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Early steps for a measurable and impactful ecodesign process: the case of urea production

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Abstract

As governments increasingly promote ecodesign through updated regulations, new products shall integrate this approach throughout the product development phase. This paper presents the steps performed to identify existing ecodesign criteria and product parameters to support ecodesign processes. The proposed criteria and parameters are taken from three main sources: the qualitative assessment life cycle criteria, the circularity scoring system, and the 2024 Ecodesign and Sustainable Product Regulation. Criteria and parameters are classified by life cycle stage, and an accounting method is proposed to facilitate their evaluation. As a result, a reference set of 15 criteria and 36 parameters is proposed as a general framework for the ecodesign of any product or technology. This set can be fine-tuned to specific product needs, which we illustrate with the case of novel technology for urea production. To do so, we conducted a participatory workshop with experts, which helped to narrow down the reference set to 25 parameters based on their relevance, ease of measurement and effects on functionality. Overall, the proposed ecodesign process is helpful to guide a more sustainable development of new technology prototypes under development.

Keywords: ecodesign, sustainability, circular economy, material efficiency, life cycle

Nomenclature

EU	European Union
CEN	European Committee for Standardization
CENELEC	European Committee for electrotechnical Standardization
CSS	Circularity Scoring System
CO_2	Carbon dioxide
ESPR	Ecodesign for Sustainable Products Regulation
LCA	Life Cycle Assessment
QALCC	Qualitative Assessment of Life Cycle Criteria
TRcyc	Technical recyclability factor

1. Introduction

The development of new products is always an exciting process. Products are designed to fulfill many aspects, including functionality, aesthetics, costs, safety, quality, ergonomics, durability, and compliance with legislation. Environmental aspects have become an additional element to consider at the design stage of products. The specific environmental hotspots of products throughout their whole life cycle can be addressed through the Qualitative Assessment of Life Cycle Criteria (QALCC) [1] to improve their design.

During the last 15 years, there have been great efforts in the EU to promote the ecodesign of products from a regulatory perspective [2]. In 2005 and 2009, the Ecodesign Directive established a framework for setting ecodesign requirements for the so-called energy-use and energy-related products [3,4].

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These refer to any products that have an impact on energy consumption during use. Besides setting requirements that reduce the overall energy consumption of these products, the Directive referred to ecodesign aspects such as ease for reuse, ease for recycling and lifetime extension. However, these aspects were not traditionally included in the first ecodesign regulations. They started to be progressively included in latter regulations for products such as enterprise servers, vacuum cleaners, and commercial refrigerators, among others [5]. One of the limitations to further developing ecodesign requirements was the availability of standard methods to measure some of their features. During the 2020's, this limitation was overcome thanks to the release of a series of CEN/CENELEC standards on material efficiency for energy-related products [6], [7], [8]. These standards outline specific parameters and associated methods for evaluating the following aspects: ability to remanufacture (EN45553), ability to repair, reuse & upgrade (EN45554), recyclability and recoverability (EN45555), and proportion of reused components (EN45556). Cruz Ugalde and Talens Peiró [9] proposed the 'Circularity Scoring System (CSS)' method based on EN45554 to translate the ecodesign parameters into a unique score. This was specifically developed for lithium-ion batteries. The authors highlighted the need to adjust criteria proposed in CEN-CENELEC standards to generate relevant results for the products of interest.

In July 2024, the 2024/1781 Ecodesign for Sustainable Products Regulation (ESPR) replaced the 2009/125/EC Ecodesign Directive and established a framework for setting ecodesign requirements for specific product groups [10]. One of the newest features is the fact that it targets virtually almost all categories of physical goods available in the EU market, except for food, feed, medical products, and certain vehicles, among others. Similar to the 2009 ecodesign regulations, the ESPR will develop regulations on a product-by-product basis, as well as based on product groups with similar features. Product groups will be prioritized, and their regulations will be developed following a working plan over a given time period. Textiles and steel are the first product groups to be regulated in light of the results given by a 2023 prioritization study [11].

