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# Life Cycle Assessment (LCA) PEF vs. ReCiPe

**Whitepaper**

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# LCA Whitepaper Series

## Foreword

Welcome to our LCA Whitepaper Series, each dedicated to a specific aspect of Life Cycle Assessment (LCA). As a critical tool in the field of sustainability, LCA provides a comprehensive view of the environmental impacts associated with all the stages of a product's life, from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. This series aims to delve into the intricate aspects of LCA, shedding light on the various methodologies, standards, and frameworks that guide its application.

In each whitepaper, we will focus on a specific topic, be it ISO standards that govern LCA, industry-specific standards such as Global Feed LCA Institute (GFLI), various allocation methods, ReCiPe method vs. Product Environmental Footprint (PEF), and many more. Our goal is to provide a clear, comprehensive, and accessible understanding of these complex topics, enabling you to apply this knowledge in your sustainability journey.

Whether you are a seasoned professional in the field of sustainability or a newcomer looking to understand the intricacies of LCA, these whitepapers will serve as a valuable resource. We invite you to join us in this exploration of LCA, as we strive to contribute to a more sustainable future.



# LCA Methodologies: PEF vs. ReCiPe

## Introduction

In the second paper of this series, we tackle the field of LCAs from a more methodological angle. We focus on two prominent LCA methodologies, one a hyper-relevant, more recent initiative, and the other an already more firmly established one in the LCA community. The Product Environmental Footprint (or PEF) was established by the European Commission to create a more standardized methodology for performing LCAs and green labeling in the EU. ReCiPe was created from a more academic perspective to get a better understanding of the complex emissions and resource data. We will thoroughly discuss both methodologies and compare the impact both have on the performance of an LCA.

## The EU and its sustainable future

In an era of growing concerns about environmental degradation and climate change, the European Union's Green Deal has emerged as a transformative force, demanding urgent action and comprehensive strategies to achieve sustainable goals. To become the first climate-neutral continent, the EU invested one-third of the €1.8 trillion from the NextGenerationEU Recovery Plan to transition towards a modern, resource-efficient, and competitive economy.

In recent years, there has been a remarkable surge in awareness among various stakeholders regarding the pressing need for sustainable practices. Consumers are becoming increasingly conscious of the environmental impact of their choices, demanding products and services that align with their new values. Businesses, too, are recognizing the importance of sustainability in maintaining their social license to operate and meeting evolving market expectations. Policymakers are enacting regulations and policies to drive sustainability and mitigate the adverse effects of climate change.

However, despite the heightened awareness, the translation of intent into concrete actions has been limited. Many stakeholders face difficulties with the effective implementation of sustainable practices, whether due to financial constraints, limited knowledge, or competing priorities. While some organizations have taken commendable steps towards sustainability, the overall progress remains insufficient to address the magnitude of the challenges we face.



This discrepancy between awareness and action underscores the need for a paradigm shift. It is not enough to merely acknowledge the importance of sustainability; it requires a fundamental reevaluation of our approaches and a commitment to tangible change. This is where a Life Cycle Assessment (LCA) and its methodologies can serve as pivotal tools to drive that approach to a more sustainable future.

In the following sections of this article, we will dive deeper into the two more profound frameworks for performing an LCA: the Product Environmental Footprint method of the European Commission, and the more detailed ReCiPe methodology. By understanding the implications and differences of these methodologies, you will be able to assess which methodology suits your business better and pave the way to a more sustainable future for your business.

### Product Environmental Footprint (PEF)

The Product Environmental Footprint (PEF) – sometimes also called Environmental Footprint (EF), which is its broader baseline concept – is an LCA method created by the European Commission and the Joint Research Centre (JRC). The goal of this initiative came from the need to create a common, consistent methodology for doing Life Cycle Assessments and green labeling as at one point, there were too many options not to become overwhelmed.

The overarching purpose of PEF – as a general LCA – is to enable reducing the environmental impacts of goods, services, and organizations considering supply chain activities (from the extraction of raw materials through production and use to final waste management). Consisting of both a detailed methodology and a database, PEF provides a framework of detailed requirements for modeling the environmental impacts of energy and emissions, waste streams, etc. This PEF framework will thus allow companies and other organizations to increase their transparency, comparability, and validity towards different stakeholders.

