

**STAR-ProBio**

**Sustainability Transition Assessment and Research of Bio-based  
Products**

***Grant Agreement Number 727740***



## Deliverable 8.3

Fast-track documentation for the procedure of  
certification of biobased products:  
Sustainably criteria for the production of bio-based  
products — Integrated assessment tool

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## Abstract

This document is developed as part of the work under the STAR-ProBio project and is intended as a basis for a standard (national or industry). It is based on the Integrated Assessment Tool (IAT), which provides a methodology for companies to both qualitatively and quantitatively assess environmental, social, economic, circularity and ILUC aspects of sustainability of bio-based products and services throughout the entire life-cycle. It represents a tool that can be applied by companies for sustainability self-assessment, benchmarking, eco-design and pre-check sustainability certification process.

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## **Sustainably criteria for the production of bio-based products — Integrated sustainability assessment tool**

ICS: 27.190 ; 13.020.30 ; 13.020.40

Descriptors: environment, biodiversity, sustainability, sustainable production, nature protection, non-natural grassland, biodiverse grassland, peatland, bio-based products, bioliquids, biomass, life-cycle analysis, life cycle inventory

This document has been edited by the Royal Dutch Standardization Institute, NEN, on request by and in coordination with the STAR-ProBio project team, led for this subject by TU Berlin.



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## Abbreviations

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Abbreviation	Description
WP	Work Package
Tx.y	Task of Work Package x followed by the number y of the task
Dx.y	Deliverable of Work Package x followed by the number y of the deliverable
SAT-ProBio	Sustainability Assessment Toolkit of STAR-ProBio project
IAT	Integrated Assessment Tool
SDG	Sustainable Development Goal
CEN	European Committee for Standardization
ISO	International Organization for Standardization
RED	Renewable Energy Directive
RSB	Roundtable on Sustainable Biomaterials
EPD	Environmental Product Declaration
PEF	Product Environmental Footprint
PEFCRs	Product Environmental Footprint Category Rules
OEF	Organization Environmental Footprint
ILCD	International Reference Life Cycle Data System
ISCC	International Sustainability & Carbon Certification
F.U.	Functional Unit
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
EoL	End-of-Life
GHG	Greenhouse Gases
iLUC	Indirect Land Use Change
CoC	Chain of Custody
EO	Economic Operator
BP	Biomass Producer
PO	Point of Origin
RP	Reference Product



## Executive summary

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This document is developed as part of the work under the STAR-ProBio project and is intended as a basis for a standard (national or industry). An early draft of the document has been submitted for evaluation to CEN, the European Standardization Committee, and the comments given used to develop this document. The groundwork for development of SAT-ProBio standardization document was the Integrated Assessment Tool (IAT), integrally described in part B of D8.2.

The IAT, Integrated Assessment Tool provides a methodology for companies to both qualitatively and quantitatively assess environmental, social, economic, circularity and ILUC aspects of sustainability of bio-based products and services throughout the entire life-cycle. It enables companies from bio-based industries to conduct internal sustainability assessments of their products for benchmarking, eco-design and sustainability qualification purposes. It lends itself as the basis for further developments like the tuning of environmental labels aiming at supporting well-informed decisions, thus increasing the market of qualified and more sustainable bio-based products. Accordingly, the IAT allows organizations to investigate what are the “interactions” of bio-based product on a wide range of sustainability areas, enabling them to identify areas of improvement, benchmarking and, thanks to the communication format, to be more transparent with the different stakeholder groups. Specifically, the implemented scoring system allows for determining how well a bio-based product performs compared to an “ideal performance”. IAT has a strong focus on applicability and business relevance, and seeks finding a compromise between applicability of the tool by companies and the coverage of sustainability impact categories for each area of protection. Furthermore, the proposed tool combines system approach with product approach.



## 1. Introduction

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It is widely accepted that sustainability at large encompasses environmental, social and economic aspects [1]. This document represents a tool, which operationalizes the results of the STAR-ProBio research project<sup>1</sup> in order to allow a sustainability assessment. This to further support European Bioeconomy strategy and policies [2], [3]. The landscape of sustainability assessment tools is however not mature and even if there are numerous tools available there is none complete enough to be commonly accepted or recommended for the bioeconomy as a whole.

STAR-ProBio constitutes a multidisciplinary and multi-actor collaborative project. It has conducted a thorough analysis of the existing certification and standardisation landscape and developed coherent criteria and indicator sets aiming at enhancing and further developing existing sustainability certification schemes and assessment approaches. A significant number of well-developed and relevant sustainability assessment and certification schemes exists within the different sectors and niches of the bioeconomy. However, STAR-ProBio identified a number of potential gaps regarding sustainability principles, criteria and indicators within the existing schemes.

In particular, it was concluded that existing standards and certification schemes tend to lack focus on the assessment of end-of-life and circularity aspects, the risk of indirect land use changes, and that social and economic impacts are addressed superficially. In this regard, the project has developed a harmonised framework for environmental life cycle assessment (LCA), social LCA (S-LCA), and techno-economic assessment of life cycle costing (LCC) To this aim, an integral part of STAR-ProBio was the adoption of life-cycle methodologies for sustainability assessment in the form of SAT-ProBio framework. The approach is coherent with the current European sustainability standard (EN 16571) through extending the criteria and indicators to new sustainability areas identified by STAR-ProBio project (ILUC, circularity, s-LCA, LCC).

The STAR-ProBio project, developed the SAT-ProBio framework, integrally described in D8.2 [4]. This framework provides two tools: (1) a sustainability assessment tool (IAT, Integrated Assessment Tool) – as a tailored instrument for the assessment of specific bio-based products enabling also the comparison of the bio-based products against fossil-based products, and (2) a sustainability certification tool (SCT, Sustainability Certification Tools) – as an overarching umbrella, describing the methodological framework and underpinnings. Both tools can be used by stakeholders and companies in order to assess specific bio-based products sustainability.

The Integrated Assessment Tool (IAT) is a sustainability assessment and communication tool which operationalizes main results of the STAR-ProBio. For each pillar of sustainability: economic, social and environmental, the IAT develops a set of criteria and qualitative & quantitative indicators (to which principles have been associated following the definitions reported in EN 16571 and ISO 13065) and related metrics and methodologies. The IAT laid down in this document is intended to address aspects of the whole life cycle of a bio-based product fixing for each aspect a thresholds or expected requirements for the case studies. Some thresholds are pending whereas for others just indicative value have been defined.

This document provides a methodological framework and technical requirements. It is based on the combination of the following methodologies:

- Life Cycle Assessment (LCA) methodology for quantitatively tackling aspects related to the environmental pillar, which have been integrated with a set of qualitative indicators to better define the context and the commitment of economic operators compared to the areas of protection;

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<sup>1</sup> STAR-ProBio (Sustainability Transition Assessment and Research of Bio-based Products) is a project subsidized under the Horizon 2020 programme, Grant Agreement Number 727740





- Soil erosion (RUSLE method) and affected biodiversity (JRC method) associated to the biomass production
- A tool for identifying ILUC risks for the bio-based product under assessment
- Social Life Cycle Assessment (S-LCA), based on the methodology reported in [5];
- Environmental Life Cycle Costing (E-LCC), related to the economic assessment of the life cycle costing (LCC) of a bio-based product;
- Circularity principles and metrics.

## 2. Scope

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This document provides a methodological framework for conducting an integrated sustainability assessment of bio-based products addressing their most relevant environmental, social and economic aspects from a life cycle perspective.

This framework is of use to organizations (bio-based industry) for conducting internal sustainability assessments of their products for benchmarking, eco-design and sustainability classification (e.g. check-list) purposes.

For each pillar of sustainability (economic, social and environmental), this document proposes a set of criteria and qualitative & quantitative indicators and related metrics and methodologies.

This document addresses the whole life cycle of a bio-based product. It is intended to be used by the organization that transforms the bio-based product into its final use.

NOTE The framework allows organizations to investigate what are the interactions of a bio-based product on a wide range of sustainability areas, enabling them to identify area of improvement (eco-design), benchmarking and to be more transparent with all stakeholder groups.

## 3. Normative references

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The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 16214-1, *Sustainability criteria for the production of biofuels and bioliquids for energy applications - Principles, criteria, indicators and verifiers - Part 1: Terminology*

EN 16751, *Bio-based products - Sustainability criteria*

EN 16848, *Bio-based products - Requirements for Business to Business communication of characteristics using a Data Sheet*

EN 16935, *Bio-based products - Requirements for Business-to-Consumer communication and claims*

ISO 13065, *Sustainability criteria for bioenergy*



### 3.1. Terms and definitions

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For the purposes of this document, the terms and definitions given in EN 16214-1 and EN 16751 and the following apply.

**benchmark (noun)**

reference point against which something is evaluated

**benchmarking (verb)**

act of determining (or judging) alignment with the fixed reference point

## 4. Purpose of this document

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A methodological guidance (or tool) for conducting an integrated sustainability assessment of bio-based products addressing their most relevant environmental, social and economic aspects, from a life cycle perspective is described. It enables companies (bio-based industry) to conduct internal sustainability assessments of their products for benchmarking, eco-design and sustainability classification (e.g. check-list) purposes.

For each pillar of sustainability: economic, social and environmental, this document develops a set of criteria and qualitative & quantitative indicators (to which principles have been associated following the definitions from EN 16751) and related metrics and methodologies. The document is intended to address aspects of the whole life cycle of a bio-based product fixing for each aspect a thresholds or expected requirements for the case studies. Some thresholds are pending whereas for others just indicative value have been defined.

The resulting proposed score system allows to identify how far a bio-based product performs compared to an aspirational performance.

## 5. Structure

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### 5.1 Sustainability assessment and areas of protection

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An Integrated Assessment Tool (IAT), providing a methodological framework for assessing the sustainability aspects related to bio-based products from a life cycle thinking perspective, shall be established.

The IAT shall encompass the three dimensions of sustainable development (social, economic and environmental) and the cross-cutting aspects, such as circularity and indirect land-use change (ILUC) (Figure 1).

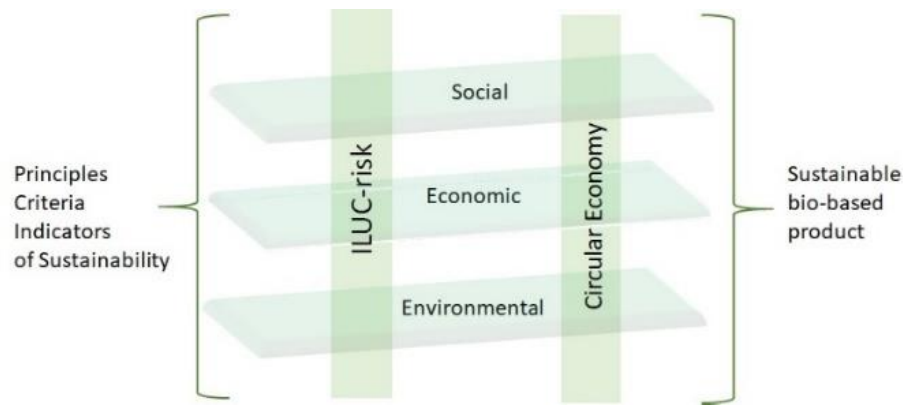


Figure 1: Sustainability Aspects of the IAT

The tool consists of 33 impact categories and related areas of protection of which 11 regarding the environmental area, 14 for the social area, 1 for the economic area and 6 related to circularity. In addition, ILUC risk in the production of bio-based products should be considered in the IAT. The identified impact categories are listed in Figure 2.

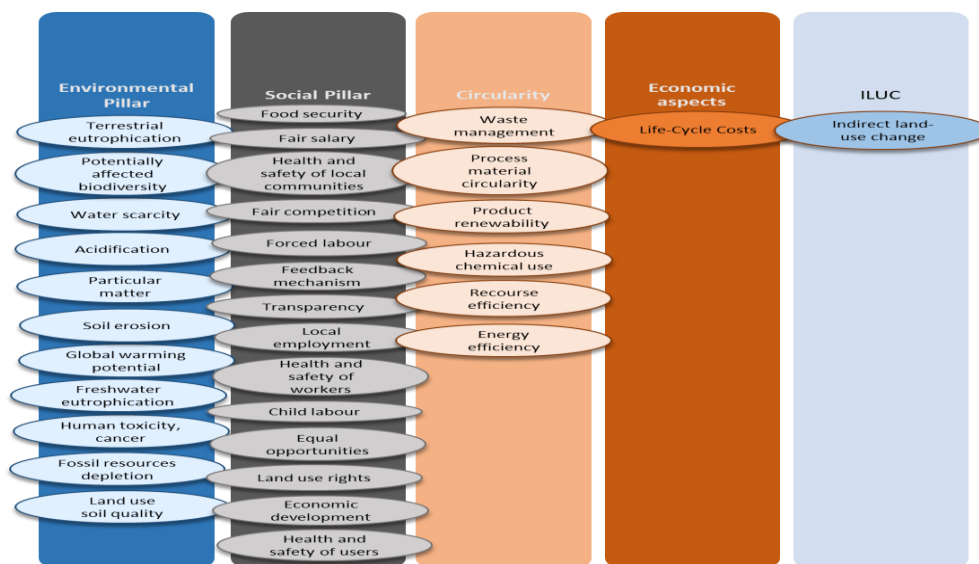


Figure 2: Identified impact categories and related sustainability pillars

## 5.2 Basics of the IAT

For the identified areas of protection, principles and criteria shall be defined. These should be in line with EN 16751 and ISO 13065.

NOTE 1 Specific standard for products are for instance, NTA 8080-1 [6] and ISCC [7].

Qualitative and preferably quantitative indicators shall be set. For each indicator related metrics and associated methodologies shall be described, providing indications on their measurement like the identification of the life cycle step where the indicator is requested.



The IAT framework consists of 24 principles, 32 criteria and 48 indicators as described in Table 1 (see for more background Annex A). Some of the indicators are considered as 'major must' (indicated in bold in Table 1). These are to be minimally addressed in order to claim any level of sustainability.

Develop a comprehensive and applicable IAT to assess the sustainability of selected bio-based products, by setting clear rules, guidelines and guidance, including a clear definition of expectations (i.e. thresholds) and a scoring system.