Even though this prioritization study does not refer to new innovative products, the ESPR regulation contains many aspects that are important to consider when aiming to ecodesign new products. Next to regulations, current and future EU research and innovation calls stress the need for a life cycle approach in the development of revolutionary circular and net-zero technologies and products. Conducting a life cycle assessment (LCA) during the design phase of products is essential, as performing it towards the end of the project leaves no room for implementing ecodesign strategies and effectively improving the products.

In this paper, we pose that integrating ecodesign criteria and parameters at the early stages of these projects is imperative but that a clear methodology is needed to make the process measurable and impactful. For this reason, we propose an interdisciplinary method leading to a set of diverse ecodesign criteria and product parameters that are aimed to be addressed during the development of new products and technologies. We illustrate this process with a novel technology for urea production that is being developed as part of the CONFETI project, which is funded by the EIC Pathfinder Challenge program [12]. The result is a set of criteria and parameters that are easy to understand and to measure, and that are deemed critical for the functionality of the proposed technology.

2. Methodology

The proposed methodology consists of three steps: 1) definition and description of the product of interest, 2) review of ecodesign criteria, parameters and accounting methodologies proposed in standards and regulations, and 3) prioritization of parameters based on interdisciplinary expert input. This methodology can be applied to any product or technology but it is here illustrated with the case of the ecodesign process of CONFETI's electrochemical reactor for urea production [12] as an example of best practices in research projects.

2.1. Step 1. Definition and description of the product of interest

The first step in any ecodesign process is the definition of the product of interest and its life cycle. Identifying key components within the product is essential to propose ecodesign parameters and accounting methodologies that are fit for purpose. This is especially relevant in the early development of lab-scale prototypes, as the functionality remains at the center of all the research efforts but there is still room to adjust the conceptual design to meet environmental goals. For this reason, detailed discussions are essential to gain a better understanding of the product and its components at this stage.

In the case of CONFETI's electrochemical reactor, several conceptual designs were proposed at the early stages of the project. In general terms, the proposed technology aims to produce urea by capturing CO_2 along with N_2 and/or nitrates to provide on-demand fertilizers. Next to creating a disruptive functional device, the reactor aims to reduce the environmental impacts associated with conventional fertilizer production. For this reason, identifying environmental hotspots and proposing improvement strategies is vital, and an ecodesign process was thus initiated.

To this end, an interdisciplinary environment facilitated the characterization of the life cycle of the conceptual designs. Two groups of experts played different roles in this process. On the one hand, academics with expertise in electrochemistry, computational chemistry, materials chemistry and inorganic chemistry envisioned the main product parts, such as membranes or electrocatalysts, and the assembly of these parts in a functional device. In addition, they are the main sources of information about the material and energy inputs into the life cycle of the device. On the other hand, experts in industrial ecology, who are the authors of this paper, built the complete life cycle of the product, from raw material extraction to product use and end of life. They are responsible for conducting the environmental assessment of the conceptual designs and for acting as facilitators in the ecodesign process. To do so, this latter group developed the proposal of criteria, parameters and accounting methodologies applied in the ecodesign (step 2) and provided feedback to the former expert group (step 3). Further details on the electrochemical reactor are not available yet but are not central to understanding the application of the proposed methodology.

2.2. Step 2. Review of ecodesign criteria, parameters and accounting methodologies

Once the object of interest is defined (in our case, the life cycle of the electrochemical reactor), we need to identify the variables that will support the ecodesign process. These variables are meant to monitor the current environmental performance of the product and progress towards environmental goals with the application of improvement strategies. The selection of variables started with a detailed review of the ecodesign criteria included in the QALCC [1], the CSS based on CEN/CENELEC material efficiency standards [9], and the product parameters given in Annex I of the ESPR [10].

The QALCC generally includes all the life cycle stages of the product. In our study, we used as the initial reference the list of criteria given by the edTOOL® ecodesign tool [13]. edTOOL® includes as life cycle stages the raw materials, production, packaging, distribution, use and maintenance, and end of life. For each life cycle stage, a list of 10 to 22 criteria is disclosed depending on the life cycle stage. Since edTOOL® is designed for qualitative assessments, many of the criteria are presented without a specific accounting methodology, making quantification challenging in many cases. For example, criteria in the 'raw materials' stage, such as scarcity and origin, are defined but lack a detailed calculation method.