The PEF project initially began in 2013 and has been divided into two phases: the Pilot Phase, which ended in 2018, and the still ongoing Transition Phase. The first phase consisted of creating a comprehensive framework based on scientific research and in line with ISO standards 14040-44 and ISO 14025, as well as creating an accompanying database. The goal of the last phase – before implementation – is finetuning the current methodology, aligning usage, and monitoring the different category rules included in the framework.

The chosen approach for the PEF's impact assessment part is the so-called midpoint-level method. This method consists of 16 different impact categories and their units in which the impact is expressed. The midpoint-level category entails single environmental problems, such as global warming potential (in g  $CO_2$ ), water use (in  $m^3$ ) and freshwater ecotoxicity (in CTUe).

This allows for a holistic understanding of the overall environmental footprint of a product or a service, and a clear overview to highlight the most important “hotspots” where action should be taken. Additionally, the PEF framework is not the same for different industries. For various sectors, the EU established PEF Category Rules (PEFCR), a ruleset that describes how to calculate the environmental impact of a specific product group. The resulting rules will then apply to the entire EU market. By setting consistent category rules, the PEF provides a natural benchmark for a company to compare its impact to a certain standard. Currently, ± 20 product groups exist, ranging from batteries and accumulators to pasta and pet food.

Imagine a company that produces marmalades and jams based on cherries and strawberries, that wants to perform its first LCA for one of their products. The assessment, which is considered “cradle-to-grave”, has the purpose of being used for the optimization of internal processes, for benchmarking the LCA against competitors and for obtaining a certain certification. The company will use the PEFCRs for “food products” and will focus the assessment on 4 of the 16 impact categories: “Climate Change: Global Warming Potential”, “Water Use”, “Resource Depletion: Fossil Fuels” and “Land Use”. We will use this example to guide you throughout the rest of this whitepaper and the next ones in this series.

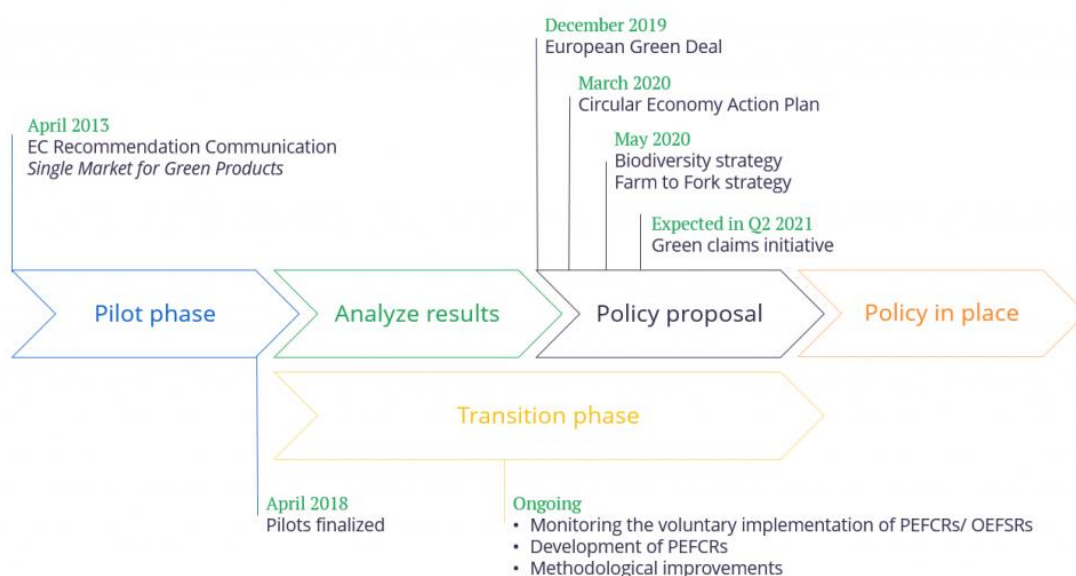


Figure 1: Timeline and PEF developments (source: PRé Sustainability)

