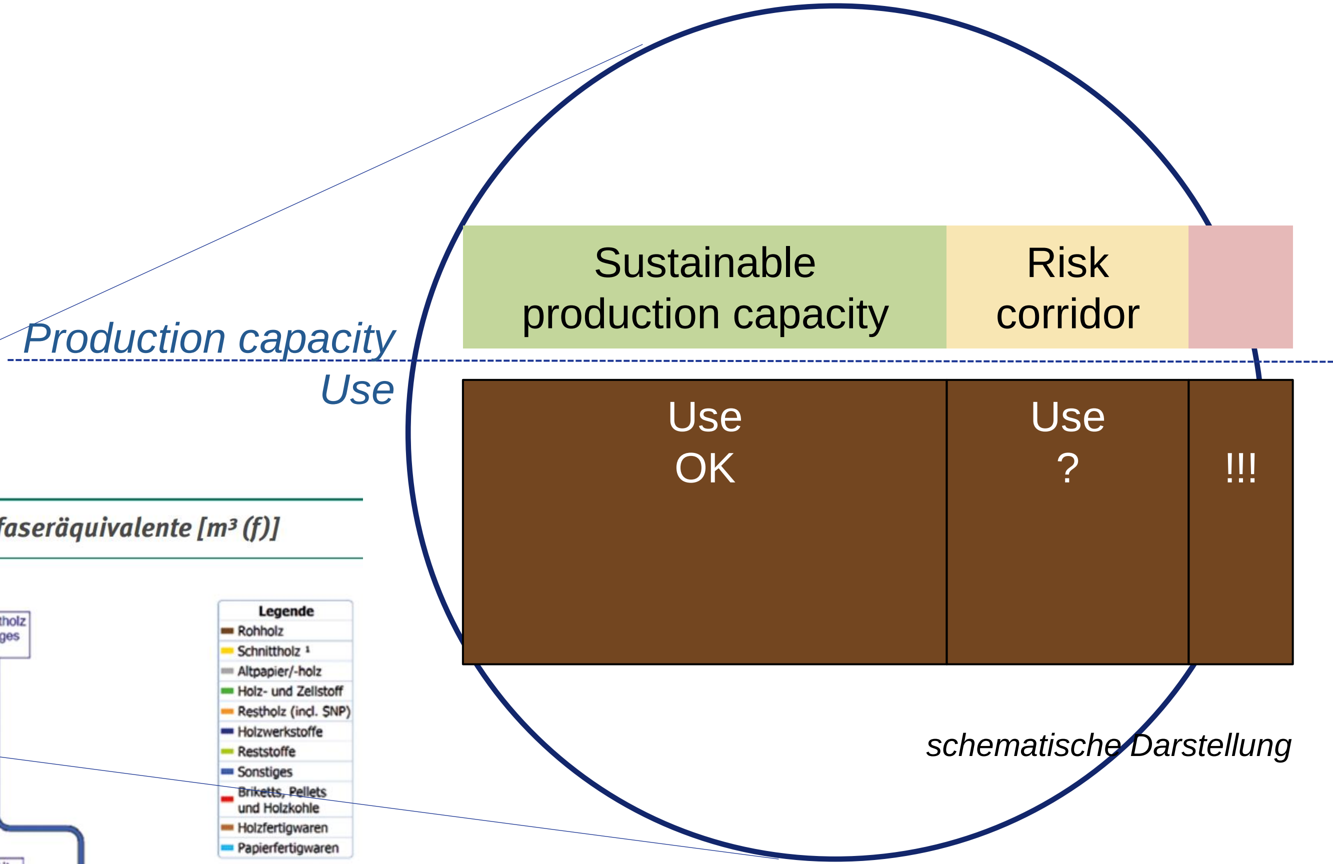
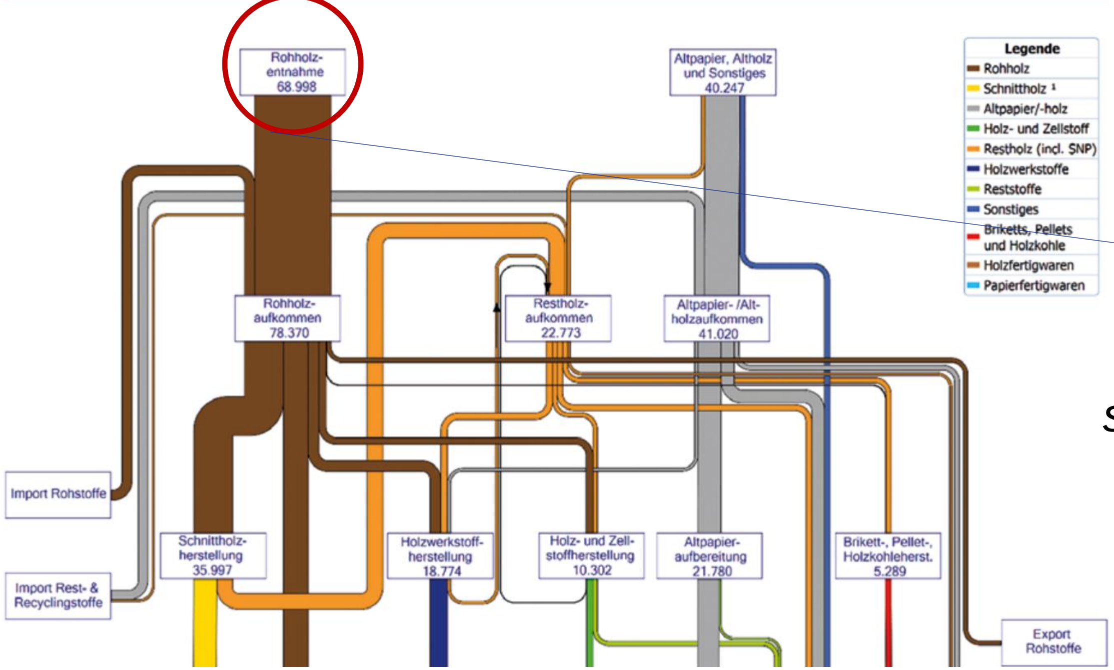