The list of criteria in the CSS is shorter, primarily because it aims to assess the potential for use and maintenance, and end of life [9]. For lithium-ion batteries, nine out of 25 possible criteria were selected to 'avoid double counting'. The strength of this method lies in providing calculation methods for each criterion. Some methods refer to specific quantitative data, while others use rating classes from A to E, which Cruz Ugalde and Talens Peiró [9] standardized into a numerical range from one to five - five being the most favorable to facilitate use and maintenance, and one indicating minimal relevance. This allows for easier scoring and weighting to produce a final circularity score.

The annex I of the ESPR includes a total of 20 product parameters. Some of the parameters are described in detail and contain a more specific subset. For example, the description of parameter (a) on durability refers to products' guaranteed lifetime, technical lifetime, mean time between failures, resistance to stress or aging mechanisms, among others. Despite the availability of subsequent parameters, calculating methods to quantify them are not given. The parameters given cover from the raw materials extraction, production, use and maintenance to the end of life. Additionally, they include some parameters derived from LCA, such as the environmental, carbon, and material footprints. References to calculation methods are missing. Fig. 1 summarizes the product parameters included in the ESPR, and their location within the life cycle of the product.

Based on all this information, a total of 15 criteria and 36 product parameters were revised. At this stage, all the defined criteria were classified based on the life cycle stage of products: raw materials, production, use and maintenance and end of life. Note that product packaging and distribution parameters were excluded, as lab-scale innovations are barely contextualized on a larger market scale. This is the case of the electrochemical reactor.