## The importance of PEF and its link to other EU regulations

Other, recently initiated EU regulations can potentially be linked to PEF. First, PEF can help align the analytical part of more qualitative studies such as Environmental Product Declaration



(EPD) and EU Ecolabel, to identify and quantify the most relevant environmental impacts. Secondly, PEF can assist the Compliance Criteria on Environmental Claims, introduced by the Unfair Commercial Practices Directive (UPC). These criteria summarize that companies should be obliged to back up the environmental benefits of their products. As this is still quite subjective, a relevant or similar PEF study can substantiate the Environmental Claims with scientific evidence. PEF can furthermore be included in the Corporate Social Reporting Directive (CSRD) of the EU, as it functions as a standardized methodology to report ESG data, focused on environmental impacts. Finally, the EU also introduced a classification system to define economic activities as environmentally sustainable, called the EU Taxonomy. PEF can here, in a very objective way, highlight certain economic activities as sustainable and others as not, and thus additionally motivate companies to be more sustainable, as most EU companies must report against the Taxonomy.

The jam-producing company we introduced in the previous paragraph, will witness various positive spillover effects of its LCA to other sustainability initiatives it has started. For example, the LCA based on the PEF methodology will probably reinforce the CSRD and EU Taxonomy of the company, when zooming in on the local material sourcing initiative the company had started a couple of years ago.

As the Transition Phase is planned to be finalized in 2024, it is an excellent time for companies to anticipate these upcoming policy requirements and already implement PEF in their business processes and other reporting actions. If PEF eventually gets implemented this year, what will be the impact on EU businesses subject to the new policy requirements?

- Businesses will need to adopt and apply the PEF methodology to measure and communicate their environmental performance.
- An increased emphasis on eco-design will be initiated, where companies will have to optimize their products' environmental impacts.
- Enhanced transparency leads to the exposure of greenwashing companies and false sustainability claims.
- Implementing PEF allows companies to differentiate themselves in the market.
- Increased consumer awareness could lead to higher demand for environmentally friendly products.

### PEF-score and Eco-score

In addition to having a direct impact on various EU regulations, using the PEF methodology as a basis, many other standards can be created. An excellent example of such a standard is the "PEF-score". This scoring tool is the result of the impact assessment phase of an LCA,



which analyses the environmental impacts of the product in question over its entire life cycle. By multiplying the activity data – data from own production processes, suppliers, and/or customers – and environmental data obtained from LCA databases such as Ecoinvent, the PEF-score measures the environmental cost of any product. The PEF score is based on the 16 impact categories we mentioned above, weighted, and divided into 5 categories and then aggregated into a single, final score. Subsequently, the lower the PEF-score, the lower the environmental impact of the product. The score enables, on the one hand, consumers to compare the environmental impact of products within the same category – the relevant PEFCRs – or across different categories. On the other hand, brands are allowed to benchmark, comprehend, and enhance their product lines over successive collections through eco-design practices.

The Eco-score is based on the PEF methodology and the EF databases, which are recommended by the European Union. In this score, which is more focused on benchmarking one product against the other, we compare the PEF-score of the evaluated product with that of the reference product associated with it. The PEF methodology includes 13 product references, of which 10 are dedicated to clothing. These reference products are a set of environmental impact averages per category of a certain product. The amount of 13 references means a rather low representation in the different categories. But, as the reference products are created based on the PEFCRs, they are not fixed and are evolving continuously. The PEF-score is then scaled between 0 and 100%, where the value of 50% is considered the value of the chosen reference product. From this scale, the letters A to E are used to communicate the environmental performance of a certain product. The Eco-score works in intervals of 20%, meaning that for example an A score is considered between 0 and 20% in this particular scale. You can observe the process of going from the LCA of a product to the Eco-score visually in Figure 2.

This interesting, consequential feature of the PEF methodology cannot only make the topic of LCAs “sexier”, it is also the perfect example of a tangible, benchmarking tool for consumers to compare two or more products easily and rapidly with each other. In the case of the company producing jam that we mentioned above, the Eco-score can serve as an easier-to-understand tool for every stakeholder involved, instead of the 16 more complex impact categories of environmental performance.