*Table 1: IAT Matrix including Principles, Criteria and Indicators*

Principle	Criteria	Indicator	
<b>Mitigate climate change</b>	The economic operator provides information on how greenhouse gas (GHG) emissions related to their operation are managed	1	Describe procedures taken to identify and minimize GHG emission and/or potential impacts on climate change related to their operations.
		2	<b>Provide the "Cradle to grave" Global Warming Potential (GWP) of the bio-based product determined through LCA analysis (i.e. GWP bio)</b>
Promote good air quality	The economic operator provides information on how air pollutants related to their operations are managed	3	Provide the "Cradle to grave" particulate matter emissions (PM) of the bio-based product (i.e. LCA analysis -> PM)
Conserve and protect water resources	The economic operator provides information on how biomass producers address the depletion and quality of water.  The economic operator provides information on how quality and quantity of water withdrawn and released are addressed.	4	Describe measures taken to address the impacts on water quality and quantity identified related to the production of biomass suppliers.
		5	Describe procedures to identify potential impacts and provide water consumption related to their operations.
		6	Provide the "Cradle to grave" water use of the bio-based product (i.e. LCA analysis -> water deprivation)
Protect soil quality and productivity	The economic operator provides information on how biomass producers address soil quality, erosion and productivity	7	Describe procedures to identify and address potential impacts on soil quality, productivity and soil erosion forces.
		8	Describe measures taken by biomass producers to address the impacts on soil quality, productivity and soil erosion forces.
		9	Provide the agricultural land occupation (stage 1) needed for producing the biomass used in the bio-based product.
		10	Provide land occupation associated to the operation and the erosion risk associated with the crop and region. Provide the amount of specific soil loss for bio-based product (i.e. LCA analysis -> soil erosion)
		11	Provide the "Cradle to grave" Land use of the bio-based product (i.e. LCA analysis -> Land use – soil quality index)



Principle	Criteria	Indicator	
Promote efficient use of energy resources and prevent depletion of non-renewable energy resource.	The economic operator provides information on how energy efficiency and non-renewable energy resources consumption are addressed.	12	Provide the "Cradle to grave" Non-renewable energy resources consumption for bio-based product (i.e. LCA analysis -> Resource use fossil)
Promote positive and reduce negative impacts on eco-systems and biodiversity	The economic operator provides information on potential impacts on eco-system quality and biodiversity	13	Provide the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Acidification Terrestrial and Freshwater)
		14	Provide the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication Freshwater)
		15	Provide the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication terrestrial)
		16	Describe procedures to identify potential impacts on biodiversity.
		17	Describe measures taken to promote positive and reduce negative impact on the biodiversity.
	The economic operator provides information on how biodiversity values are addressed	18	Provide the number of potentially affected species for bio-based product (i.e. LCA analysis -> potentially affected biodiversity)
Minimize the impacts on human health	The economic operator provides information on how human health values are addressed within the area of operation	19	Describe measures taken to promote positive and reduce negative impact on the human health within the area of operation.
		20	Provide the "Cradle to grave" potential impacts on human health for bio-based product (i.e. LCA analysis -> Cancer human health effects)
Reduce to a zero indirect Land-Use Change (ILUC) risk.	The economic operator provides information on how high and low Indirect Land-Use Change (ILUC) risk of biobased products is addressed	21	Provide ILUC risk for the bio-based product determined according to "ILUC Risk Tool"
Promote responsible use of high concern materials	The economic operator provides information on how hazardous chemical is addressed	22	Describe measures taken to avoid, reduce or find greener alternatives to the use of substances of very high concern (SVHC) through a screening of the product's raw materials against substances on the hazardous chemical databases, SINLIST and SUBSPORT.
Promote use of renewable materials	The economic operator provides information on the use of renewable raw materials	23	Describe measures taken to promote the use of renewable material resources and provides the % of biogenic carbon / total carbon (Product renewability)
Promote the use of material circularity. Minimize the use of	The economic operator provides information on the use of recycled	24	Describe measures taken to increase the use of recycled or renewable raw materials and the recyclability of the bio-based end product.



Principle	Criteria	Indicator	
virgin raw materials and maximize the recyclability of end products	materials and how an effective recyclability of the bio-based product is achieved	25	<b>Provide the material circularity index (MCI) of the bio-based product</b>
Promote responsible waste management	The economic operator provides information on how waste is managed and reduced	26	Describe measures taken to manage and reduce the waste.
		27	Provide the amount of total non-valorised waste generated per unit of product and useful co-product
	The economic operator provides information on bio-based disposal	28	Provide guidance and clear instructions to the consumers on how the bio-based product is to be disposed after use
Promote efficient use of energy	The economic operator provides information on how energy efficiency related to their operations is achieved	29	Describe measures taken to address energy efficiency
		30	Provide energy intensity i.e. heat and power sourced from renewable and non-renewable or internally-derived pathways consumed per unit of product and useful co-product.
Promote the use of renewable energy sources	The economic operator provides information on how the use of renewable energy sources is promoted	31	Describe measures taken to promote the use of renewable energy.
		32	Provide the share of renewable energy compared to the overall energy consumed for a given process or processes under consideration.
Promote the minimisation of life cycle costs associated with the entire life cycle, including external costs (environmental externalities)	The economic operator provides information on the life cycle costing including the environmental-related external costs	33	Describe measures taken to reduce the environmental-related costs (e.g. internalization of the environmental impacts)
		34	Provide the Societal Life Cycle Costing (LCC) including external costs for society.
Respect Labour Rights	The economic operator provides information on how forced labour is addressed <sup>0</sup>	35	<b>Describe measures taken to safeguard rights relating to forced labour including prohibiting policies, evidences, incidents and corrective action plans and a plan-do-check-act process in place to raise awareness on the topic</b>
	The economic operator provides information on how child labour is addressed <sup>0</sup>	36	<b>Describe measures taken to address child labour, including prohibiting policies, evidences (such as records on worker's age), incidents and corrective actions plans and a plan-do-check-act process in place to raise awareness on the topic</b>
	The economic operator provides information on how fair salary is addressed <sup>0</sup>	37	<b>Provide information regarding the salary of workers, including the percentage of workers whose wages meet at least legal minimum standards, incidents of delayed payments, percentage of workers paid a living wage or receive additional social benefit</b>
	The economic operator provides information on how equal opportunities and discrimination are addressed <sup>0</sup>	38	Describe measures taken to address equal opportunities, including whether a non-discrimination policy is in place, a system to enforce it, incidents and corrective action plans and a public commitments on this issue



Principle	Criteria	Indicator	
	The economic operator provides information on how health and safety of workers are addressed <sup>0</sup>	39	Describe measures taken to address health and safety of workers, including whether they comply with local laws, whether workers have the needed protective equipment, incidents and corrective plans, a plan-do-check-act process in place to protect workers' health beyond laws and public commitments on this issue
Respect health and safety of end users	The economic operator provides information on how health and safety of end users are addressed	40	<b>Describe measures taken to ensure the health and safety of end users (stage 5), including evidence that the product is safe for users, compliance with product safety laws and programmes in place to raise awareness on safety risks associated with the product.</b>
Promote consumer satisfaction	The economic operator provides information on how they provide feedback mechanisms	41	Describe measures taken to offer mechanisms for users (stage 5) to provide feedbacks, including measures to improve the mechanism, if there are surveys related to customers satisfaction and actions taken in response to the results of these surveys
Promote transparency	The economic operator provides information on how transparency is addressed	42	Describe measures taken to address transparency, including if there are compliance with regulations, consumer complaint, sustainability reporting and targets
Respect of health and safety of local communities	The economic operator provides information on how health and safety of local community are addressed	43	Describe measures taken to address health and safety of local communities, including noise, air emissions etc.
Promote local development	The economic operator provides information on how local employment is addressed	44	Describe measures taken to address local employment, including public commitments to grow local employment and the number of indefinite or temporary jobs (higher than 6 months) created or lost during the reporting period
	The economic operator provides information on how economic development is addressed	45	Describe measures taken to address economic development, including any policy, which prioritises buying goods and services from local suppliers (regional or at national level), contribution to skill development, and the percentage of employees and market share of the company that have grown in the last 5 years
Respect land use rights	The economic operator provides information on how land use rights are addressed	46	Describe measures taken by the raw materials producers (stage 1) to address land use rights, including percentage of small-scale entrepreneurs who have documented legal rights to land and who feel that their land rights are secured and if land grabbing risk is being mentioned
Respect Food Security	The economic operator provides information on how they address food security	47	Describe measures taken by the raw materials producers (stage 2) to address food security, including measures to improve and ensure local food security, a plan-do-check-act to identify and reduce risks on this topic.





Principle	Criteria	Indicator	
Promote fair competition in the market	The economic operator provides information on how fair competition in the market is addressed	48	Describe measures taken to address fair competition in the market, including incidents regarding anti-competitive behaviour, measures to increase employee awareness in this topic

## 6. Step-by-step Assessment Methodology

### 6.1 Boundaries of the IAT

The IAT is an overarching structure for conducting an extensive assessment for the environmental, economic and social pillars and cross-cutting aspects, such as circularity and ILUC-risk of the selected case studies.

The sustainability shall be developed and the following documented:

- Description of the metrics and methodologies, needed for the execution of the sustainability analysis of bio-based products (see 6.2);
- Description of guidelines for the application of each indicator (see 6.3);
- Description of the scoring system used (see 6.4);
- Threshold values some of them specific for the product category the bio-based product belongs to, needed for determining “how well” the bio-based product under consideration performs in comparison to (i) an ideal situation, (ii) a specific target (e.g. circular indicators), (iii) a reference scenario (e.g. LCA thresholds) or (iv) a minimum requirement (e.g. social aspects);

The performed assessment shall reflect the real bio-based product life cycle under investigation. The applicability of each of the criteria for the following parts of the product life cycle shall be established and documented:

- 1) Biomass production or acquisition;
- 2) Raw material feedstock production;
- 3) Bio-based product production;
- 4) Bio-based product transformation into a final use;
- 5) Product use;
- 6) End-of-life.

NOTE More detail is given in Figure A.1

### 6.2 Metrics and related methodological approaches and standards

The full list of principles, criteria and indicators for the product shall be developed and documented. Per indicator the following shall be documented:

- i. The indication of the product life cycle stage(s) covered by the indicator;



- ii. Threshold values that serve as a benchmark that a bio-based product meet sustainable criteria in reference to given indicator (this is linked to the possible establishment of minimum requirements);
- iii. A score (linked to an established scoring system, see 6.3);
- iv. Indication of the comparability with fossil based counterparts or other bio-based products;
- v. The importance of the indicator (for example: major must, minor must or recommendation);

It is necessary to consider all the 48 indicators in Table 1. Table B.1 presents an example of a completed IAT framework derived from the STAR-ProBio project containing all the 48 indicators.

## 6.3 IAT Implementation

This subclause provides a short guidance and support on how the IAT indicators should be calculated and verified. To resolve confidentiality issues associated to the acquisition of some sensitive data and information (e.g. type of suppliers, raw materials used etc.), that could rise among the various value chain actors, a modular approach for data collection and assessment is recommended.

This approach is based on the acquisition of data through a series of life-cycle-stage tailored questionnaires, included in Annex D. As described in Figure 3, the applicant of the IAT (stage 4) shall acquire data related to stage 3 directly from the bio-based material producers (stage 3) using as a minimum the questionnaire presented in Figure D.3. In addition, the applicant is responsible for responding to the questions related to stages 4, 5 and 6, respectively included in Figures D.4, D.5 and D.6.

In turn, the information related to stage 2 has to be collected by the bio-base material manufacturing (stage 3), using the questions provided in Figure D.2, while the information related to stage 1, is collected by the raw material producers (stage 2), using Figure D.1.

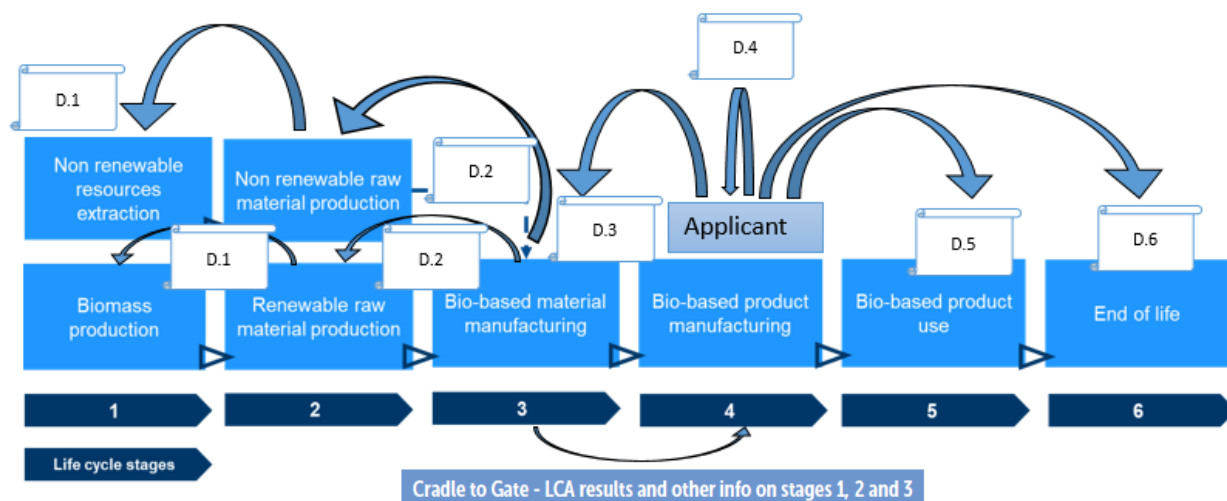


Figure 3 - Modular approach for data collection and assessment



Considering potential issues surrounding data availability and confidentiality for conducting the cradle-to-grave LCA for the bio-based product by the applicant, the bio-based material manufacturing (stage 3) will provide the cradle-to-gate LCA results on the material to the applicant, to be used for the cradle-to-grave LCA as well as the results related to soil erosion and affected biodiversity along with other valuable information. The successful application of this approach will depend on the collaboration of all the value chain actors involved in the production of the bio-based products.

Table C.1 provides guidance on how to calculate/measure the performance of each indicator.

## 6.4 Elements of IAT

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### 6.4.1 General

An IAT includes indicators, some of them are quantitative and other qualitative[8]. For all of these, threshold values are proposed in order to determine “how well” the analysed bio-based product performs in comparison to: (i) a good practice (e.g. the companies has a certain policy in place), (ii) a specific target (e.g. renewable content), (iii) a reference scenario (e.g. LCA thresholds) or (iv) a minimum requirement (e.g. social aspects).

Quantitative indicators are expressed in absolute values and compared to a reference value. Conversely, qualitative indicators related to the existence of policies regarding GHG emissions, energy efficiency, biodiversity protection etc. or the fulfilment of minimum social requirements are based on self-declarations of the economic operators and are determined through the compilation of the specific questionnaires with a simple yes/no condition.

For each of the proposed indicators a score is allocated of which, some are considered to be major must (see the bold ones in Table 1). These requirements shall be met.

The process of assigning a numerical score to each indicator varies, depending on its particular sustainability pillar (economic, social, environmental or circularity) and on the characteristic of indicator (qualitative/quantitative): for quantitative indicators the assigned score when the threshold is passed, is “2” whereas for qualitative it is “1”.

NOTE Allocating a same weight for each indicator, is suggested by a recent study [9].

In addition, it has to be decided which indicators have the most important characteristic. Internal and external consultations on these aspects should result in supporting results for the interpretation and the judgment on the performance.

### 6.4.2 Presence of Internal Policies, Code of Conducts and Good Practices

The environmental, circularity and economic pillars include both qualitative and quantitative indicators. The qualitative indicators are related to the existence of policies or initiative, which address identified areas of protection and are assigned a value of 0 in the absence of policies and 1 in presence of policies.

Figure 4, provides an overview of the 10 IAT policy-related indicators. Five of these relate to environmental aspects, whereas four relate to circularity aspects and one indicator relates to economic, and the applicability to the different life cycle stages.



Figure 4 – Qualitative Internal Policy related IAT indicators

The total score of each stage ( $T_p$ ) results from the sum of the weighted average scores along the row, that is the indicators as showed in the following Formula (1):

$$T_p = \sum_{k=0}^{10} (\bar{a}_k) \quad (1)$$

where:

- $k$  is the addressed aspect (indicator)
- $\bar{a}_k$  is the weighted average score for each indicator, calculated as follows:

$$a = \sum_{n=0}^n (W_n \times r_n) \quad (2)$$

where:

- $n$  is the economic operator that operates in the correspondent stage
- $W_n$  is the relevance of the economic operator expressed as the ratio between the material amount produced by the  $n$ -economic operator divided of total used materials of the corresponded stage
- $r_n$  is the  $n^{\text{th}}$  response

The column "Volume representativeness",  $V$ , in Figure 4 corresponds to the representativeness of economic operators that have replied to the questionnaire, calculated as follows:

$$V = \sum_{n=0}^n (W_n \times 100) \quad (3)$$

**EXAMPLE** If the applicant collects questionnaires from 10 biomass producers (stage 1) and they represent in total 90% of the total volume (on mass basis) of biomass used, the 'share' will be 90%. The weighted average scores are calculated with the formula (2). As an example, in the figure, the total score for stage 1, is 1,8. Please note that only 3 indicators are applicable to this stage. The same formula is used for calculating the total score of stage 3 (bio-based material manufacturing), considering that in this case, all the indicators apply. For stage 4 (bio-based product manufacturing) there will be only one questionnaire filled by the applicant, so the representativeness is always 100%, and the boxes indicating the average value are either coloured in green (existence of policy) or in red (absence of policy).