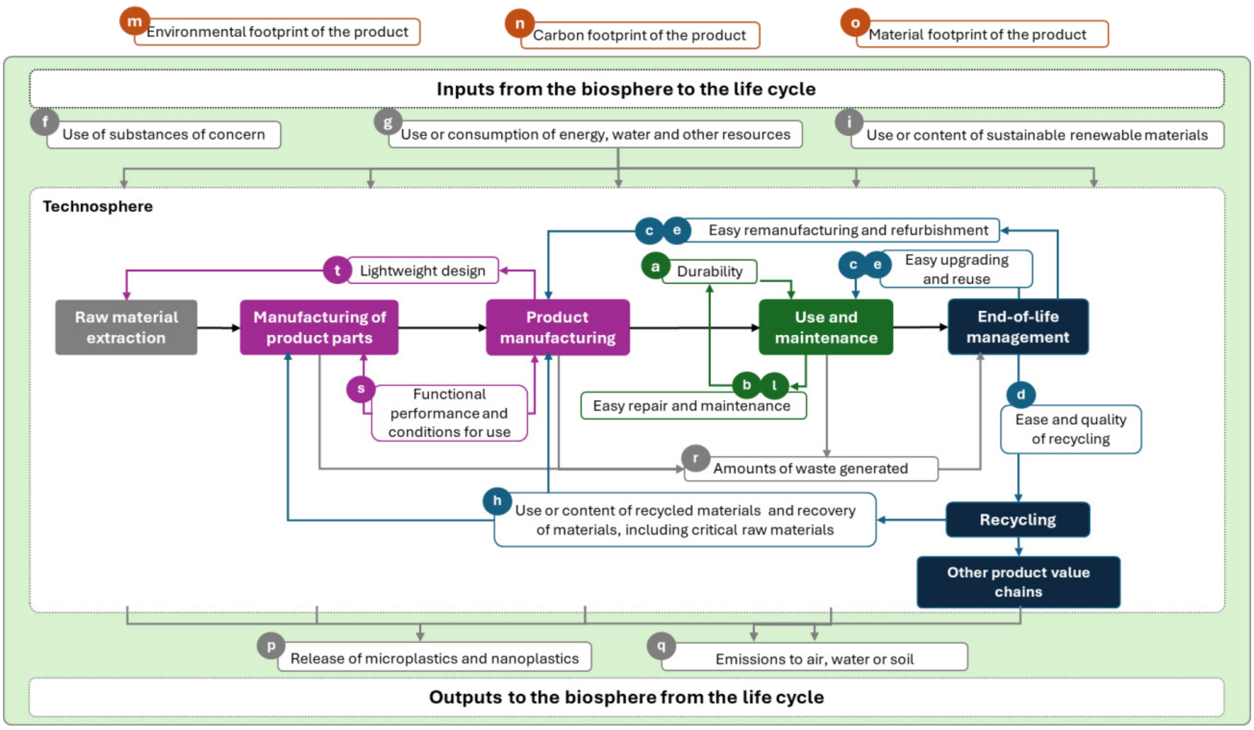

Fig. 1. Criteria and product parameters for the ecodesign of an alternative urea production technology. Lettering (a-t) refers to Annex I of the ESPR [10].

It is also important to note that some criteria were applicable to more than one life cycle stage, for example 'raw materials to the life cycle' and 'emissions to air, water and soil'. Others referred to the complete life cycle of the products and therefore defined at a higher hierarchical level. This is the case of ‘environmental footprint’, ‘carbon footprint’ and ‘material footprint’.

Once the classification stage was complete, two levels of aggregation were identified: criteria, which are generally broader (e.g. durability), and parameters (e.g. number of cycles during use), which are more specific and typically have a method explaining their calculation. Within each criterion, one or multiple specific parameters can be defined. Then, each parameter can be described along with its calculation methodology. A reference set of criteria and parameters is available in the Annex. This set serves as a baseline and can be further fine-tuned depending on the product under study. To do this fine-tuning, we further categorized the parameters in three groups following their accounting methodologies and data needs:

(1) Parameters for which data are intrinsic to the data collection process of an LCA (e.g., energy use or waste generation).
(2) Parameters that are indicators resulting from an LCA (e.g. global warming indicator).
(3) Parameters that relate to functional variables related to the design or operation of the product (e.g. technical life or steps for disassembly).

From this grouping, it is clear that LCAs are an integral part of the ecodesign process. Thus, experts should be able to collect the necessary data and conduct a comprehensive LCA. In the case of the electrochemical reactor, experts involved in the development of the lab-scale prototype are able to provide raw data for group (1), whilst industrial ecologists can structure and calculate parameters in groups (1) and (2). Group (3) holds larger uncertainty given the early stages of development of the technology. For this reason, our method suggests a participatory prioritization of group (3) parameters.

2.3. Prioritization of parameters based on interdisciplinary expert input

To optimize the efforts of the working group in the ecodesign process, we conducted an online participatory workshop with all the academic experts involved in the development of the technology. We suggest this process to prioritize parameters that are more complex and uncertain, and to reach a consensus with the working group. Our suggested prioritization process aims to identify group (3) parameters that can be easily understood and easily measured and are perceived as important to produce a functional and more environmentally friendly device.

The participatory process consists of two parts. First, we collected individual perceptions around importance, measurability and understanding from the experts. We also inquired about the potential effects of improving a parameter on the functionality of the product (i.e. creating a device that can produce a certain amount of urea per day). To do so, experts were asked to evaluate each group (3) parameter through a set of questions (Table 1) in a questionnaire matrix format. 8 experts from the working group, including at least one representative from each discipline or product part, filled out the questionnaire. With these individual perceptions, we organized a 1.5-hour online workshop to discuss the experts’ responses and to reach a consensus towards prioritization. Based on the degree of importance assigned to each parameter, we presented the 10 most voted parameters along with their level of understanding, effects on functionality and ease of measurement. Redundancies and discrepancies in these interconnections were discussed along with more technical details that the experts could provide on their experiments with the product parts.

Table 1. Fields of the questionnaire used to collect expert perceptions

Question	Type of answer
Please mark the parameters that you have trouble understanding	1. I need further clarification 2. It is easy to understand
Do you think that changes in this parameter can affect the functionality of the electrochemical reactor?	1. Yes, efforts to improve this parameter can have a negative effect on functionality 2. No, the functionality will not be altered 3. I don't know yet
Considering the proposed methodologies, how easy do you think it is to measure each parameter?	1. Data is easy to collect 2. Data is easy to estimate 3. Data is available in the literature 4. Data is difficult to quantify 5. I don't know
From your perspective, please rank the 10 most important parameters for the design of a functional and more sustainable electrochemical cell	1. Most important parameter within your selection 10. Most important parameter within your selection

3. Results

3.1. A reference set of criteria and parameters for product ecodesign

The reference set of criteria includes 36 parameters. From this original set, 12 are measurable with input data from partners for the planned LCAs (group (1)) and 4 are indicators resulting from the LCAs (group (2)). However, 20 of them (group (3)) demand in-depth discussions with the partners involved in the development of the technologies because of their complexity and uncertainty.

