

Bioeconomy-adapted Technology Needs Assessment Methodology

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Introduction

- Technology Needs Assessment for the bioeconomy
- Translating into application

Bioeconomy

The bioeconomy is generally understood as

the production, utilization, conservation, and regeneration of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes and services) within and across all economic sectors and enable a transformation to a sustainable economy

(International Advisory Council of the Global Bioeconomy Summit 2018).

Challenges

- Identifying solutions: technology overview
- How to measure sustainability? MISTICs, MCA
- Scale: individual (firm), regional, national, supply chain.
- Policy implications

Classical TNA and bioeconomy-adapted TNA

	Classical TNA	Bioeconomy-adapted TNA
Definition of technology	Equipment, products, techniques, practices, knowledge and skills that support climate mitigation and/or adaptation	Technologies that support the sustainable production, use, transformation, conservation or regeneration of biological resources.
Objective	Prioritize climate technologies aligned with national priorities	Prioritize bioeconomy technologies based on resource availability and national bioeconomy strategy
Preparation and scoping	Select sectors based on national climate strategies	Map biomass sectors, value chains and economic activities using national accounts and input-output tables
Technology prioritization	MCA ranking and sensitivity analysis	MCA, sensitivity analysis and MISTICs logic
Barrier Analysis	Financial, environmental, technical, market and social barriers	Feedstock availability, competing biomass uses, scale-up finance, regulation, and acceptance
Technology Action Plan	Define actions, actors, timelines, resources, financing and monitoring	Plan value-chain logistics, stakeholder roles, financing and monitoring

Technologies in the bioeconomy

Bioeconomy Technology Categories

Food and Feed	Bio-based energy	Fibre	Bio-based materials
Biofertilizer Biopesticide Gene editing Fermentation	Biogas Bioethanol Biodiesel	Natural fibres Bio-based semi-synthetic fibres Bio-based synthetic fibres	Bioplastics Bio-based construction materials Engineered living materials

Assessment implications

Biomass dependence	Multiple and competing biomass uses	Circularity potential	Context-specific feasibility
Availability, quality, seasonality	Food, feed, fibre, fuel, soil and ecosystem functions	Residue valorization, cascading use	Local ecology, skills, markets, regulation

Gaps, barriers and feasibility constraints

- **Biomass supply**
Feasibility depends on reliable, high-quality and available biomass
- **Logistics and processing**
Implementation requires storage, transport, preprocessing and infrastructure
- **Technology scale-up**
Scale-up involves pilot-to-commercial risks and cost uncertainty
- **Market uptake**
Market uptake depends on demand formation and standards, while scaling may create new lock-ins
- **Policy and governance**
Barriers include fragmented regulation and unclear residue rules
- **Adoption and acceptance**
Adoption depends on skills, digital access and stakeholder trust

Trade-offs and synergies

Trade-off: Benefits in one dimension may place pressure on other ecological, economic or social functions.

Area	Potential gain	Potential pressure
Crop residues	Bioenergy production	Food security, reduced soil cover and organic matter
Bio-based materials	Reduced fossil dependence	Land, chemicals or waste-systems
AI tools	Efficiency and monitoring gains	Data, energy

Synergy: Interactions between two or more actions can produce a stronger outcome together

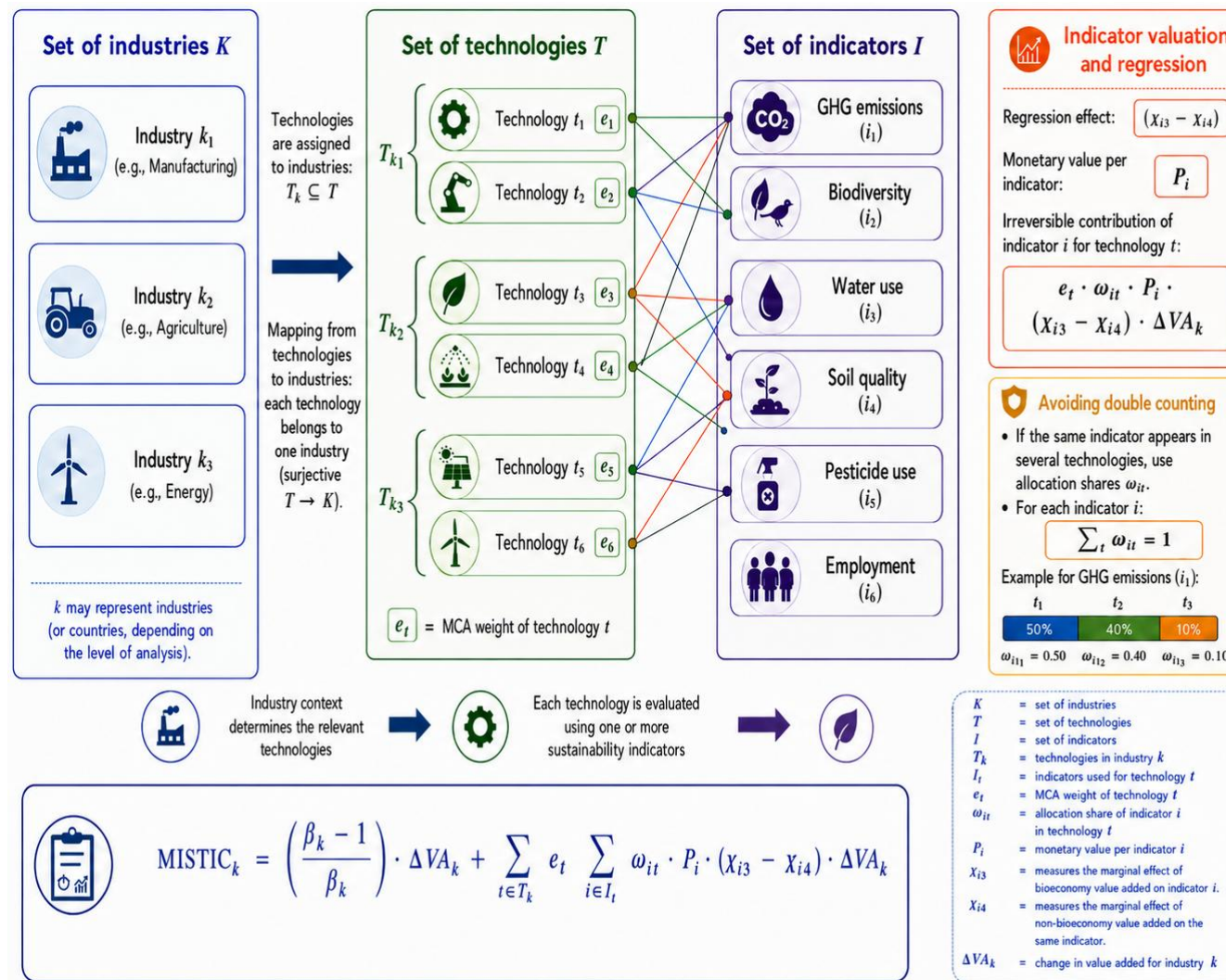
Action 1	Action 2	Combined positive outcome
Use waste and side streams	Convert them into bio-based products or fuels	Waste reduction and value creation
Treat wastewater and recover nutrients	Use recovered nutrients as fertilizer	Pollution reduction and nutrient reuse
Apply AI in research and design	Develop bio-based processes	Faster discovery and process optimization