### 6.4.3 LCA indicators

All the nine environmental-related LCA indicators will score 2 points when the LCA resulting value is below the value of the reference product (threshold).

Figure 5 provides an example in which six out of the nine LCA indicators perform below the reference value, obtaining a total of 12 points between them.

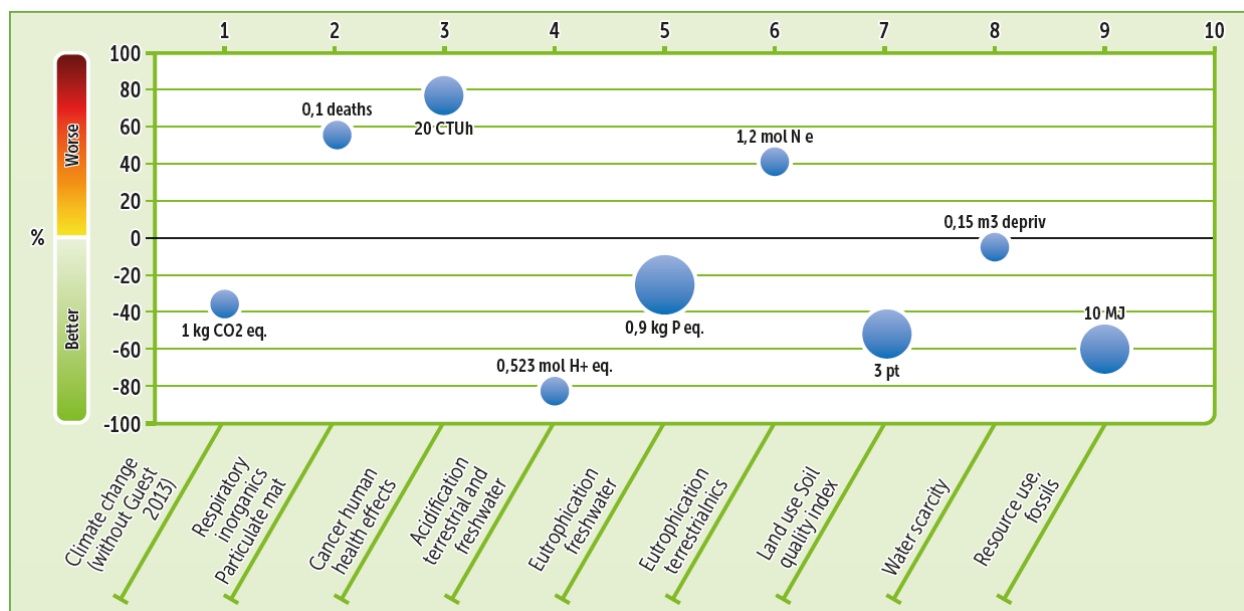


Figure 5 – LCA indicators performance example

### 6.4.4 Biomass production

In addition to the LCA indicators, the IAT includes the following two additional quantitative indicators related exclusively to the production of biomass (at stage 1):

- i) Affected biodiversity;
- ii) Soil erosion.

The methodology for calculating both indicators are described in Table C.1.

### 6.4.5 ILUC

The ILUC risk is estimated using the ILUC Risk tool developed by the University of Bologna [22].

NOTE 1 It consists of a user-friendly Excel file usable by biomass producers, intermediate product producers, bio-based material producers, auditors, and policy makers, on different detail levels.

The recommended scoring is based on three risk levels, namely; low, medium and high, depending on the relative risk level obtained using the tool.

NOTE 2 If the ILUC value is low the highest score, i.e. 2, is awarded.

### 6.4.6 Social indicators

All the fourteen social indicators are qualitative and the fulfilment is proven with a simple yes/no condition. The indicators are related to the existence of policies or initiative to address identified areas of protection within the social pillar.

They assume a value that is 0 or 1 (0 = when the economic operator related to a stage declares the absence of policies, 1 = when the economic operator related to a stage declares the presence of policies).

Figure 6 provides an overview of the IAT social indicators and their applicability to the different life cycle stages.

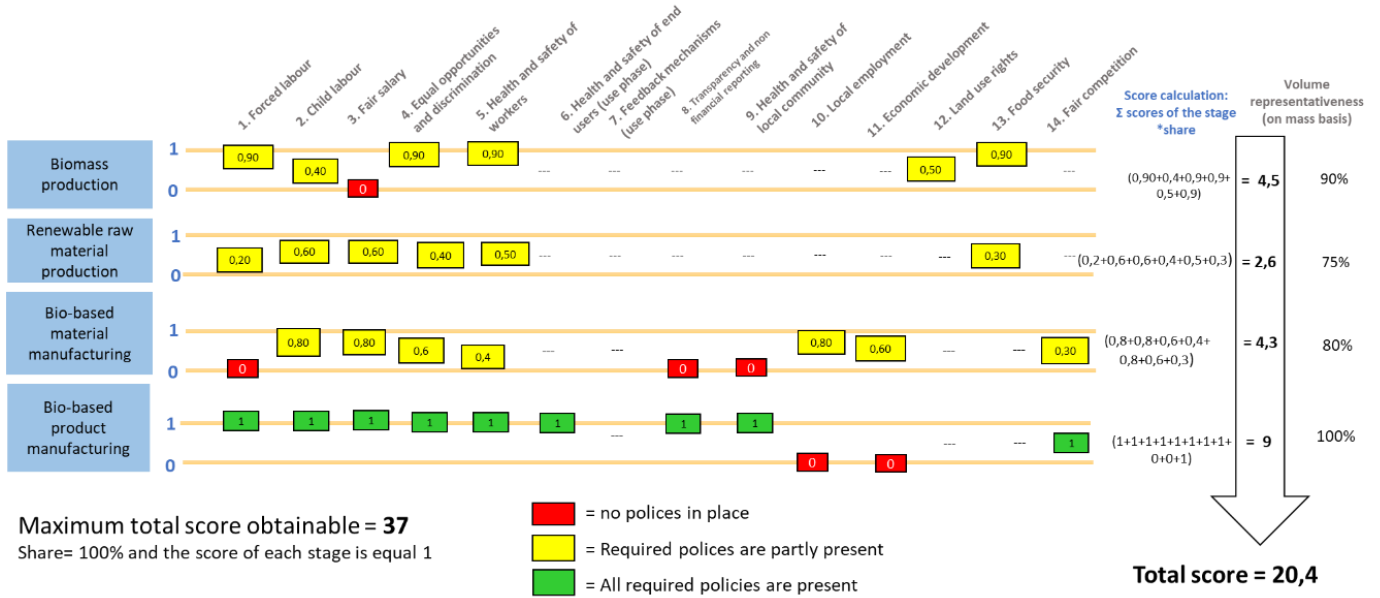


Figure 6 - IAT social indicators example

The total score of each stage ( $T_s$ ) results from the sum of the weighted average scores along the row, that is the indicators as showed in the following Formula (4):

$$T_s = \sum_{k=0}^{14} (\bar{a}_k) \quad (4)$$

where:

- $k$  is the addressed aspect (indicator)
- $\bar{a}_k$  is the weighted average score for each indicator, calculated as in Formula (2).

The column "share",  $S$ , in Figure 6 corresponds to the representativeness of economic operators that have replied to the questionnaire, calculated as follows:

$$\bar{a} = \frac{\sum (W_n \times response_{nnn=0})}{\sum W_n} \quad (5)$$

where:

- $n$  is the economic operator that operates in the correspondent stage
- $W_n$  is the relevance of the economic operator expressed as the ratio between the material amount produced by the  $n$ -economic operator divided of total used materials of the corresponded stage
- Response = it refers to the answer in the questionnaire (1= presence of the policy 0 = not present)

**EXAMPLE** In Figure 6, the total score for stage 1, is 4,5. Please note that only 7 indicators are applicable to this stage. The same formula is applied for calculating the total score of stage 2 and stage 3 (renewable raw material production bio-based material manufacturing), taking into account that in this case, respectively 6 and 10 indicators apply. For stage 4 (bio-based product manufacturing) there will be only one questionnaire filled by the applicant, so the



representativeness is always 100%, and the boxes indicating the average value are either coloured in green (existence of policy) or in red (absence of policy).

### 6.4.5 Circularity indicators

The IAT includes seven quantitative indicators for assessing the product and system circularity. The indicators are expressed in absolute values, which may be lower or higher than the threshold values (see Figure 7), for obtaining a score of 2 points.

The IAT consists of a reference value for all of the indicators, except for the energy intensity, therefore, this indicator in the example does not have a value. The total score of the bio-based product manufacturing (stage 2) shall be given by the sum of "2" each time the indicator meets the propose threshold. The same applies to stage 2, with the difference that in case of 2 or more manufactures, an average value should be calculated.

	Absence of hazardous chemicals	Renewable content	Material circularity index	Waste intensity	Disposal instruction	Energy intensity	% renewable energy
UNIT	Yes  or No	%	Dimension less (0-1)	Kg non valorized waste/unit of biobased product	Yes  or No	MJ/ unit of biobased product	%
Threshold value	Absence	> 50%	> 0,5	Not defined	Indicated	Not defined	> 20%
Bio-based material manufacturing	N.A.	N.A.	N.A.	0,015	N.A.	2,3	25%
Bio-based product manufacturing		60%	0,6	0,012		3,1	10%
N.A. not applicable							

Figure 7 - IAT circularity indicators example

### 6.4.6 Total score

In addition to the categories described in 6.4.2 until 6.4.7, a further score for relevant standards applicable to the bio-based product category under consideration shall be provided. If a certificate related to such a standard is present, an additional 2 points may be assigned.

Example For mulch films, a relevant product-category standard is EN 17033.

The maximum overall score that can be achieved is 105, as summarized in the Table 2.

Table 2 - IAT maximum overall score

Category of Indicators	Maximum Score
Policies and Initiatives (6.4.2)	23
Quantitative LCA indicators (6.4.3)	18
Affected biodiversity (6.4.4i)	2
Soil erosion (6.4.4ii)	2
ILUC (6.4.5)	2
Social (6.4.6)	34
LCC	2



Circularity (6.4.7)	20
Relevant standards applicability (6.4.8)	2
<b>Total Maximum Score</b>	<b>105</b>

Based on the obtained score along scale presented in Figure 8, the overall performance may be visualized and one can assess the necessary actions for the bio-based product under consideration.

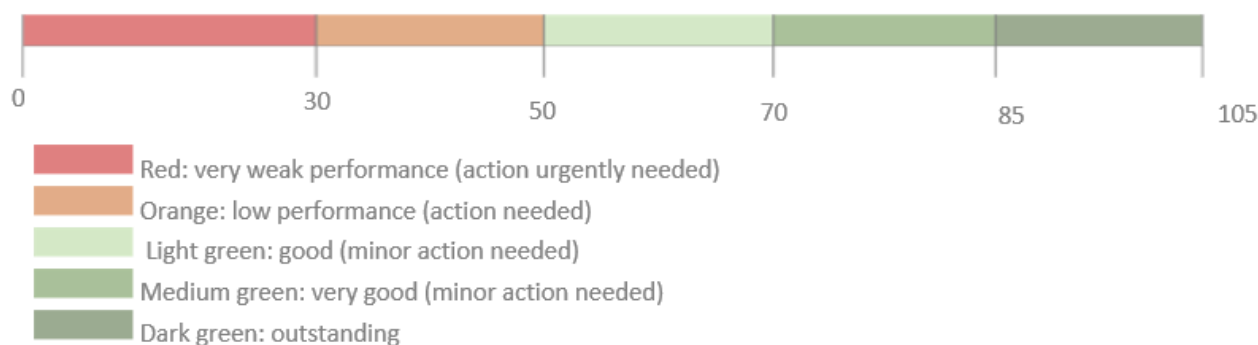


Figure 8 - IAT score visualization

## 6.5 Communication of results






Communication to consumers shall be in line with EN 16935. For communication within the product life cycle EN 16848 applies.

NOTE See [10] for further instructions.

It is recommended to summarize the results of the IAT framework in a graphical way, showing the performance of each indicator in relation to the thresholds. Table 2 shows the basic principles that are to be used if communication is considered. The fundamental principles of communication are presented with next to them how the IAT incorporates them.



Table 3 – Basic principles of IAT communication [10]

Fundamental Principles	IAT
 <b>RELIABILITY</b> Build your claims on a reliable basis <ul style="list-style-type: none"> <li>• Accurate and scientifically true</li> <li>• Robust and consistent</li> <li>• Substantiated data and assumptions</li> </ul>	<p>Reliability: IAT proposes scientifically robust indicators for assessing the performance of identified area of concern. The proposed metrics are in line with internationally standards, guidelines and best practices</p>
 <b>RELEVANCE</b> Talk about major improvements, in areas that matter <ul style="list-style-type: none"> <li>• Significant aspects ('hotspots') covered</li> <li>• Not masking poor product performance, no burden shifting</li> <li>• Genuine benefit which goes beyond legal compliance</li> </ul>	<p>Relevance: it is one of the value added of IAT. IAT conducts an assessment of identified areas of concern that should be considered for bio-based products for the three pillars of sustainability. The selection of indicators is directly based on research activities performed in WPs.</p>
 <b>CLARITY</b> Make the information useful for the consumer <ul style="list-style-type: none"> <li>• Exclusive and direct link between claim and product</li> <li>• Explicit and easy to understand</li> <li>• Limits of claim clearly stated</li> </ul>	<p>Clarity: IAT provides the consumers with information about the sustainability performance of bio-based products. It is possible to see in the final Sustainability Report (see Figure 3) of the product, how well it performed in relation to the reference product.</p>
 <b>TRANSPARENCY</b> Satisfy the consumer's appetite for information, and do not hide <ul style="list-style-type: none"> <li>• Developer of the claim and provider of evidence published</li> <li>• Traceability and generation of claim (methods, sources, etc.) published</li> <li>• Confidential information open to competent bodies</li> </ul>	<p>Transparency: all the information about the performance of bio-based product are accessible. In this way it is possible to trace back how the final score has been obtained.</p>
 <b>ACCESSIBILITY</b> Let the information get to the consumer, not the other way around <ul style="list-style-type: none"> <li>• Clearly visible: claim easily found</li> <li>• Readily accessible: claim close to the product, and at required time and location</li> </ul>	<p>Accessibility: IAT proposes to add a QR code close to the label from which it is possible to get all related information.</p>

Source: Modified from UNEP 2017

Beyond the basic principles of Table 3, the IAT communication shall provide insight in the results of the assessment related to the proposed metrics. It should contain the following sustainability information:

- The score (percentage)positioning of the bio-based product compared to the reference product or the average impact of the sector the bio-based product belongs to;
- The score (percentage) position of the bio-based products compared to the minimum social requirements;
- Absolute Life Cycle Inventory and Analysis (LCIA) results for the Functional Unit of the bio-based product and where possible their relevance;
- Circular indicators performance against reference value;
- Soil erosion, preferably compared to a MIN and MAX scale
- Affected biodiversity, preferably along a MIN and MAX range
- ILUC risk when existing;
- The distribution (for instance average value) of the economic operators that have in place policies suitable to guarantee the minimum social requirements;
- Circular indicators performance;
- Transversal aspects relating to the presence of relevant standards for the particular bio-based product group (e.g. for biodegradable mulch film it could be the level of compliance with EN 17033)[21] ;
- The overall sustainability score proportional to the obtainable maximum score;
- Product specific properties;

Annex F presents further reporting and visual examples.



## Annex A (informative)

### Background to the principles, criteria, indicators and thresholds

For the identified areas of protection required under 5.1, principles and criteria have been defined in the STAR-ProBio project in line with EN 16751, ISO 13065 and NTA 8080-1. After that, qualitative and quantitative indicators have been set. Overall 48 indicators, 32 criteria and 24 principles were determined for the IAT. For each indicator related metrics and associated methodologies were described, providing indications on their measurement like the identification of the life cycle step where the indicator is requested.