For our analysis, the life cycle stages considered were the raw materials to the life cycle, the production, the use and maintenance, and the end of life. When considering a life cycle approach, the ‘raw material inputs’ are not limited to the initial extraction stage but instead as an input needed for every stage. As shown in the Annex, four main criteria were described: the use of substances of concern (SoC), the use or consumption of resources, the use or content of recycled materials and the use or content of sustainable renewable materials. All of them are well-aligned with the ESPR. The term SoC (annex I, product parameter (1)g of the ESPR) refers to substances already regulated under EC/1907/2006, EC/2019/1021 and EC/1272/2008, and includes substances ‘negatively affecting the reuse and recycling of materials in the product in which it is present’. Data for these parameters are generally readily available from technology developers and can be deducted from material declarations from manufacturers. This is the case of the number of SoC, and their respective quantities, and the use and consumption of resources, such as water, energy and materials. Other parameters may require additional gathering from material suppliers. For example, the presence of critical and strategic raw materials, as well as bio-based materials are relatively new concepts not commonly addressed in regulations and relatively unknown by manufacturers. The recycled content is another parameter that will also require further investigation for its calculation.

For the production stage, the parameter considered was lightweight design, referred to in Annex I product parameter (1)t of the ESPR. This criterion can be estimated by two parameters: the ‘reduction of material consumption’ measured as the percent reduction in material mass, and the ‘integration of functions within the material and single product component’.

At the use and maintenance stage, the number of parameters was extended to a total of 12, most of which have been defined in recent years as part of the material efficiency standards. From these 12 parameters, seven can be estimated based on methods given by the CSS [9], four parameters can be estimated using other accounting methods, and only one parameter has no method disclosed. In the context of CSS, the rating scales proposed by ability to repair, reuse & upgrade standard (EN45554) [14] were standardized into a numerical range from one to five, so that they can be more easily scored and evaluated in subsequent versions of the same product. The two parameters on durability can be quantified as number of cycles, and technical life (given in months or years). The parameter on the ‘number of materials and components use’ can be estimated by a simple number of units as suggested by the QALCC. At present, there is no method available to assess the use of standard components. To our knowledge, it could be estimated as the number of units. However, more specific information from experts would be beneficial to ensure its usefulness.

At the end of life, the criterion considered was the ease and quality of recycling, proposed by the ESPR. This criterion could be accounted for as the technical recyclability factor (TRcyc), proposed by the CEN/CENELEC and also selected by Cruz Ugalde and Talens Peiró [9]. This parameter can be calculated for the complete product and for critical parts of the product. The method to measure in both cases is the proportion (%) by mass of the part that can be technically recycled.

The parameters and the related accounting methodology described for the ‘Emissions from the life cycle’ can be calculated for each life cycle stage. Most of the parameters are clear, and the availability of data is ensured, except for the ‘microplastic and nanoplastic release’ which is relatively new and would require further discussion on data availability with experts. The parameters related to the environmental impact categories would require the development of an LCA, and the use of specific life cycle impact assessment methods (i.e. ReCiPe methods). The Annex includes the complete reference set of criteria with their related parameters and methods.

3.2. Applicability of the reference set to an electrochemical reactor

The reference list of parameters was then tailored to the specific functional needs and properties of the electrochemical reactor. Our participatory workshop set the basics for ecodesigning the electrochemical reactor, where the 20 complex parameters (group (3)) were narrowed down to 9 based on their perceived importance, ease of measurement and effects on functionality. Durability and the number of destructive steps represented the top 4 parameters by importance. Others were excluded because they either demand large measurement efforts (e.g. microplastic release) or are not envisioned in the conceptual designs (e.g. diagnostic support and interfaces). The workshop not only served to prioritize parameters, but also to reach a common agreement on the need to measure certain parameters in the lab (e.g. through the disassembly of the device). Table 1 shows the final set of 25 parameters that we have defined for the ecodesign of the electrochemical reactor.