Implication for TNA: prioritization should make trade-offs visible, identify synergies and test robustness under uncertainty

Implications for the bioeconomy-adapted TNA methodology

- **Context and scoping**
 - Start from national bioeconomy priorities, biomass resources and value chains
 - Use national accounts and input-output tables to situate bioeconomy activities
- **Technology prioritization**
 - Define sustainability, circularity and governance criteria drawing on the FAO Aspirational Principles and Criteria and the G20 High-Level Principles on Bioeconomy
 - Use MCA with sensitivity analysis and MISTICs logic to assess technologies
- **Stakeholder involvement**
 - Include actors across biomass production, processing, use and governance
 - Assess local needs, acceptance and implementation in coordination with stakeholders
- **Implementation and operationalization**
 - Link barriers, enabling measures and TAPs to value-chain conditions
 - Use the Excel tool for indicators, scoring, weighting and prioritization

MISTIC Approach



MISTIC Calculator — Inputs

- Pick a **country and sector** from the dropdowns (yellow cells)
- Set (or keep the default) **social cost of carbon (or other indicators)**
- Every downstream step (risk, hurdle rate, GHG effect) recalculates automatically

MISTIC Calculator — Full Step-by-Step Calculation

Yellow = your inputs. Blue = from data. Grey = computed. Change country/sector dropdown to update all

Step 1 — Select country and sector

Country	Bulgaria
Sector	03 Fishing and aquaculture
Sector code (internal)	03
Lookup key (internal)	Bulgaria 03

Step 2 — Social cost of carbon (you can change this)

Social cost of carbon (SCC)	191
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MISTIC Calculator — Output

- Combines a **reversible investment benefit** with an **irreversible climate benefit**
- One **MISTIC score**, with a plain-language read-out of what it means
- A built-in **sensitivity table** shows how the result shifts with the carbon price

Step 8 — MISTIC = SIRB / Hurdle Rate + SIIB

SIRB / Hurdle Rate (reversible benefit)	-3,585
+ SIIB (irreversible climate benefit / cost)	1,154

MISTIC = SIRB / Hurdle Rate + SIIB	-2,431
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● **NEGATIVE MISTIC of 2,4311 EUR M:**
investment must generate irreversible
environmental benefits to be sustainable.

Step 9 — Sensitivity: MISTIC at different carbon prices

SCC (EUR/t CO ₂ eq)	SIIB (EUR M)
50	0,302
100	0,604
150	0,907
191	1,154
250	1,511
300	1,813
400	2,417

Extending MISTIC — MCA Weights

- Each technology gets an **MCA-derived weight (e_t)** reflecting its relative priority
- Its indicators (GHG, biodiversity, water, soil, etc.) are **regressed on bioeconomy value added** to estimate marginal effects
- Effects are **converted to monetary value** with an indicator-specific price, weighted to avoid double-counting, and summed into MISTIC's irreversible term

$$MISTIC_k = \frac{\beta_k - 1}{\beta_k} \Delta V A_k + \sum_{t \in T_k} e_t \sum_{i \in I_t} \omega_{it} P_i (\chi_3^i - \chi_4^i) \Delta V A_k$$

Step 2.1 — MCA Extension (FAO indicators)

#	Indicator
1	Share of renewable energy – transport
2	Gross added value circular economy sectors (EI M)
3	Patent applications EPO (number)
4	Energy productivity (EUR per kg oil eq)

Customizing MISTIC for Other Countries

- **Bioeconomy value-added time series** = 20+ years of BE VA by country $\times$ sector, to compute SIRB and the hurdle-rate parameters (α , σ) (Input-Output Data)
- **A matching non-bioeconomy panel** = NBVA alongside BVA, year and country, to re-estimate the GHG (and other indicator) regression coefficients (Input-Output Data)
- **Country-level indicator data** = values for whichever indicators are used (renewable energy, R&D, emissions, etc.), ideally Eurostat-comparable
- **Technology** $\rightarrow$ industry mapping and MCA weights ($e^{\lambda t}$)
- **Monetary prices for indicators** = a defensible price P_i for indicators (biodiversity, soil, water, etc...) if those are included

Thank you