Different interactions resulted in the definition of adapted (using for example existing methodologies) or alternative metrics in order to make the tool applicable and robust. For example, considering the importance of ensuring sustainability in biomass production/acquisition and the high uncertainty that characterizes some of the LCA impact categories (i.e. soil erosion, biodiversity and water scarcity) additional criteria and indicators specific for biomass production have been included in the assessment tool. The latter covers biodiversity, soil quality and water quality and depletion.

The IAT assumes the trade-off among the coverage of relevant topics/concerns and its applicability by companies. The IAT, in the process of sustainability assessment combines the existing methodologies and STAR-ProBio approaches:

- Life Cycle Assessment (LCA) methodology [11] for tackling, in quantitative terms, relevant aspects related to the environmental pillar which have been integrated with a set of qualitative indicators to better define the context and the commitment of economic operators compared to the areas of concern;
- Soil erosion (Rusle method) and affected biodiversity (JRC method) associated to the biomass production;
- A tool for identifying ILUC risks for the bio-based product under consideration;
- Social Life Cycle Assessment (S-LCA) assessment, based on the methodology reported in [7];
- Environmental Life Cycle Costing (E-LCC) related to the economic assessment of the life cycle costing (LCC, [12]) of a bio-based product;
- Circularity principles and metrics, see also CEN/TR 16597 [13].

These methodologies have been applied following a Life Cycle Thinking (LCT) approach and selecting the existing standards that best fitted with the purpose of the tool itself. The life cycle stages run from biomass production (stage 1) up to the end of life (stage 6). Figure A.1 illustrates the general life cycle stages of a bio-based products.

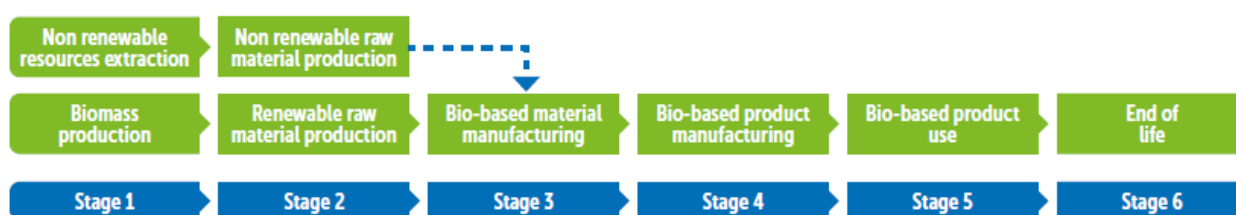


Figure A.1 - Life cycle stages of a bio-based product (general scheme)



In order to assess the sustainability of a bio-based product, utilizing the IAT matrix, specific guidelines and guidance are needed. These include a clear definition of all expectations (i.e. thresholds) and a scoring system. The IAT intends to propose for each indicator, a case study-specific “thresholds” or “expected minimum performance”. However, as described in Annex E, indicative values exist for some thresholds, while values are still yet to be proposed for very few other thresholds.

For each indicator the IAT needs to contain of a level of performance, specifying how the indicator should perform. This is called the IAT threshold<sup>2</sup>. For most of the environmental indicators, the threshold is defined as a better performance in respect with the performance of the Reference Product (RP) or benchmark which corresponds to the representative LCA value of the specific product group to which the bio-based product belongs (see [14]). In order to determine if a given bio-based product is environmentally preferable, it is necessary to define a benchmark to which a comparison is to be made. Within the STAR-ProBio project, a virtual RP was defined (using secondary and literature, market data) given the fact that the definition of a real benchmark cannot be achieved without a tight involvement and collaboration of the representative economic operators.

For the circularity indicators, different options for establishing expectations are included. For the social indicators, expectations are defined based on the methodology reported in [5] that correspond to the minimum social requirements.

The IAT developed also includes information where comparability with fossil based counterpart, when possible, is indicated.

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<sup>2</sup> Threshold in IAT reflect the reasonable expectations by stakeholder groups such as a product characterize by an ameliorative environmental performance compared to the *status quo*, no child labour along supply chain etc.



## Annex B (informative)

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### Template for an IAT Matrix

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An example of a complete IAT framework matrix is given in Table B.1. It contains all the principles, criteria and indicators required under 6.1. The criteria and indicators as presented in Table B.1 are all to be considered when completing an IAT framework in line with this document.

Furthermore, Table B.1 informatively presents the identified six parts of the product life cycle that the criterion is deemed to be applicable to (6.2.i). Thresholds (6.2.ii), scoring (6.2.iii), comparability indications (6.2.iv), as well as characteristics (6.2.v) are given as examples. These can be different for different bio-based products.



Table B.1 Matrix example



= **Quantitative** indicator Y/N **qualitative** indicator

	Principle	Criteria	Indicator		life cycle stages	IAT threshold (i.e. <u>expectations</u> )	Type	Compa rability fossil
ENVIRONMENTAL	Mitigate climate change	The economic operator provides information on how greenhouse gas (GHG) emissions associated with their operations are managed	1	Describe procedures taken to identify and minimize GHG emission and/or potential impacts on climate change in relations to their operations.	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific procedures, policies or initiatives addressing GHG emissions	Y/N	✓
			2	The applicant (stage 4) provides the "Cradle to grave" Global Warming Potential (GWP) of the bio-based product, (LCA analysis) (i.e. GWP bio) <b>(MAJOR MUST)</b>	Stage 1-6	The GWP "Cradle to grave" of the bio-based product has to be below the value of the Reference Product (RP) <sup>3</sup>		✓
	Promote good air quality	The economic operator provides information on how air pollutants resulting from their operations are managed	3	The applicant (stage 4) provides the "Cradle to grave" particulate matter emissions (PM) of the bio-based product (i.e. LCA analysis -> PM)	Stage 1-6	The PM "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP) <sup>4</sup>		✓
	Conserve and protect water resources	The economic operator provides information on how biomass producers address the depletion and quality of water	4	Describe measures taken to address the impacts on water quality and quantity identified, related to the production of biomass suppliers	1	The producers of biomass should have in place specific procedures, policies or initiatives to reduce and protect the quality of water resource <sup>5</sup>	Y/N	

<sup>3</sup> See Chapter 3.1 for the threshold values of specific case studies

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)



		The economic operator provides information on how quality and quantity of water withdrawn and released are addressed.	5	Describe procedures to identify potential impacts and provide water consumption associated with their operations.	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific procedures, policies or initiatives to protect water resource.	Y/N	
			6	The applicant (stage 4) provides the "Cradle to grave" water use of the bio-based product (i.e. LCA analysis -> water deprivation)	Stage 1-6	The water deprivation "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP) <sup>24</sup>		NO
	<b>Protect soil quality and productivity</b>	The economic operator provides information on how biomass producers address soil quality, erosion and productivity	7	Describe procedures to identify and address potential impacts on soil quality, productivity and soil erosion forces.	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific policies or initiatives to identify and address potential impacts on soil quality, productivity and soil erosion forces, associated with the biomass production	Y/N	
			8	Describe measures taken by biomass producers to address the impacts on soil quality, productivity and soil erosion forces.	1	The producers of biomass should have in place specific measures to protect soil quality, productivity and soil erosion forces <sup>4</sup>	Y/N	
			9	The applicant (stage 4) provides the agricultural land occupation (stage 1) needed for producing the biomass used in the bio-based product.	1	Renewable feedstock production should minimize the agricultural land occupation (reference value not defined yet)	Y/N	NO
			10	The applicant (stage 4) provides the erosion risk associated with the biomass production (crop and region specific) used for producing the bio-based product. Provide the amount of specific soil loss for bio-based product (i.e. LCA analysis -> soil erosion)	1	The Soil erosion risk should be minimized.  The soil erosion induced by the bio-based product has to be below a safeguard level, expressed at the field (hence Mg soil ha <sup>-1</sup> yr <sup>-1</sup> ), assumed to be 30% of the maximum value, as determined using the proposed methodology (see D2.2).		NO
			11	The applicant (stage 4) provides the "Cradle to grave" Land use of the bio-based product (i.e. LCA analysis -> Land use – soil quality index)	Stage 1-6	The Land use –soil quality index "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP).		NO

<sup>4</sup> See chapter 3.3 for the threshold values of specific case studies

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)



<b>Promote efficient use of energy resources and prevent depletion of non-renewable energy resource</b>	The economic operator provides information on how energy efficiency and non-renewable energy resource consumption are achieved.	12	The applicant (stage 4) provides the "Cradle to grave" Non-renewable energy resource consumption for bio-based product (i.e. LCA analysis -> Resource use fossil)	Stage 1-6	The non-renewable energy resource consumption "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP) <sup>4</sup>		
<b>Promote positive and reduce negative impacts on eco-systems and biodiversity</b>	The economic operator provides information on potential impacts on eco-system quality and biodiversity	13	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Acidification Terrestrial and Freshwater)	Stage 1-6	The acidification terrestrial "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP).		NO
		14	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication Freshwater)	Stage 1-6	The eutrophication freshwater "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP).		NO
		15	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication terrestrial)	Stage 1-6	The eutrophication terrestrial "Cradle to grave" of the bio-based product has to be below of the Reference Product (RP) <sup>5</sup> .		NO
		16	Describe procedures to identify potential impacts on biodiversity <sup>5</sup> .	1	The producers of biomass have to have in place specific measures to identify potential impacts on biodiversity. <sup>6</sup>	Y/N	NO
		17	Describe measures taken to promote positive and reduce negative impact on the biodiversity.	1	The producers of biomass have to have in place specific measures to reduce negative impact on the biodiversity. <sup>6</sup>	Y/N	NO

<sup>4</sup> See Chapter 3.3 for the threshold values of specific case studies

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)

<sup>6</sup> NOTE Potential impacts on biodiversity can include impacts on ecosystems, habitats and identified rare, threatened and vulnerable species of local, regional or global importance.



		The economic operator provides information on how biodiversity values are addressed	18	Provide the number of potentially affected species for bio-based product (i.e. LCA analysis -> potentially affected biodiversity)	1	The potentially affected biodiversity associated with the biomass production used in the manufacturing of the bio-based product has to be below a safeguard level, assumed to be 30% <sup>6</sup> of the maximum value for the specific crop/s used for manufacturing the bio-based product.		NO
	<b>Minimize the impacts on Human Health</b>	The economic operator provides information on how Human Health values are addressed within the area of operation	19	Describe measures taken to promote positive and reduce negative impact on the Human Health within the area of operation.	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific procedures or policies to minimize the impacts on Human Health.	Y/N	
			20	The applicant (stage 4) provides the "Cradle to grave" potential impacts on Human health for bio-based product (i.e. LCA analysis -> Cancer Human health effects)	Stage 1-6	The Cancer human health effects "Cradle to grave" of the bio-based product must be below the Reference Product (RP) <sup>4</sup> .		✓
<b>ILUC</b>	Reduce to a zero indirect Land-Use Change (ILUC) risk.	The economic operator provides information on its strategies adopted to reach a "low ILUC risk" level	21	The applicant (stage 4) provides ILUC risk for the bio-based product determined according to "ILUC Risk Tool"	Stage 1-4	Minimize the indirect Land-Use Change (ILUC) risk.		NO
<b>PRODUCT AND SYSTEM</b>	Promote responsible use of high concern materials	The economic operator provides information on how hazardous chemical is addressed	22	Describe measures taken to avoid, reduce or find greener alternatives to the use of substances of very high concern (SVHC) through a screening of the product's raw materials against substances on the hazardous chemical databases, SINLIST and SUBSPORT.	Stage 3,4	High concern chemicals are not allowed to be used.  The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific procedures, policies or initiatives addressing safety aspects regarding chemicals embedded in the products they produce.	Y/N	✓

<sup>4</sup> See Chapter 3.3 for the threshold values of specific case studies

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)

<sup>7</sup> The minimum and the maximum values are obtained applying the methodology described in D2.2 to the top-ten producer countries (FAOSTAT data) of the crop/s used in the manufacturing of the bio-based product. Therefore MIN and MAX consider the specific yields of the geographic area along with their biodiversity richness.



Promote use of renewable materials	The economic operator provides information on the use of renewable raw materials	23	The applicant (stage 4) describes measures taken to promote the use of renewable material resources and provides the % of biogenic carbon / total carbon (Product renewability)	4	Maximize the use of renewable feedstock components. The bio-based product renewability should be above a minimum value <sup>4</sup>		NO
Promote the use of material circularity. Minimize the use of virgin raw materials and maximize the recyclability of end products	The economic operator provides information on the use of recycled materials and how an effective recyclability of the bio-based product is achieved	24	The applicant (stage 4) describes measures taken to increase the use of recycled or renewable raw materials and the recyclability of the bio-based end product.	4	The applicant company (stage 4) should have in place specific procedures, policies or initiatives promoting the use of recycled and/or renewable raw materials and the recyclability of the bio-based end product (stage 6).	Y/N	✓
		25	The applicant (stage 4) provides the material circularity index (MCI) of the bio-based product. <b>(MAJOR MUST)</b>	5	Maximize the material circularity of the bio-based products. The MCI should be higher compared to the MCI of the Reference Product (RP) <sup>4</sup>		✓
Promote responsible waste management	The economic operator provides information on how waste is managed and reduced	26	Describe measures taken to manage and reduce the waste.	Stage 3,4	Waste should be reduced to a minimum. The recyclability of waste should be maximized. The applicant company (stage 4) and the bio-based material manufacturing companies (stage 3) should have in place specific policies, procedures, initiatives addressing waste management and its reduction.	Y/N	✓
		27	Provide the amount of total non-valorized waste generated per unit of product and useful co-product	Stage 3,4	The waste intensity value should be below a reference value <b>(not defined yet)</b>		
	The economic operator provides information on bio-based disposal	28	The applicant (stage 4) provides guidance and clear instructions to the consumers on how the bio-based product is to be disposed after use	4	The bio-based final product has to contain clear indications on its disposal. End consumers (stage 5) need to know how the bio-based product has to be disposed so as to properly perform an appropriate waste management (stage 6).	Y/N	✓
Promote efficient use of energy	The economic operator provides information on how energy	29	Describe measures taken to address energy efficiency	Stage 3,4	Energy efficiency has to be maximized. The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific policies, procedures or initiatives addressing energy efficiency <sup>5</sup>	Y/N	✓





		efficiency related to their operations is achieved	30	Provide energy intensity i.e. heat and power sourced from renewable and non-renewable or internally-derived pathways consumed per unit of product and useful co-product.	Stage 3,4	The energy intensity value should be below the reference value <b>(not defined yet)</b>		✓
	Promote the use of renewable energy <sup>7</sup> sources	The economic operator provides information on how the use of renewable energy sources is promoted	31	Describe measures taken to promote the use of renewable energy.	Stage 3,4	The use of renewable energy sources should be maximized. The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place specific policies and initiatives, which address the use of renewable energy <sup>5</sup>	Y/N	✓
			32	Provide the share of renewable energy compared to the overall energy consumed for a given process or processes under consideration.	Stage 3,4	The renewable energy should be above a minimum value		
ECONOMIC	Promote the minimisation of life cycle costs associated with the entire value chain	The economic operator provides information on the life cycle costing	33	Describe measures taken to reduce the environmental-life cycle costs	Stage 3,4	The life cycle costs should be minimised. The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) should have in place initiatives to reduce the costs associated with the life cycle of the bio-based product	Y/N	✓
			34	The applicant (stage 4) provides the Environmental Life Cycle Costing (LCC) of the bio-based product	Stage 1-6	The environmental LCC "Cradle to grave" of the bio-based product has to be below the Reference value <b>(not defined yet)</b>		✓
SOCIAL	Respect Labour Rights	The economic operator provides information on how the issue of forced labour is addressed	35	Describe measures taken to safeguard rights relating to forced labour including prohibiting policies, evidences, incidents and corrective action plans and a plan-do-check-act process in place to raise awareness on the topic <b>(MAJOR MUST)</b>	Stage 1-4	Forced labour is not allowed (i.e. social minimum requirement). The applicant (stage 4), bio-based material manufacturers (stage 3), biomass producers (Stage 1) and raw materials producers (Stage 2) have to have in place formal policies, procedures or initiatives addressing forced labour and evidences that such incidence do not occur.	Y/N	✓
		The economic operator provides information on how the topic of	36	Describe measures taken to address child labour, including prohibiting policies, evidences (such as records on worker's age), incidents and corrective actions plans and a plan-do-check-act process in place to raise awareness on the topic		Child labour is not allowed (i.e. social minimum requirement). The applicant (stage 4), bio-based material manufacturers (stage 3), biomass producers (Stage 1) and raw materials producers (Stage 2) have to have in place formal policies,	Y/N	✓