4. Conclusions

The 2024/1781 Ecodesign for Sustainable Products Regulation (ESPR) represents an opportunity to improve the design of products from an environmental perspective. The regulation includes a list of relevant product parameters relevant for the design of new products. The information given is quite general, and thus how these parameters will be accounted for and evaluated is still unprecise. We complemented ESPR product parameters the QALCC and the CSS criteria to obtain a reference set of 36 parameters with their accounting methodologies. Their ease of measurement and importance was discussed during a workshop with technology experts for a specific product, where the number of parameters was reduced to 25. The results of the parameters are aimed to be compared with the results obtained from the required LCAs, especially for some aspects regarded to be initially positive as the use of bio-based and secondary materials.

Even though the alternative electrochemical reactor introduced on this paper is unlikely to be regulated in the next years, investigating the potential application of ecodesign parameters would prove useful to ensure the sustainability of this new technology. This ecodesign and monitoring process will not only be helpful for the electrochemical reactor. It can also support the ecodesign process of any new technology, product or process developed in other research projects or industries. The scientific and societal impact of this method is thus high.

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Table 2. Set of criteria and parameters and accounting methodologies selected for the ecodesign and monitoring of the environmental impacts and benefits of the electrochemical reactor. ● measurable with input data from partners for the planned LCAs; ● indicators resulting from the LCAs; ● prioritized after participatory process with project partners

Criteria	Parameters	Accounting methodology
Raw materials to the life cycle		
Use of substances of concern	Presence of substances regulated under EC/1907/2006 (REACH); EC/1272/2008 (Hazards' categories) and EC/2019/1021 (POP)	● Number and their respective quantity (g)
Use or consumption of energy, water and other resources	Water use	● Quantity in physical units (g)
	Energy use	● Quantity in physical units (kWh, MJ)
	Material use	● Quantity in physical units (g)
Use or content of recycled materials and recovery of materials, including critical raw materials	Presence of Critical and Strategic Raw Materials	● Number of Critical Raw Materials and their respective quantity (g) ● Recovery potential (%)
	Recycled content	● Proportion (%), by mass, of recycled material in a product ● Number of cycles, if recycled internally
Use or content of sustainable renewable materials	Presence of bio-based materials	● Proportion, by mass, of biobased material in a product (g)
	Use of renewable energy sources	● Proportion (%) of renewable energy input
Production		
Lightweight design	Reduction of material consumption (only when comparing diverse versions of the same product/part)	● Proportion (%), by mass, of reduction of material consumption
Use and maintenance		
Durability	Cycles For complete product For critical product part	● Number of cycles that the product or product part can fulfil before needing replacement
	Technical life For complete product For critical product part	● Months or years of operation of the product or product part
Functional performance and conditions for use	Conversion yield	● Quantity of output in physical units (for nitrogen-based materials g, kg; for energy kWh, kJ)
Easy repair, maintenance, upgrading, reuse, remanufacturing and refurbishment	Use of standard components	● Number of standard components purchased
	Number of destructive steps For complete product For critical product part	● Number of steps that can destroy product parts or critical product parts during reparation or disassembly
End of life		
Easy and quality of recycling	Technical Recyclability Factor for critical product parts	● Proportion (%) by mass of the product part that can be technically recycled.
Emissions from the life cycle		
Emissions to air, water or soil	Quantity and nature of the emissions	● Quantity in physical units (g)
Amounts of waste generated	Generation of waste	● Quantity in physical units (g)
	Generation of hazardous waste	● Quantity in physical units (g)
Life cycle environmental impacts		
Environmental footprint of the product	Set of ReCiPe or Environmental Footprint impact indicators	● Calculated through the life cycle assessment (LCA) methodology
Carbon footprint of the product	Global Warming indicator	● kg CO_2 eq calculated based on IPCC
Material footprint of the product	Mineral resource scarcity	● kg Cu eq according to the ReCiPe method (LCA)
	Fossil resource scarcity	● kg oil eq according to the ReCiPe method (LCA)

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ANNEX

Reference set of criteria and parameters and accounting methodologies for the ecodesign of new products and technologies. ● Group (1): Parameters for which data are intrinsic to the data collection process of an LCA; ● Group (2): Parameters that are indicators resulting from an LCA; ● Group (3): Parameters that relate to functional variables related to the design or operation of the product.