Abb. 2.7 | **Holzfluss in Deutschland für das Jahr 2015 in m³ Holzfaseräquivalente [m³ (f)]**



Quelle: Abb 2.7 wiedergegeben aus Bringezu et al. (2020): *Pilotbericht zum Monitoring der deutschen Bioökonomie,* S. 29

Sankey-Diagrammes could be extended to show production capacities and uncertainty

High-potential indicators to fill identified gaps

4. **Planetary Boundaries -** a scientific-political concept consisting of 9 main indicators that are intended to map the Earth's planetary biocapacity. It can be used to show whether and to what extent planetary biocapacities have already been exceeded, what room for maneuver is still available and in which areas urgent and far-reaching action is required. *Units: different target values (and comparisons with the actual values).*
5. **Systemic LCA methods** - a variety of life cycle assessment (LCA) methods offer possibilities for estimating and interpreting the effects of certain products, processes and production systems by means of input/output modelling of micro- and meso-economic processes (ecological LCA (E-LCA), social LCA (S-LCA), business LCA (LCC) and combined or integrated LCA (LCSA) can be used to analyse the ecological, social and economic aspects; also absolute LCA methods in relation to Planetary Boundaries. ***Units:*** *various.*

High-potential indicators to fill identified gaps

6. **Biodiversity loss (potential species loss)** - The indicator is used to depict the product-specific potential biodiversity loss. It consists of the land cover (or land use change), which is multiplied by a characterisation factor that expresses the potential species loss Chaudhary et al. (2015). ***Units****: regional species loss per m^2, regional species loss per year per m^2, global species loss per m^2, global species loss per year per m^2.*

7. **Sustainable biomass potential** - The indicator shows the amount of biomass that can be utilised within a year and within an economy in accordance with nature conservation and biodiversity. Work already exists on individual aspects of sustainable biomass potentials (e.g. bioenergy potential targets, wood potentials), but there is currently no explicit indicator that systematically covers these aspects. ***Units****: tonnes or petajoules*.

High-potential indicators to fill identified gaps

8. **Spatial representation of the type, intensity and change in land use** - describes the type, intensity and change in land use in a spatial breakdown; can act as an early warning system to identify regional hotspots and interactions between different types of land use. ***Unit:*** *Map with information on regional land use (e.g. distribution of areas by agriculture, forests, cities in % and hectares; distribution by biomass type (e.g. meadows, arable land, forest areas) in % and hectares)*
9. **Pollutant and particulate matter emissions from the bioeconomy** - measures those substances in the air that have a negative impact on air quality; determines the gaseous pollutant emissions that are not greenhouse gases, such as ammonia, nitrogen oxides, volatile organic compounds, carbon monoxide, sulphur dioxide and the particulate matter content in the air; can show the total air pollutants emitted by a country (in tonnes) or the local air quality at specific measuring stations (in $\mu g/m^3$). ***Units:*** *tonnes or* $\mu g/m^3$

Recommended actions

4.1. Include spatial information that can be used to identify bioeconomy hot spots where negative environmental impacts are particularly high or not in line with sustainable biomass production.

4.2. Included detailed maps to visually communicate how land is used, how these uses are changing and how natural systems are affected by bioeconomy activities.

1. **Develop and apply a more comprehensive, multi-layered monitoring approach** that takes into account precautionary environmental protection and monitors whether bioeconomic activity remains within the sustainable biomass potential *(3 specific actions)*
2. **Define sustainability targets** for the bioeconomy *(4 specific actions)*
3. **Maintain the footprint concept** and develop it further *(4 specific actions)*
4. **Spatial information** - Enable decision-makers and the public to see the bioeconomy as a set of activities embedded in specific locations and based on the productivity of nature *(2 specific actions)*
5. **Future pathways** - Integrate possible future bioeconomy pathways and their potential environmental and social impacts into the trend analysis of bioeconomy monitoring *(4 specific actions)*
6. **Coordinate the development of monitoring** in related policies at both national and international levels *(3 specific actions)*
7. **Address research gaps** *(5 specific actions)*

Research gaps

1. **Sustainable biomass potentials** - Driving question: What are the sustainable biomass potentials in Germany, the EU and globally?
2. **Biodiversity** - Driving question: How can biodiversity loss be measured in the context of bioeconomic activities?
3. **Water** - Driving question: How can the water scarcity and water pollution associated with bioeconomy be monitored?
4. **Circular economy** - Driving question: how can bioeconomy and circular economy monitoring be linked?
5. **Coordination Germany/EU/International** - Example: Establish exchanges between EU Member States (also internationally) on the topic of monitoring the bioeconomy.


Biodiversität
Biomassepotenzial
Biodiversität
Biodiversität
tenzial
Biomassepotenzial
Landnutzungsänderung
Landnutzungsände
Grenzen
Planetarische Grenzen
Landnutzungsänderung
Planetarische Grenzen

Thank you for your attention

Aaron Best, Ecologic Institute

Berlin, 31 October 2024

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