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)



	child labour is addressed		(MAJOR MUST)		procedures or initiatives addressing child labour and evidences that such incidence do not occur.		
	The economic operator provides information on how fair salary is addressed	37	Provide information regarding the salary of workers, including the percentage of workers whose wages meet at least legal minimum standards, incidents of delayed payments, percentage of workers paid a living wage or receive additional social benefits  (MAJOR MUST)		All workers are paid at least the legal or industry minimum wage (i.e. social minimum requirement. The applicant (stage 4), bio-based material manufacturers (stage 3), biomass producers (Stage 1) and raw materials producers (Stage 2) have to provide the minimum wage <sup>5</sup>	Y/N	✓
	The economic operator provides information on how equal opportunities and discrimination are addressed	38	Describe measures taken to address equal opportunities, including whether a non-discrimination policy is in place, a system to enforce it, incidents and corrective action plans and a public commitments on this issue		Non-discrimination measures should be applied to all workers. The applicant (stage 4), bio-based material manufacturers (stage 3), biomass producers (Stage 1) and raw materials producers (Stage 2) are obliged to have a system in place to guarantee, monitor and enforce the non-discrimination policy	Y/N	✓
	The economic operator provides information on how health and safety of workers are addressed	39	Describe measures taken to address health and safety of workers, including whether they comply with local laws, whether workers have the needed protective equipment, incidents and corrective plans, a plan-do-check-act process in place to protect workers' health beyond laws and public commitments on this issue		Compliance with health and safety regulations must be met to all level and for all workers. The applicant (stage 4), bio-based material manufacturers (stage 3), biomass producers (Stage 1) and raw materials producers (Stage 2) should comply with health and safety regulations. <sup>5</sup>	Y/N	✓
Respect health and safety of end users	The economic operator provides information on how health and safety of end users are addressed	40	The applicant (stage 4) describes measures taken to ensure the health and safety of end users (stage 5), including evidence that the product is safe for users, compliance with product safety laws and programmes in place to raise awareness on safety risks associated with the product (MAJOR MUST)	4	The bio-based products must be safe, so no health and safety concerns related to end users (stage 5) should occur. The bio-based product conforms to all national and European requirements and standards regarding product safety.	Y/N	✓

rs of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulation od professional practice of agriculture, including crop rotation on all agriculturally used areas accordin s certified under a voluntary system that covers one or more indicators required by IAT, this may be ref

gnized best practice. One example is proven implementation of sustainable agricultural il Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the the response(s)



Promote consumer satisfaction	The economic operator provides information on how they provide feedback mechanisms	41	The applicant (stage 4) describe measures taken to offer mechanisms for users (stage 5) to provide feedbacks, including measures to improve the mechanism, if there are surveys related to customers satisfaction and actions taken in response to the results of these surveys	4	Presence of an effective mechanism for customers (stage 5) to provide feedback, or presence of management measures to improve feedback mechanisms exist.	Y/N	✓
Promote transparency	The economic operator provides information on how transparency is addressed	42	The economic operator describes measures taken to address transparency, including if there are compliance with regulations, consumer complaint, sustainability reporting and targets	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) have to comply with regulations regarding transparency and non-financial reporting disclosure.	Y/N	✓
Respect of health and safety of local communities	The economic operator provides information on how health and safety of local community are addressed	43	Describe measures taken to address health and safety of local communities, including noise, air emissions etc.	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) have a system or a mechanism in place to ensure the respect of policies relating to local community health and safety impacts.	Y/N	✓
Promote local development	The economic operator provides information on how local employment is addressed	44	Describe measures taken to address local employment, including public commitments to grow local employment and the number of indefinite or temporary jobs (higher than 6 months) created or lost during the reporting period	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) have publicly committed to grow local employment.	Y/N	✓
	The economic operator provides information on how economic development is addressed	45	Describe measures taken to address economic development, including any policy, which prioritises buying goods and services from local suppliers (regional or at national level), contribution to skill development, and the percentage of employees and market share of the company that have grown in the last 5 years	Stage 3,4	The applicant company (stage 4) and bio-based material manufacturing companies (stage 3) have a policy prioritising buying goods and services from local suppliers (regional or national). The companies (stage 3 and 4) actively contributes to skill development.	Y/N	✓
Respect land use rights	The economic operator provides information on how land use	46	The applicant (stage 4) describes measures taken by the raw materials producers (stage 1) to address land use rights, including percentage of small-scale entrepreneurs who have documented legal rights to land and who feel that their land	1	Land use rights should be respected. The biomass producers have to comply with a minimum land use rights.	Y/N	✓



		rights are addressed		rights are secured and if land grabbing risk is being mentioned				
	Respect Food Security	The economic operator provides information on how they address food security	47	The applicant (stage 4) describes measures taken by the raw materials producers (stage 2) to address food security, including measures to improve and ensure local food security, a plan-do-check-act to identify and reduce risks on this topic.	1	The renewable raw materials producers (Stage 2) is obliged to have policies in place to reduce risks to the local food security in the area where the production of biomass takes place <sup>5</sup>	Y/N	✓
	Promote fair competition in the market	The economic operator provides information on how fair competition in the market is addressed	48	Describe measures taken to address fair competition in the market, including incidents regarding anti-competitive behaviour, measures to increase employee awareness in this topic	Stage 3,4	For the applicant company (stage 4) and bio-based material manufacturing companies (stage 3) there is to be no legal actions pending or completed during the reporting period regarding anti-competitive behaviour and no violations of anti-trust and monopoly legislation expected and documented statement or procedures (policy, strategy, 51etc.) to prevent engaging in or being complicit in anti-competitive behaviour	Y/N	✓

<sup>5</sup> Some indicators of IAT matrix may be wholly or partly covered by relevant legal requirements, national regulations or recognized best practice. One example is proven implementation of sustainable agricultural cultivation/good professional practice of agriculture, including crop rotation on all agriculturally used areas according to Council Regulation (EC) No 73/2009 Cross Compliance or according to national legislation. If the organization is certified under a voluntary system that covers one or more indicators required by IAT, this may be referenced in the response(s)



## Annex C (normative)

### Metrics and standards

This Annex provides the required methods used to determine the metrics to assess the indicators. Table C.1, provides guidance on how to calculate/measure the performance of each indicator. The information is clustered in the following indicator categories: i) quantitative LCA indicators related to the environmental pillar; ii) additional environmental-related quantitative indicators; iii) qualitative indicators related to the environmental, economic and circular dimensions; iv) ILUC-related indicator; v) quantitative indicators related to circularity; vi) quantitative indicator related to the economic dimension; vii) qualitative indicators related to the social dimension

Table C.1 also presents standards that may be used for executing the measurement.

*Table C.1 — Guidance on the determination of sustainability indicators*

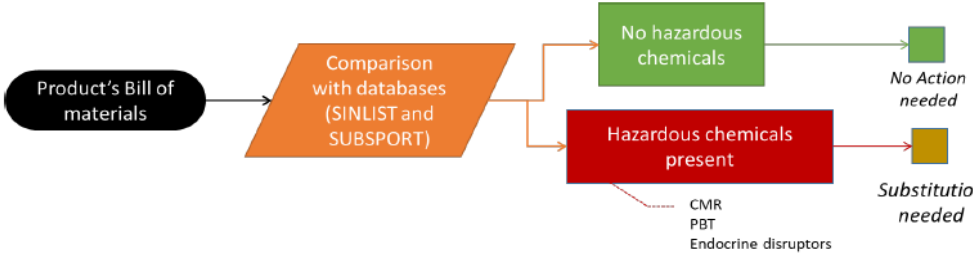
Indicator	Method
<b>Environmental pillar</b>	
Quantitative LCA indicators I: 2, 3, 6, 11, 12, 13, 14, 15,20	<p>Life Cycle Assessment (LCA) is the most reliable and widely accepted method to identify environmental issues within a process and verifies claims of sustainability advantages. It identifies hot spots in processes, materials and products, providing a benchmark against which improvements can be measured. It provides transparent and reliable environmental results of a product and/or process, enabling producers, providers and customers to make well informed decisions. (NOVA, 2019).</p> <p>Reference standards:</p> <ul style="list-style-type: none"> <li>• ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework</li> <li>• ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines</li> <li>• EN 16760 – Bio-based products – Life Cycle Assessment</li> <li>• CEN/TR16957:2016 Bio-based products - Guidelines for Life Cycle Inventory (LCI) for the End-of-life phase</li> <li>• Product Environmental Footprint (PEF) methodology</li> </ul> <p>A description of the selected LCA impact categories is reported in D2.2, "Selection of environmental indicators and impact categories for the life cycle assessment of bio-based products.". Available at : <a href="http://www.star-probio.eu">www.star-probio.eu</a></p> <p>A detailed description and guidance of the LCA impact categories and related indicators is included in Annex Bquant</p>
Soil erosion I:10	<p>This indicator indicates the soil loss by erosion (unit: kg of soil loss) and it is specific to crop and geographical area. It is only relevant for Stage 1. Further details about the methodology are reported in D2.2, "Selection of environmental indicators and impact categories for the life cycle assessment of bio-based products.". Available at: <a href="http://www.star-probio.eu">www.star-probio.eu</a></p>

<p>Affected biodiversity</p> <p>I: 18</p>	<p>This indicator combines the agricultural land occupation life cycle inventory data (only Stage 1) with species richness of the biome where the activity takes place (unit: m2.year*PAS - potentially affected species). Further details are reported in D2.2, "Selection of environmental indicators and impact categories for the life cycle assessment of bio-based products.". Available at: <a href="http://www.star-probio.eu">www.star-probio.eu</a></p>
<p>Environmental qualitative indicators:</p> <p>I: 1, 4, 5, 7, 8, 9, 16, 17, 19</p>	<p>These indicators provide complementary information to LCA results about the commitment of the economic operator in dealing with concerns related to its operations</p> <p>Reference standards:</p> <ul style="list-style-type: none"> <li>• EN 16751:2016 Sustainability criteria for bio-based products</li> <li>• ISO-13065:2015 Sustainability criteria for bioenergy</li> <li>• NTA 8080-1 Sustainably produced biomass for bioenergy and bio-based products-Part 1: Sustainability requirements.</li> </ul>

### Environmental pillar – ILUC

<p>ILUC risk (scale-based indicator)</p> <p>I: 21</p>	<p><i>ILUC Risk tool</i> developed by UNIBO.</p> <p>The risk approach to the ILUC phenomenon was adopted for two reasons: (a) consistency with the EU ILUC management for biofuels (RED II), and (b) reduction of uncertainty in ILUC modelling. The ILUC risk is estimated using the ILUC Risk tool developed by UNIBO, which consists of a user friendly Excel file usable by biomass producers, intermediate product producers, bio-based material producers, auditors, policy makers, on different detail levels. The tool was developed parameterizing a system dynamic model aimed at predicting changes in land demand due to future changes in bio-based material production. The model (called SydILUC) was developed, calibrated and validated on FAOSTAT global yearly datasets for the main crops. The model was, then, run on a full range of possibilities, and transformed into a matrix that was shifted to excel. The ILUC Risk tool takes in the input from the economic operators, give the possibility to auditors to adjust the details of the input, uses the matrix to estimate a range of future land demand change, and transform it into ILUC risk. The ILUC Risk tool is designed to be compatible with the low ILUC-risk practices defined by DBFZ, and hence accounts for the effect of: (i) use of agricultural residues to produce bio-materials in place of the main raw biomass; (ii) use of co-products from the bio-based material production as substitutes to the raw biomass in competing sectors (e.g. food, feed); (iii) use of waste for the production of bio-based materials; (iv) erosion and soil organic carbon depletion due to intensive agricultural practices; (v) crop production on former abandoned land.</p>
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### Product and system circularity

<p>High concern chemicals</p> <p>I: 22</p>	<p>Hazardous chemical use is a "qualitative" parameter that "flag-up" the use of substances within the product's inventory (including solvents, catalysts, additives or other chemicals) that are classified "hazardous". This is undertaken by comparing the raw materials (stage 3) with the known global databases for hazardous chemicals, mainly SINLIST12 and SUBSPORT13,14 which also contains lists of chemicals of concerns captured by the EU-REACH And US-EPA.</p>  <pre> graph LR     A([Product's Bill of materials]) --&gt; B[/Comparison with databases (SINLIST and SUBSPORT)/]     B --&gt; C[No hazardous chemicals]     B --&gt; D[Hazardous chemicals present]     C --&gt; E[No Action needed]     D --&gt; F[Substitution needed]     D --- G[CMR PBT Endocrine disruptors]     </pre>
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	Source: STAR-ProBio, Deliverable D3.1, "Expanding environmental sustainability criteria to address the manufacturing and other downstream processes for bio-based products". 2019. Confidential report.
Renewable content of bio-based end product I: 23	The most used method for determining the renewability of a bio-based product is the determination of the biogenic carbon (through a specific analytical measure) and the total carbon that constitute the bio-based product. The % renewability is expressed as follows: $C_{bio}/C_{tot} \times 100$ . The reference standard is: CEN EN 16640:2017 - Bio-based products - Bio-based carbon content - Determination of the bio-based carbon content using the radiocarbon method. [17]
Product Circularity I: 24,25	<p>The Material Circularity Indicator (MCI), according to the Ellen MacArthur Foundation (EMF) methodology (Ellen MacArthur Foundation &amp; Granta Design, 2015) [18], is a number that can range from 0 (pure linearity) to 1 (pure circularity). A purely linear production provides for the exclusive use of virgin raw materials that turn into waste at the end of the use phase of the product. Vice-versa, pure circularity includes the use of recycled materials and does not produce wastes (regenerative streams). Till December 2019 MCI was focused solely on technical cycles and mechanical recycled materials, without considering bio-based and compostable materials and composting process as possible end of life option</p> <p><a href="https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Methodology_May2015.pdf">https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Methodology_May2015.pdf</a></p> <p>On the contrary the current version includes biological materials and composting as possible end of life for biological materials. <a href="https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/MCI-SC-28Nov-2019-Master-MB-4.pdf">https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/MCI-SC-28Nov-2019-Master-MB-4.pdf</a></p> <p>Independently from EMF developments in 2018 and 2019 within, StarProBio project, a methodological approach has been developed. It provides a metric for quantifying the circularity of bioplastics and it has been applied to a real case study represented by biodegradable mulch films. A paper titled "Metrics for quantifying the circularity of bioplastics: the case of bio-based and biodegradable mulch films" is under publication in Resources, Conservation &amp; Recycling (RCR) within the Special Issue on "Sustainable Cycles and Management of Plastics". [19]</p>
Waste reduction and management (kg waste/kg useful process outputs) I: 26,27, 28	<p>Ratio of total mass of process waste over the total mass of the useful process outputs. It is applied to the stages 3 and 4.</p> $Waste\ factor = \frac{M_{totW}}{M_{Prod} + M_{co.prod} + M_{re.proc}}$ <p> <math>M_{totW}</math> = Total mass of waste generated from the production process (kg)  <math>M_{Prod}</math> = Total mass of target product generated from the process (kg)  <math>M_{co.prod}</math> = Total mass of useful co-products (kg)  <math>M_{re.proc}</math> = Total mass of re-processed waste (kg) </p> <p>Source: STAR-ProBio, Deliverable D3.1, "Expanding environmental sustainability criteria to address the manufacturing and other downstream processes for bio-based products". 2019. Confidential report</p>
Energy efficiency (qualitative) I: 29	Using energy efficiently helps organizations save money as well saving resources and tackle climate change. Reference Standard: ISO 50001 [20]
Energy intensity (MJ energy/kg useful process outputs)	<p>Energy intensity is defined as the ratio of the absolute energy consumption (fuel, electricity, heating, cooling, steam) of the process to the total mass of valuable process outputs. It is applied to the stages 3 and 4.</p> $Energy\ intensity = \frac{E_{fuel} + E_{el} + E_{heat} + E_{cooling} + E_{steam}}{M_{Prod} + M_{co.prod} + M_{re.proc}}$ <p> <math>E_{fuel}</math> = Fuel derived energy used (MJ)  <math>E_{el}</math> = Electricity derived energy used (MJ) </p>