Criteria	Parameters	Accounting methodology
Raw materials to the life cycle		
Use of substances of concern	Presence of substances regulated under EC/1907/2006 (REACH); EC/1272/2008 (Hazards' categories) and EC/2019/1021 (POP)	● Number and their respective quantity (g)
Use or consumption of energy, water and other resources	Water use	● Quantity in physical units (g)
	Energy use	● Quantity in physical units (kWh, MJ)
	Material use	● Quantity in physical units (g)
Use or content of recycled materials and recovery of materials, including critical raw materials	Presence of Critical and Strategic Raw Materials	● Number of Critical Raw Materials and their respective quantity (g) ● Recovery potential (%)
	Recycled content	● Proportion (%), by mass, of recycled material in a product ● Number of cycles, if recycled internally
Use or content of sustainable renewable materials	Presence of bio-based materials	● Proportion, by mass, of biobased material in a product (g)
	Use of renewable energy sources	● Proportion (%) of renewable energy input
Production		
Lightweight design	Reduction of material consumption (only when comparing diverse versions of the same product/part)	● Proportion (%), by mass, of reduction of material consumption
	Integration of functions within the material and single product component (only when comparing diverse versions of the same product/part)	● Proportion (%), by mass, of reduction of material consumption
Use and maintenance		
Durability	Cycles For complete product For critical product part	● Number of cycles that the product or product part can fulfil before needing replacement
	Technical life For complete product For critical product part	● Months or years of operation of the product or product part
Functional performance and conditions for use	Conversion yield	● Quantity of output in physical units (for nitrogen-based materials g, kg; for energy kWh, kJ)
Easy repair, maintenance, upgrading, reuse, remanufacturing and refurbishment	Availability of spare parts	● e.g. Publicly available, available to manufacturer, not available
	Number of materials and components used	● Number of units
	Fasteners and connectors classification	● e.g. Reusable and easy to remove, non-reusable and difficult to remove
	Necessary tools	● Types of tools needed for repair or disassembly (e.e. No tools needed, commercial tools, product-specific tools...)

Criteria	Parameters	Accounting methodology
	Availability of information - comprehensiveness	● Information needed for repair and disassembly. Publicly available, available to repair service provider, available to manufacturer only...
	Use of standard components	● Number of standard components purchased
	Number of destructive steps For complete product For critical product part	● Number of steps that can destroy product parts or critical product parts during reparation or disassembly
	Number of steps for disassembly For complete product For critical product part	● Minimum number of steps to recover all the product parts or critical product parts during disassembly or repair
	Diagnostic support and interfaces	● e.g. intuitive interface, coded interface, publicly available software/hardware interface...
End of life		
Easy and quality of recycling	Technical Recyclability Factor For complete product For critical product part	● Proportion (%) by mass of the product part or critical parts that can be technically recycled.
Emissions from the life cycle		
Emissions to air, water or soil	Quantity and nature of the emissions	● Quantity in physical units (g)
Microplastic and nanoplastic release	Microplastics and nanoplastics released	● Quantity in physical units (g)
Amounts of waste generated	Generation of waste	● Quantity in physical units (g)
	Generation of hazardous waste	● Quantity in physical units (g)
Life cycle environmental impacts		
Environmental footprint of the product	Set of ReCiPe or Environmental Footprint impact indicators	● Calculated through the life cycle assessment (LCA) methodology
Carbon footprint of the product	Global Warming indicator	● kg CO_2 eq calculated based on IPCC
Material footprint of the product	Mineral resource scarcity	● kg Cu eq according to the ReCiPe method (LCA)
	Fossil resource scarcity	● kg oil eq according to the ReCiPe method (LCA)