<p>I: 30</p>	<p>Eheat. = Heat derived energy used (MJ)  Ecooling = Cooling derived energy used (MJ)  Esteam = Steam derived energy used (MJ)</p> <p>Note 1: the different energy inputs in the numerator have to be reported separately so as to discriminate the different nature (quality) of used energy. This information is relevant for example for deriving the primary energy consumption of the process. To this regard electricity inputs (Eel.) from the grid have to be multiplied by a factor of 3 to reflect the primary energy invested in the production and distribution of electricity to the final destination.</p> <p>Note 2: when determining this indicator it is important to avoid double counting. Example: if fuel (e.g. natural gas) is internally used for producing electricity and steam in a CHP plant the latter two energy inputs do not need to be reported in the numerator. Sources: GRI Standard 302-3 and STAR-ProBio D3.1</p>
<p>Use of renewable energy resources  (quant.) I: 31, 32</p>	<p>Ratio of the renewable energy to the total amount of consumed energy. It is applied to the stages 3 and 4.</p> $\text{Share of renewable energy (\%)} = \frac{E_{\text{fuelren}} + E_{\text{el. ren}} + E_{\text{heatren}} + E_{\text{coolingren}} + E_{\text{steamren}}}{E_{\text{fuel}} + E_{\text{el.}} + E_{\text{heat.}} + E_{\text{cooling}} + E_{\text{steam}}} \times 100$ <p>ren: energy from renewable resources</p>
<p><b>Economic</b></p>	
<p>Environmental LCC (quantitative indicator)  I: 33, 34</p>	<p>Life Cycle Costing (LCC) is an economic assessment of all costs related to a product, process or service, over the entire life cycle, from raw materials, transport, production until use and disposal. Goal of LCC is to minimize overall costs, associated with all life cycle phases, providing economic benefits for all supply chain actors as a whole. The SETAC publication on Life Cycle Costing distinguishes three types of LCC <sup>a)</sup></p> <ul style="list-style-type: none"> <li>• Conventional LCC: economic assessment of the life cycle of a product, often excluding one or more life cycle phases, like the disposal phase;</li> <li>• <b>Environmental LCC</b>: economic assessment of the entire life cycle of a product, performed in parallel with an LCA study applying the same system boundaries but without monetization of environmental impacts in order to avoid double counting with LCC results;</li> <li>• Societal LCC: economic assessment of the entire life cycle of a product including external costs for society, like for instance through the monetization of environmental impacts (Figure below)</li> </ul> <p>Like LCA, LCC follows the ISO standards 14040/14044. At the moment, there are no general ISO standards available for LCC, but the SETAC publication on Life Cycle Costing is often used as a reference. Within IAT Environmental LCC has been proposed.</p> <div data-bbox="459 1608 1337 1921"> <p>LCC as a methodology where costs of a given asset are considered throughout its life cycle (2014/24/EU – Art. 67)</p> <pre> graph TD     LCC[LCC] --- Investment[Investment]     LCC --- Operation[Operation]     LCC --- Maintenance[Maintenance]     LCC --- EndOfLife[End of life]     Investment --- PreAcq[Pre-acquisition costs]     Operation --- PostAcq[Post-acquisition costs]     Maintenance --- PostAcq     EndOfLife --- PostAcq     </pre> <p>The diagram illustrates LCC as a methodology where costs of a given asset are considered throughout its life cycle, as per (2014/24/EU – Art. 67). It shows a central box for 'LCC' which branches into four stages: 'Investment', 'Operation', 'Maintenance', and 'End of life'. 'Investment' is categorized as 'Pre-acquisition costs', while 'Operation', 'Maintenance', and 'End of life' are categorized as 'Post-acquisition costs'. The entire process is framed within a 'Life cycle Assessment' box on the left and 'Direct costs' on the right.</p> </div>



	<i>Hunkeler D, Lichtenvort K, Rebitzer G (eds.) (2008). Environmental life cycle costing. SETAC, Pensacola, FL (US) in collaboration with CRC Press, Boca Raton, FL, USA.</i>
<b>Social</b>	
Scale-based indicators I: from 35 to 48	<p>The proposed methodology for investigating social aspects along value chain represents a simplification of the scaled-based methodology reported in the <i>Handbook for Product Social Impact Assessment</i></p> <p><a href="https://product-social-impact-assessment.com/">https://product-social-impact-assessment.com/</a> where the reference scale includes just 2 values, 0 = no social minimum requirement met and 1 = minimum social requirement met.</p>

To explain the scoring system that applies to the two LCA indicators as required in 6.4, biodiversity and soil erosion, a PLC clam shell may be employed. Figure C.1 shows an overview of the proposed process for identifying the affected biodiversity of producing clam shell of PLA, taking into consideration the assumptions given above. The needed data are the land occupation and the potentially affected species (PAS). The proposed formula is  $AF = \sum (\text{average land occupation} * \text{PAS}) * \text{share of country of origin}$ .

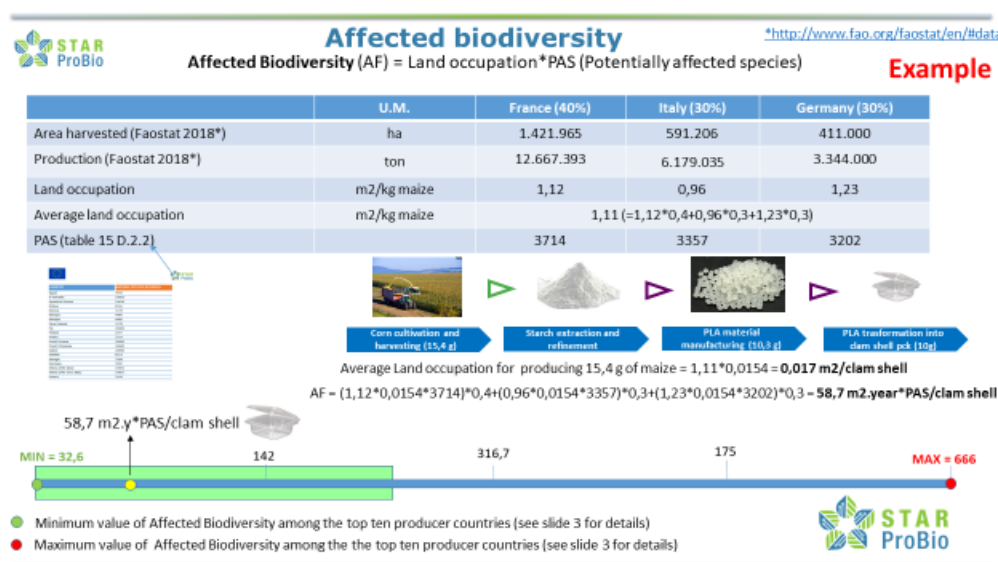


Figure C.1 - Methodology for identifying the affected biodiversity

Example      The following assumptions are made:

- Weight of clam shell: 10 g
- The PLA is produced in Europe: 40% in France, 30% in Germany and 30% in Italy;
- The maize grain for 1 kg of PLA: 1,54 kg, hence 15,4 g of maize is needed for the am shell

In this specific case the Affected Biodiversity (AB) of the clam shell is 58,7 m<sup>2</sup>.a.PAS. The details of the calculation example are shown in Figure C.1. Considering that the AB

value lies within the safeguard level, assumed to be 0-30% of the maximum value (see light green in Figure C.1), this particular indicator will score "2" points.

Figure C.2 illustrates the method for calculating the soil erosion level associated with the production of clam shell of PLA. Employing the formula presented in equation 1 above, the total value obtained is 6,97E-07 Mg/per hectare. This is very close to the minimum value, yet lies within the safeguard levels (light green area in figure C.1), assumed to be 30% of the maximum possible value specific for the used crops.

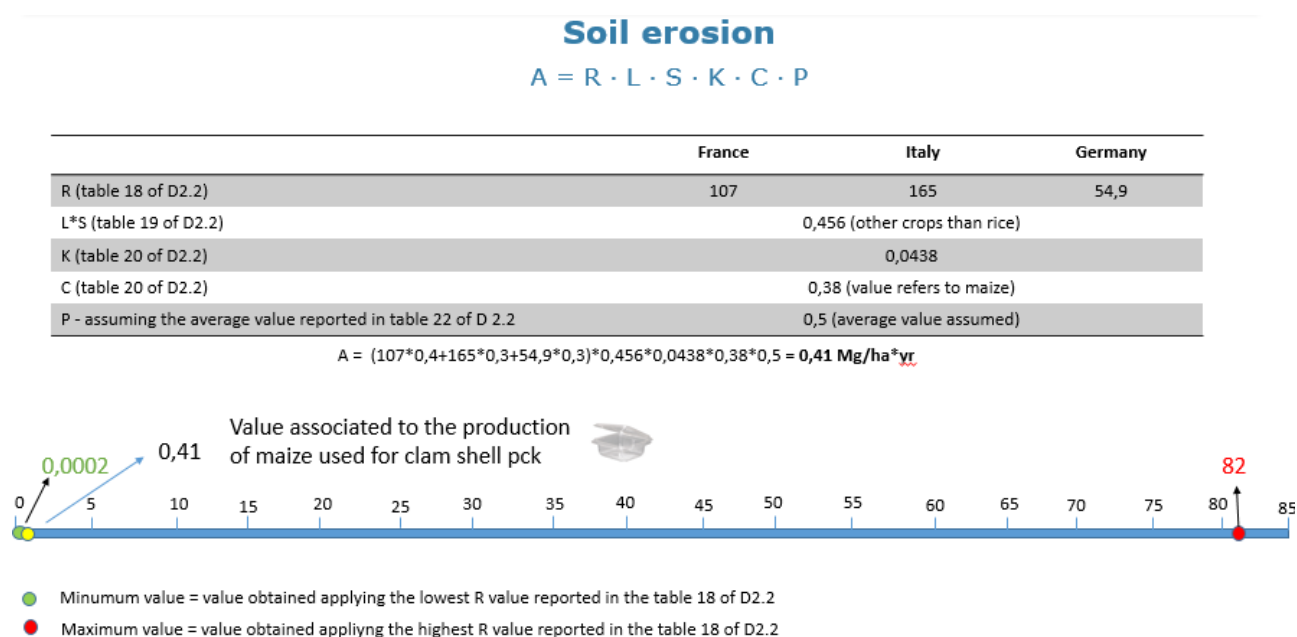


Figure C.2 - Calculation example of the soil erosion level



## Annex D ( Informative)

### Data collection

The following figures present the base questionnaires recommended to be used for the collection of environmental, circular and social information on related policies, initiatives and measures. All of the responses follow a yes/no approach.

*Table D.1 — Questionnaire for biomass producers (Stage 1)*

Questions – Environmental pillar	yes	no
<b>Indicator 4: Impacts on water quality and quantity</b>		
Do you adopt measures, procedures, policies or initiatives to reduce water consumption and protect the quality of water resources?		
<b>Indicator 8: Soil quality, soil productivity and soil erosion forces</b>		
Do you have in place specific measures to monitor the changes in soil condition in order to avoid soil erosion and/or to conserve and improve soil health and productivity?		
<b>Indicator 16: Impacts on biodiversity</b>		
Do you adopt measures to identify potential impacts on biodiversity?		
<b>Indicator 17: Promote positive and reduce negative impact on biodiversity</b>		
Do you adopt measures to promote positive and reduce negative impact on biodiversity?		
Questions – Social pillar	yes	no
<b>Indicator 35: Forced labour</b>		
Do you adopt measures to safeguard rights related to forced labour?		
<b>Indicator 36: Child labour</b>		
Do you have in place policies against employing children? <b>The company or facility has a system in place to enforce the policy prohibiting child labour.</b>		
<b>Indicator 37: Fair salary</b>		
Do you have policies for ensuring fair salaries?		
<b>Indicator 38: Equal opportunities and discrimination</b>		
Do you have an equal opportunities and non-discrimination policy in place?		
<b>Indicator 39: Health and safety of workers</b>		
Do you adopt measures to ensure health and safety of workers?		
<b>Indicator 46: Land use rights</b>		
Do you have policies in place for respecting land use rights?		
<b>Indicator 47: Food security</b>		
Do you have policies in respect of food security?		



Questions – Social pillar	yes	no
<b>Indicator 35: Forced labour</b>		
Do you adopt measures to safeguard rights related to forced labour?		
<b>Indicator 36: Child labour</b>		
Do you have in place policies against employing children?		
<b>Indicator 37: Fair salary</b>		
Do you have policies for ensuring fair salaries?		
<b>Indicator 38: Equal opportunities and discrimination</b>		
Do you have an equal opportunities and non-discrimination policy in place?		
<b>Indicator 39: Health and safety of workers</b>		
Do you adopt measures to ensure health and safety of workers?		

*Figure D.2 – Questionnaire for raw material feedstock production (Stage 2)*

Questions – Environmental pillar	yes	no
<b>Indicator 1: greenhouse gas emissions</b>		
Do you have in place procedures, policies or initiatives to identify and minimize GHG emission?		
<b>Indicator 5: Impacts on water quality and quantity</b>		
Do you have specific procedures, policies or initiatives to reduce water consumption and to improve water quality?		
<b>Indicator 7: Soil quality, productivity and soil erosion forces</b>		
Do you have specific procedures, policies or initiatives to identify and address potential impacts on soil quality, productivity and soil erosion forces, associated to the biomass production?		
<b>Indicator 19: Minimize the impacts on human health</b>		
Do you adopt measures to promote positive and reduce negative impact on the human health within the area of operation?		
<b>Question – Circularity</b>		
<b>Indicator 22: Promote responsible use of high concern materials</b>		
Do you have in place specific procedures, policies or initiatives addressing safety aspects regarding chemicals embedded in the products they produce?		
<b>Indicator 26: Promote responsible waste management</b>		
Do you have in place specific policies, procedures, initiatives addressing waste management and its reduction?		
<b>Indicator 29: Promote efficient use of energy</b>		
Do you adopt measures to address energy efficiency?		
<b>Indicator 31: Promote the use of renewable energy sources</b>		
Do you adopt measures to promote the use of renewable energy?		
<b>Questions- Economic</b>		
<b>Indicator 33: Promote the minimisation of life cycle costs associated with the entire value chain</b>		
Do you have in place initiatives to reduce the costs associated to the life cycle of bio-based product?		



Questions – Social pillar	yes	no
<b>Indicator 35: Forced labour</b>		
Do you adopt measures to safeguard rights related to forced labour?		
<b>Indicator 36: Child labour</b>		
Do you have in place policies against employing children?		
<b>Indicator 37: Fair salary</b>		
Do you have policies for ensuring fair salaries?		
<b>Indicator 38: Equal opportunities and discrimination</b>		
Do you have an equal opportunities and non-discrimination policy in place?		
<b>Indicator 39: Health and safety of workers</b>		
Do you adopt measures to ensure health and safety of workers?		
<b>Indicator 42: Promote transparency</b>		
Do you have measures to address transparency and non-financial reporting publication?		
<b>Indicator 43: Respect of health and safety of local communities</b>		
Do you have measures to address health and safety of local communities?		
<b>Indicator 44: Promote local development - local employment</b>		
Do you have measures to address local employment?		
<b>Indicator 45: Promote local development - economic development</b>		
Do you have measures taken to address economic development?		
<b>Indicator 48: Promote fair competition in the market</b>		
Do you take measures to address fair competition in the market?		

*Figure D.3 - Questionnaire for bio-based product production (stage 3)*

Questions – Environmental pillar	yes	no
<b>Indicator 1: greenhouse gas emissions</b>		
Do you have in place procedures, policies or initiatives to identify and minimize GHG emission?		
<b>Indicator 5: Impacts on water quality and quantity</b>		
Do you have specific procedures, policies or initiatives to reduce water consumption and to improve water quality?		
<b>Indicator 7: Soil quality, productivity and soil erosion forces</b>		
Do you have specific procedures, policies or initiatives to identify and address potential impacts on soil quality, productivity and soil erosion forces, associated to the biomass production?		
<b>Indicator 19: Minimize the impacts on human health</b>		
Do you adopt measures to promote positive and reduce negative impact on the human health within the area of operation?		
<b>Question – Circularity</b>		
<b>Indicator 22: Promote responsible use of high concern materials</b>		
Do you have in place specific procedures, policies or initiatives addressing safety aspects regarding chemicals embedded in the products they produce?		



<b>Indicator 24: Promote the use of material circularity</b>		
Do you have in place specific procedures, policies or initiatives promoting the use of recycled or renewable raw materials and the recyclability of the bio-based end product?		
<b>Indicator 26: Promote responsible waste management</b>		
Do you have in place specific policies, procedures, initiatives addressing waste management and its reduction?		
<b>Indicator 29: Promote efficient use of energy</b>		
Do you adopt measures to address energy efficiency?		
<b>Indicator 31: Promote the use of renewable energy sources</b>		
Do you adopt measures to promote the use of renewable energy?		
<b>Questions- Economic</b>		
<b>Indicator 33: Promote the minimisation of life cycle costs associated with the entire value chain</b>		
Do you have in place initiatives to reduce the costs associated to the life cycle of bio-based product?		
<b>Questions – Social pillar</b>	<b>yes</b>	<b>no</b>
<b>Indicator 35: Forced labour</b>		
Do you adopt measures to safeguard rights related to forced labour?		
<b>Indicator 36: Child labour</b>		
Do you have in place policies against employing children?		
<b>Indicator 37: Fair salary</b>		
Do you have policies for ensuring fair salaries?		
<b>Indicator 38: Equal opportunities and discrimination</b>		
Do you have an equal opportunities and non-discrimination policy in place?		
<b>Indicator 39: Health and safety of workers</b>		
Do you adopt measures to ensure health and safety of workers?		
<b>Indicator 42: Promote transparency</b>		
Do you have measures to address transparency and non-financial reporting publication?		
<b>Indicator 43: Respect of health and safety of local communities</b>		
Do you have measures to address health and safety of local communities?		
<b>Indicator 44: Promote local development - local employment</b>		
Do you have measures to address local employment?		
<b>Indicator 45: Promote local development - economic development</b>		
Do you have measures taken to address economic development?		
<b>Indicator 48 : Promote fair competition in the market</b>		
Do you take measures to address fair competition in the market?		

*Figure D.4 - Questionnaire for bio-based product transformation (stage 4)*



Questions – Social pillar	yes	no
<b>Indicator 40 : Respect health and safety of end users</b>		
Do you take measures to ensure health and safety of end users?		
<b>Indicator 41: Promote consumer satisfaction</b>		
Do you have in place mechanisms for users to provide feedback?		
<b>Indicator 24: Promote use of renewable materials</b>		
Do you have measures to promote the use of renewable material resources (% of biogenic carbon / total carbon) and provide the information to costumers?		

*Figure D.5 - Questionnaire related to the use phase (stage 5)*

Questions – PRODUCT AND SYSTEM CIRCULARITY	yes	no
<b>Indicator 28: Promote responsible waste management</b>		
Do you provide guidance and clear instructions to the consumers on how the bio-based product has to be disposed after use?		

*Figure D.6 - Questionnaire related to the End-of-Life phase (stage 6)*

## Annex E ( Informative)

### IAT application case studies

The applicability of the IAT is a fundamental to its adoption by corporate organizations . For this reason, the IAT is tested in the selected STAR-ProBio project case studies: Polybutylene Succinate (PBS): including the fine chemicals 1,4 bio-butanediol and 100 % bio-based succinic acid; PLA packaging and biodegradable Ecovio mulch film so as to identify weaknesses, limitations and area of improvement of the IAT itself.

This Annex provides a preliminary set of thresholds for each of the IAT indicators, for the case studies. Some of these, like LCA results, are product specific, while others are applicable to all bio-based products, independently of their product group. All social thresholds belong to the latter category.

*Table E.1 — LCIA Thresholds for mulch film and packaging (indicative values)*

			<b>mulch film</b>	<b>mono-use packaging</b>	
<b>N</b>	<b>LCA impact category</b>	<b>Unit</b>	<b>F.U. <sup>b</sup> 1 ha of mulched soil <sup>a</sup></b>	<b>F.U. <sup>b</sup> 1 kg of average pck</b>	<b>Comparability bio-based vs fossil</b>
1	Climate change (without Guest 2013)	kg CO <sub>2</sub> e	798	4,1	Yes
2	Respiratory inorganics - Particulate mat	Deaths	2,74E-05	8,84E-08	Yes
3	Cancer human health effects	CTUh	4,65E-06	2,57E-08	Yes
4	Acidification terrestrial and freshwater	mol H+ eq	2,44	9,27E-03	No
5	Eutrophication freshwater	kg P eq	0,004	2,41E-04	No
6	Eutrophication, terrestrial	mol N eq	6	0,018	No
7	Land use - Soil quality index	Pt	366	21,2	No
8	Water scarcity	m3 depriv.	3	1,79E-02	Yes
9	Resource use, fossils	MJ	15.696	65	Yes
	Occupation - for soil erosion and biodiversity	m2a	1,28	0,252	--
10	Soil erosion (calculated from occupation)		Not applicable	Not applicable	No
11	Biodiversity		Not applicable	Not applicable	No

<sup>a</sup> corresponding to a 6 000 m<sup>2</sup> of mulched film (35 µm)  
<sup>b</sup> F.U. = Functional Unit

Table E.2 provides the thresholds for the indicators included in the social pillar. They are based on the reference scale (-2, -1, 0, 1, 2) included in the Handbook for Product Social Impact Assessment [7]. The level 0 of the scale for each indicator is adopted as threshold.





They are applied to all bio-based and fossil-based products and are not specific for the case studies.

*Table E.2 – Social thresholds*

N	Social issue or topic	Minimum social requirements
1	forced labour	The company or facility has a system in place to implement the policy prohibiting retention of all or part of a worker's salary, benefits, property or original documents and there is evidence of no forced labour
2	child labour	The company or facility has a system in place to enforce the policy prohibiting child labour and there is evidence that there is not child labour
3	fair salary	All workers are paid the legal or industry minimum wage
4	equal opportunities and discrimination	The company or facility has a system in place to monitor and enforce the non-discrimination policy.
5	health and safety of workers	Sufficient evidence indicates compliance with health and safety standards or local laws. The occupational health and safety of workers is monitored, and workers have access to all the required personal protective equipment
6	health and safety of end users	The product conforms to all national requirements regarding product safety
7	feedback mechanisms	Presence of a mechanism for customers to provide feedback Presence of management measures to improve feedback mechanisms exist
8	transparency	There has been compliance with regulations regarding transparency There has been no consumer complaints regarding transparency
9	health and safety of local community	No incidents of actual damage, adverse impacts or risks to community health and safety have been discovered or the company or facility has a system or a mechanism in place to enforce the policy on local community health and safety impacts to meet the requirements set by local laws or international standards
10	local employment	The company or facility has publicly committed to grow local employment.
11	economic development	The company or facility has a policy prioritising buying goods and services from local suppliers The company or facility actively contributes to skill development in connection to its future need for staffing and the staffing of its subcontractors and smallholders
12	land use rights	Most of the small-scale entrepreneurs have documented legal rights to land.
13	food security	The company or facility has a PDCA (plan-do-check-act) to identify and reduce risks on local food security and to identify and prevent changes in food and feed prices  Percentage of hectares that have changed in the variety of crops and arable land in the region since the appearance of feedstock demand for bio-products $\leq 25\%$



14	fair competition	<p>No legal actions pending or completed during the reporting period regarding anti-competitive behaviour and no violations of anti-trust and monopoly legislation in which the reporting organization has been identified as a participant</p> <p>Documented statement or procedures (policy, strategy, etc.) to prevent engaging in or being complicit in anti-competitive behaviour</p>
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Table E.3 provides first ideas on thresholds for the indicators of the circularity aspects. Not all of them are defined yet. On the ILUC aspects(see Table E.4) no suggestions have been finalized yet.

*Table E.3 – Circularity thresholds product and system circularity)*

N	ECONOMIC (CIRCULARITY)	Thresholds
1	Circularity index	<p><b>Not defined yet</b></p> <p>Specific for each product category. To be determined with Mac Arthur formula for the reference products. For the bio-based case study the proposed approach will be applied</p>
2	Renewable content of bio-based product	<p>50% in 2019 and 60% in 2020</p> <p><i>Based on Décret n°2016-379, 30 mars 2016 France</i></p>
3	High concern chemicals	The bio-based material and the bio-based end product shall not contain hazardous chemicals
4	Waste reduction and management (kg waste/kg useful product)	<p>0,2 in 2020 / 0,15 in 2025 / 0,1 in 2030 and 0,05 in 2035</p> <p><i>Based on D3.1 STAR-ProBio</i></p>
5	Energy intensity	<b>Not defined yet</b> Specific for each product category
6	Renewable energy	<b>Not defined yet</b>

*Table E.4 – ILUC*

N	Impact on natural land	Thresholds
1	ILUC	<b>Not defined yet</b>



## Annex F ( Informative)

### F.1 Basic communication

This Annex presents a worked out example of a communication that has proven to work. First of all the communication consists of the general product data as in Table F.1.

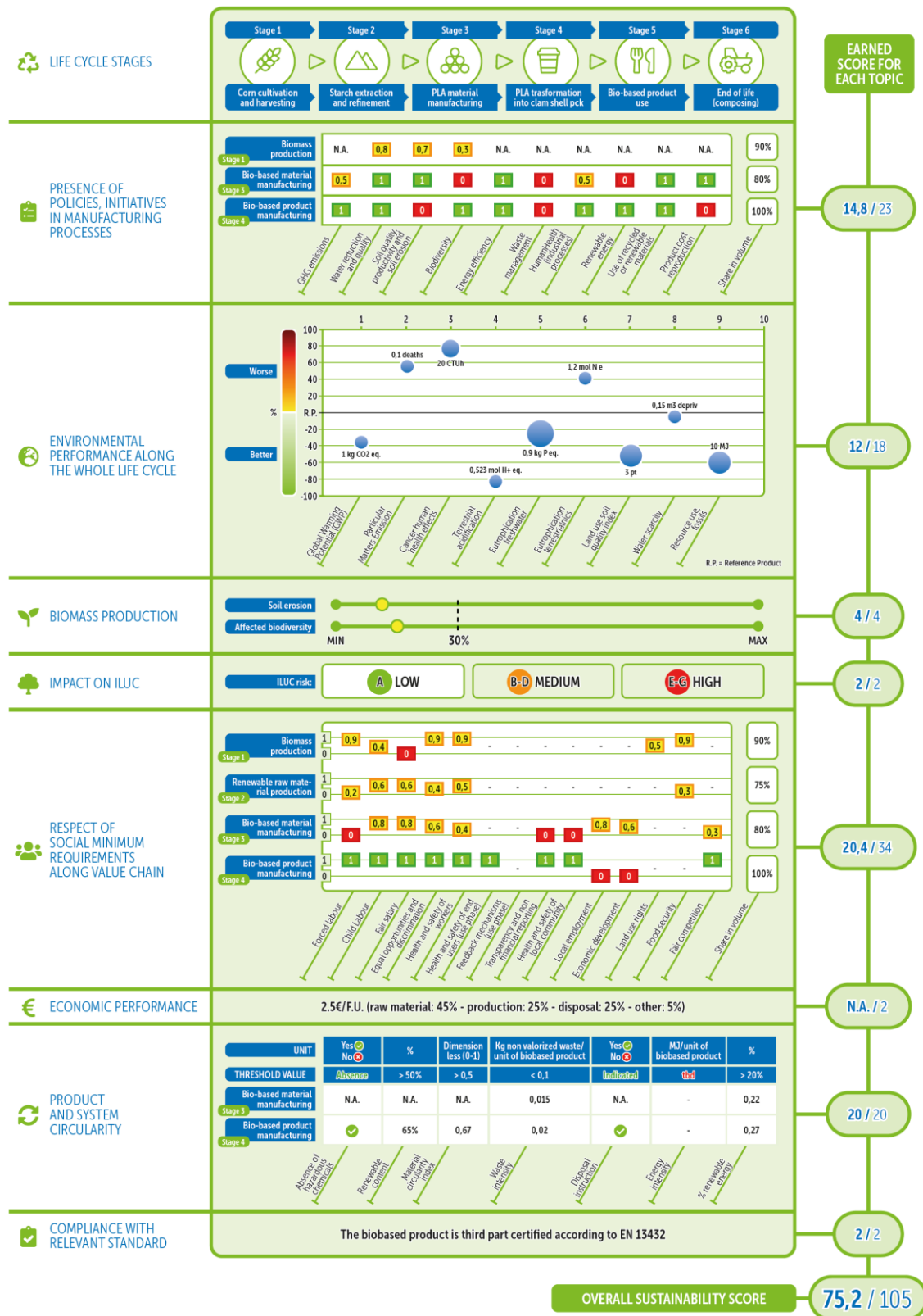
*Table F.1: General description of the bio-based product and sustainability score*

BIO-BASED PRODUCT IDENTIFICATION	
Product name (trade mark and grade/type)	
Supplier name and contact for further information	
Intended End Uses (industrial sector and intended application)	
Biomass type (e.g. plant species, animal, trees, algae, marine organisms, micro-organisms, animals. Otherwise: "not relevant" (including a justification) etc.)	
Biomass origin (e.g. territory, country, water area) Geographic origin as documented through the supply chain Otherwise: "not relevant" (including a justification)	
Contacts	
BIO-BASED CARBON CONTENT	
Bio-based carbon in relation to the total carbon (%)	
RECOVERY OPTIONS/DISPOSAL INDICATIONS	
Specification of recovery options thus clear instruction about disposal EoL potential treatment (reuse, recycle, ... disposal)	
SUSTAINABILITY SCORE	
Aggregated sustainability score whose details are reported in Part 2	

Then, in line with Clause 7 a visualization of the sustainability scoring is given in Figure F.1.



Figure F.1: Sustainability assessment results and the related sustainability score





## F.2 Correspondence of IAT with SDGs

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The Sustainable Development Goals (SDGs) also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. Specifically, SDGs define global sustainable development priorities and aspirations for 2030 and seek to mobilize global efforts around a common set of goals and targets. The SDGs call for worldwide action among governments, business and civil society to end poverty and create a life of dignity and opportunity for all, within the boundaries of the planet.

Since business is a vital partner in achieving the SDGs we here report the correspondence of Principle, Criteria and Indicator of IAT Matrix with SDGs and Targets (Table F.2) so as companies that implement the IAT can assess the sustainability profile of their bio-based products also respect to SDGs.


Overall the indicators of IAT Matrix can be directly linked to ten SDGs and twenty-two targets. SDGs 12 and 15 represent the most relevant ones in terms of number of identified targets respectively four and five.






Table F.2 - IAT Matrix and correspondence with SDGs and targets

	Principle	Criteria	Indicator		life cycle stages	Correspondence to SDGs and targets
ENVIRONMENTAL	<b>Mitigate climate change</b>	The economic operator provides information on how greenhouse gas (GHG) emissions associated with their operations are managed	1	Describe procedures taken to identify and minimize GHG emission and/or potential impacts on climate change in relations to their operations.	Stage 3,4	<b>Goal 13. Take urgent action to combat climate change and its impacts</b>  Target <b>13.2</b> Integrate climate change measures into national policies, strategies and planning
			2	The applicant (stage 4) provides the "Cradle to grave" Global Warming Potential (GWP) of the bio-based product, (LCA analysis) (i.e. GWP bio) <b>(MAJOR MUST)</b>	Stage 1-6	
	<b>Promote good air quality</b>	The economic operator provides information on how air pollutants resulting from their operations are managed	3	The applicant (stage 4) provides the "Cradle to grave" particulate matter emissions (PM) of the bio-based product (i.e. LCA analysis -> PM)	Stage 1-6	<b>Goal 12. Ensure sustainable consumption and production patterns</b>  Target <b>12.4</b> By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air water and soil in order to minimize their adverse impacts on human health and the environment.
	<b>Conserve and protect water resources</b>	The economic operator provides information on how biomass producers address the depletion and quality of water	4	Describe measures taken to address the impacts on water quality and quantity identified, related to the production of biomass suppliers	1	<b>Goal 6. Ensure availability and sustainable management of water and sanitation for all</b> 



		The economic operator provides information on how quality and quantity of water withdrawn and released are addressed.	5	Describe procedures to identify potential impacts and provide water consumption associated with their operations.	Stage 3,4	Target <b>6.3</b> By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
			6	The applicant (stage 4) provides the "Cradle to grave" water use of the bio-based product (i.e. LCA analysis -> water deprivation)	Stage 1-6	
	<b>Protect soil quality and productivity</b>	The economic operator provides information on how biomass producers address soil quality, erosion and productivity	7	Describe procedures to identify and address potential impacts on soil quality, productivity and soil erosion forces.	Stage 3,4	<b>Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss</b> 
			8	Describe measures taken by biomass producers to address the impacts on soil quality, productivity and soil erosion forces.	1	
			9	The applicant (stage 4) provides the agricultural land occupation (stage 1) needed for producing the biomass used in the bio-based product.	1	
			10	The applicant (stage 4) provides the erosion risk associated with the biomass production (crop and region specific) used for producing the bio-based product. Provide the amount of specific soil loss (Mg soil/ha*yr) for bio-based product (i.e. LCA analysis -> soil erosion)	1	
			11	The applicant (stage 4) provides the "Cradle to grave" Land use of the bio-based product (i.e. LCA analysis -> Land use – soil quality index)	Stage 1-6	
	<b>Promote efficient use of energy resources</b>	The economic operator provides information on how energy	12	The applicant (stage 4) provides the "Cradle to grave" Non-renewable energy resource consumption for bio-based product (i.e. LCA analysis -> Resource use fossil)	Stage 1-6	Target <b>15.2</b> By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally  Target <b>15.3</b> By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.  Target <b>15.5</b> Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
						<b>Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all</b>







	<b>and the prevention of non-renewable energy resource depletion.</b>	efficiency and non-renewable energy resource consumption are achieved.				
			13	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Acidification Terrestrial and Freshwater)	Stage 1-6	 <p>Target <b>15.1</b> By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services [...]</p>
			14	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication Freshwater)	Stage 1-6	
			15	The applicant (stage 4) provides the "Cradle to grave" potential impacts on freshwater and terrestrial ecosystems for bio-based product (i.e. LCA analysis -> Eutrophication terrestrial)	Stage 1-6	
	<b>Promote positive and reduce negative impacts on biodiversity</b>	The economic operator provides information on how biomass producers address biodiversity.	16	Describe procedures to identify potential impacts on biodiversity <sup>10</sup> .	1	 <p>Target <b>15.5</b> Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>Target <b>15.a</b> Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
			17	Describe measures taken to promote positive and reduce negative impact on the biodiversity.	1	
		The economic operator provides information on how biodiversity values are addressed	18	Provide the number of potentially affected species for bio-based product (i.e. LCA analysis -> potentially affected biodiversity)	1	

<sup>10</sup> NOTE Potential impacts on biodiversity can include impacts on ecosystems, habitats and identified rare, threatened and vulnerable species of local, regional or global importance.





	<b>Minimize the impacts on Human Health</b>	The economic operator provides information on how Human Health values are addressed within the area of operation	19	Describe measures taken to promote positive and reduce negative impact on the Human Health within the area of operation.	Stage 3,4	<b>Goal 3. Ensure healthy lives and promote well-being for all at all ages</b>  <b>Target 3.9</b> By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
			20	The applicant (stage 4) provides the "Cradle to grave" potential impacts on Human health for bio-based product (i.e. LCA analysis -> Cancer Human health effects)	Stage 1-6	
<b>ILUC</b>	Reduce to a zero indirect Land-Use Change (ILUC) risk.	The economic operator provides information on its strategies adopted to reach a "low ILUC risk" level	21	The applicant (stage 4) provides ILUC risk for the bio-based product determined according to "ILUC Risk Tool"	Stage 1-4	 Transversal aspects
<b>PRODUCT AND SYSTEM CIRCULARITY</b>	Promote responsible use of high concern materials	The economic operator provides information on how hazardous chemical is addressed	22	Describe measures taken to avoid, reduce or find greener alternatives to the use of substances of very high concern (SVHC) through a screening of the product's raw materials against substances on the hazardous chemical databases, SINLIST and SUBSPORT.	Stage 3,4	
	Promote use of renewable materials	The economic operator provides information on the use of renewable raw materials	23	The applicant (stage 4) describes measures taken to promote the use of renewable material resources and provides the % of biogenic carbon / total carbon (Product renewability)	4	<b>Goal 12. Ensure sustainable consumption and production patterns</b>  <b>Target 12.2.</b> By 2030, achieve the sustainable management and efficient use of natural resources <b>Target 12.5.</b> By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
	Promote the use of material circularity. Minimize the use of virgin raw materials and maximize the recyclability	The economic operator provides information on the use of recycled materials and how an effective recyclability of the bio-based product is achieved	24	The applicant (stage 4) describes measures taken to increase the use of recycled or renewable raw materials and the recyclability of the bio-based end product.	4	
			25	The applicant (stage 4) provides the material circularity index (MCI) of the bio-based product. <b>(MAJOR MUST)</b>	5	



	of end products					
	Promote responsible waste management	The economic operator provides information on how waste is managed and reduced	26	Describe measures taken to manage and reduce the waste.	Stage 3,4	
			27	Provide the amount of total non-valorised waste generated per unit of product and useful co-product	Stage 3,4	
		The economic operator provides information on bio-based disposal	28	The applicant (stage 4) provides guidance and clear instructions to the consumers on how the bio-based product is to be disposed after use	4	
	Promote efficient use of energy	The economic operator provides information on how energy efficiency related to their operations is achieved	29	Describe measures taken to address energy efficiency	Stage 3,4	
			30	Provide energy intensity i.e. heat and power sourced from renewable and non-renewable or internally-derived pathways consumed per unit of product and useful co-product.	Stage 3,4	
	Promote the use of renewable energy sources	The economic operator provides information on how the use of renewable energy sources is promoted	31	Describe measures taken to promote the use of renewable energy.	Stage 3,4	
			32	Provide the share of renewable energy compared to the overall energy consumed for a given process or processes under consideration.	Stage 3,4	
<b>ECONOMIC</b>	Promote the minimisation of life cycle costs associated with the entire value chain	The economic operator provides information on the life cycle costing	33	Describe measures taken to reduce the environmental-life cycle costs	Stage 3,4	
			34	The applicant (stage 4) provides the Environmental Life Cycle Costing (LCC) of the bio-based product	Stage 1-6	




Target **7.2** By 2030, increase substantially the share of renewable energy in the global energy mix


Target **7.3** By 2030, double the global rate of improvement in energy efficiency

N.D.





<b>SOCIAL</b>	Respect Labour Rights	The economic operator provides information on how the issue of forced labour is addressed <sup>0</sup>	35	Describe measures taken to safeguard rights relating to forced labour including prohibiting policies, evidences, incidents and corrective action plans and a plan-do-check-act process in place to raise awareness on the topic <b>(MAJOR MUST)</b>	Stage 1-4	<p><b>Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all</b></p>  <p>Target <b>8.7</b> Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms</p> <p>Target <b>8.5</b>. By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value</p> <p>Target <b>8.8</b>. Protect labour rights and promote safe and secure working environments for all workers [...]</p>
		The economic operator provides information on how the topic of child labour is addressed	36	Describe measures taken to address child labour, including prohibiting policies, evidences (such as records on worker's age), incidents and corrective actions plans and a plan-do-check-act process in place to raise awareness on the topic <b>(MAJOR MUST)</b>		
		The economic operator provides information on how fair salary is addressed	37	Provide information regarding the salary of workers, including the percentage of workers whose wages meet at least legal minimum standards, incidents of delayed payments, percentage of workers paid a living wage or receive additional social benefits <b>(MAJOR MUST)</b>		
		The economic operator provides information on how equal opportunities and discrimination are addressed <sup>0</sup>	38	Describe measures taken to address equal opportunities, including whether a non-discrimination policy is in place, a system to enforce it, incidents and corrective action plans and a public commitment on this issue		
		The economic operator provides information on how health and safety of workers are addressed <sup>0</sup>	39	Describe measures taken to address health and safety of workers, including whether they comply with local laws, whether workers have the needed protective equipment, incidents and corrective plans, a plan-do-check-act process in place to protect workers' health beyond laws and public commitments on this issue		



	Respect health and safety of end users	The economic operator provides information on how health and safety of end users are addressed	40	The applicant (stage 4) describes measures taken to ensure the health and safety of end users (stage 5), including evidence that the product is safe for users, compliance with product safety laws and programmes in place to raise awareness on safety risks associated with the product <b>(MAJOR MUST)</b>	4	Target <b>12.4.</b> By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
	Promote consumer satisfaction	The economic operator provides information on how they provide feedback mechanisms	41	The applicant (stage 4) describe measures taken to offer mechanisms for users (stage 5) to provide feedbacks, including measures to improve the mechanism, if there are surveys related to customers satisfaction and actions taken in response to the results of these surveys	4	N.D.
	Promote transparency	The economic operator provides information on how transparency is addressed	42	The economic operator describes measures taken to address transparency, including if there are compliance with regulations, consumer complaint, sustainability reporting and targets	Stage 3,4	Target <b>12.6</b> Encourage companies, especially large and transnational companies, to adopt Sustainable practices and to integrate sustainability information into their reporting cycle
	Respect of health and safety of local communities	The economic operator provides information on how health and safety of local community are addressed	43	Describe measures taken to address health and safety of local communities, including noise, air emissions etc.	Stage 3,4	N.D.
	Promote local development	The economic operator provides information on how local employment is addressed	44	Describe measures taken to address local employment, including public commitments to grow local employment and the number of indefinite or temporary jobs (higher than 6 months) created or lost during the reporting period	Stage 3,4	<b>Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation</b> 
		The economic operator provides information on	45	Describe measures taken to address economic development, including any policy, which prioritises buying goods and services from local	Stage 3,4	



		how economic development is addressed		suppliers (regional or at national level), contribution to skill development, and the percentage of employees and market share of the company that have grown in the last 5 years		ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities  <b>Target 9.2</b> Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries
	Respect land use rights	The economic operator provides information on how land use rights are addressed	46	The applicant (stage 4) describes measures taken by the raw materials producers (stage 1) to address land use rights, including percentage of small-scale entrepreneurs who have documented legal rights to land and who feel that their land rights are secured and if land grabbing risk is being mentioned	1	N.D.
	Respect Food Security	The economic operator provides information on how they address food security	47	The applicant (stage 4) describes measures taken by the raw materials producers (stage 2) to address food security, including measures to improve and ensure local food security, a plan-do-check-act to identify and reduce risks on this topic.	1	<b>Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture</b>    Target <b>2.3</b> By 2030, double the agricultural productivity and incomes of small-scale food producers [...] including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.  Target <b>2.c</b> Adopt measures to ensure the proper functioning of food commodity markets [...]
	Promote fair competition in the market	The economic operator provides information on how fair competition in the market is addressed	48	Describe measures taken to address fair competition in the market, including incidents regarding anti-competitive behaviour, measures to increase employee awareness in this topic	Stage 3,4	<b>Goal 10. Reduce inequality within and among countries</b>    Target <b>10.3</b> Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard



## Bibliography

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- [1] *Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC*
- [2] *A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment Updated Strategy, European Commission, 2018, Publications Office of the European Union*
- [3] *STAR4BBI, 2019, Policy paper on strategy for development of an RCS framework, L. Ladu, J. Clavell, R. Quitzow, O. Costenoble, M. Vrans, J. van den Berg, T. Babayan, C. vom Berg, L. Dammer, A. Partanen, H. Bos, M. van den Oever, I. Gursel*
- [4] *STAR-ProBio, 2020, Deliverable 8.2 Blueprint of sustainability certification schemes for bio-based products, J. Gołaszewski, P. Morone, S. Majer, F. Razza, L. Ladu, M. Grill, S. Ugarte, S. van Iersel, M. Voogt, M. Crepy, D. Fedrigo, E. Merloni.*
- [5] *Handbook for Product Social Impact Assessment, M. Goedkoop, D. Indrane and I. de Beer, 2018, available from Roundtable for Product Social Metrics (<https://product-social-impact-assessment.com/handbook/handbook>)*
- [6] *NTA 8080-1, Sustainably produced biomass for bioenergy and bio-based products - Part 1: Sustainability requirements, NEN, PO Box 5059, Delft, the Netherlands*
- [7] *ISCC PLUS System Document, International Sustainability & Carbon Certification, available at [issc-system.org](https://issc-system.org)*
- [8] *FAO 2019, Indicators to monitor and evaluate the sustainability of bioeconomy, S. Bracco, A. Tani, Ö. Çalicioğlu, M. Gomez San Juan, A. Bogdanski. available at: <http://www.fao.org/3/ca6048en/ca6048en.pdf>*
- [9] *Golden Compound's sustainable coffee capsule, Evaluation of sustainability according to VDI-4605 standards, A. Scharf and M. Carus, nova-Institut GmbH, Hürth (Germany), February 2019*
- [10] *Guidelines for Providing Product Sustainability Information, UNEP, 2017*
- [11] *EN 16760, Bio-based products - Life Cycle Assessment*
- [12] *Environmental life cycle costing, D. Hunkeler, K. Lichtenwort and G. Rebitzer, SETAC, Pensacola, FL (US) in collaboration with CRC Press, Boca Raton, FL, (USA), 2008*
- [13] *CEN/TR 16957, Bio-based products - Guidelines for Life Cycle Inventory (LCI) for the End-of-life phase*
- [14] *CEN/TR 17341, Bio-based products - Life Cycle Assessment*
- [15] *ISO 14040, Environmental management - Life cycle assessment - Principles and framework*
- [16] *ISO 14044, Environmental management - Life cycle assessment – Requirements and guidelines*
- [17] *EN 16640, Bio-based products - Bio-based carbon content - Determination of the bio-based carbon content using the radiocarbon method*
- [18] *CIRCULARITY INDICATORS - An Approach to Measuring Circularity, Ellen MacArthur Foundation & Granta Design, 2015, available from: [www.ellenmacarthurfoundation.org](http://www.ellenmacarthurfoundation.org)*
- [19] *Metrics for quantifying the circularity of bioplastics: the case of bio-based and biodegradable mulch films, Resources, Conservation & Recycling (RCR) within the Special Issue on "Sustainable Cycles and Management of Plastics, 2019.*
- [20] *ISO 50001, Energy management systems - Requirements with guidance for use*
- [21] *EN 17033, Plastics - Biodegradable mulch films for use in agriculture and horticulture - Requirements and test methods*



- [22] *System dynamic modelling to assess the Indirect Land Use Change risk (SydILUC)*, CIRSA, University of Bologna, <http://www.cirsa.unibo.it/en/research/environmental-management-research-group-emrg/biorefer/sydiluc>