The Eco-score was created by a consortium of French food actors (e.g. ECO2 Initiative, Marmiton, Yuka, ...), which led to its biggest developments in the food industry. Next to the food sector, this score is also making its introduction into the apparel and fashion industry, where the comparable score can be of significant value. Eventually, in the food industry, this





new score could complement current standards such as the well-known “Nutri-score” used as a worldwide indicator for the health of food products. On first thought, this new benchmarking tool will create an additional competitive dimension for food producers on sustainability. However, since no clear regulatory framework is available yet, one must be careful about simply accepting certain scores. The upside is that, as a rule, every Eco-score should be backed by a reviewed Life Cycle Assessment of that certain product.

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## From an LCA to the PEF-score and to the Eco-score

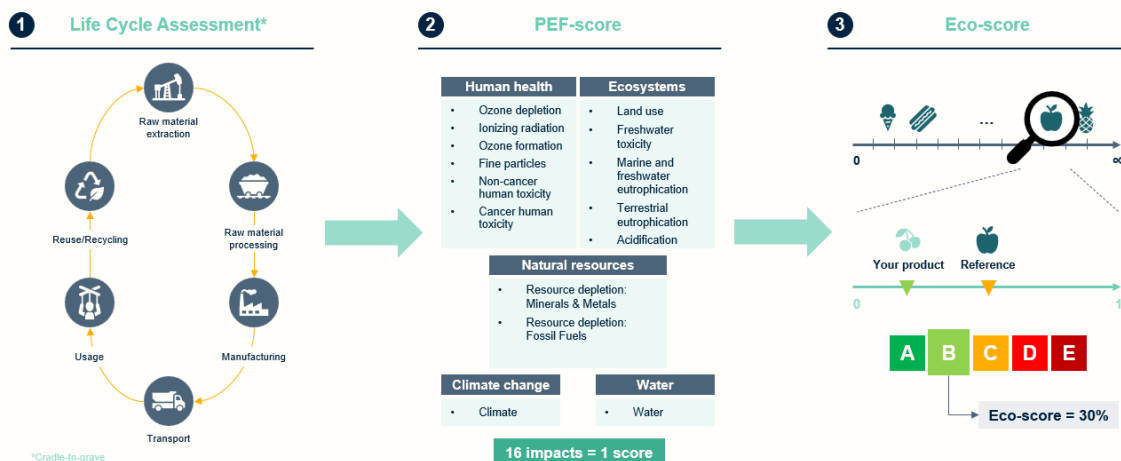


Figure 2: From LCA to Eco-score

## ReCiPe

ReCiPe is another widely used methodology for assessing the environmental impact of a product, service, or process. Developed in 2008 in the Netherlands by a collaboration between different universities and institutions, ReCiPe was designed to translate complex emissions and resource extraction data into a limited number of environmental scores, known as characterization factors. These factors help transform the extensive results obtained from life cycle inventory analyses into a concise set of indicator scores.

ReCiPe offers two pathways for deriving these characterization factors: 18 midpoint indicators – comparable to the PEF method – focusing on single environmental problems and 3 endpoint indicators with higher aggregation levels, such as human health and biodiversity. The midpoint impact categories are connected to damage pathways, ultimately leading to endpoint areas of protection. Notably, ReCiPe is unique in that it encompasses factors according to three cultural perspectives: Individualist, Hierarchist, and Egalitarian. The first one caters to short-term technological optimism, the second is the consensus or default model and the third perspective focuses on long-term precautionary considerations.



One specific feature of ReCiPe is its exclusion of potential impacts from future extractions in the impact assessment. Instead, it assumes that such impacts have already been accounted for in the inventory analyses. The resulting life cycle impact assessment (LCIA) provides an 'environmental profile', a comprehensive score list reflecting various environmental effects.

ReCiPe is regarded as a more scientific methodology, combining the scientific rigor of previously used model CML and the more straightforward interpretation of results found in Eco-indicator 99. This unique blend of scientific underlying principles and simplicity enhances the method's overall robustness. Over time, ReCiPe has undergone refinement with the 2016 version representing an improved iteration compared to the original 2008 version. Its adaptability and customization options further contribute to its widespread use and acceptance within the life cycle assessment field.

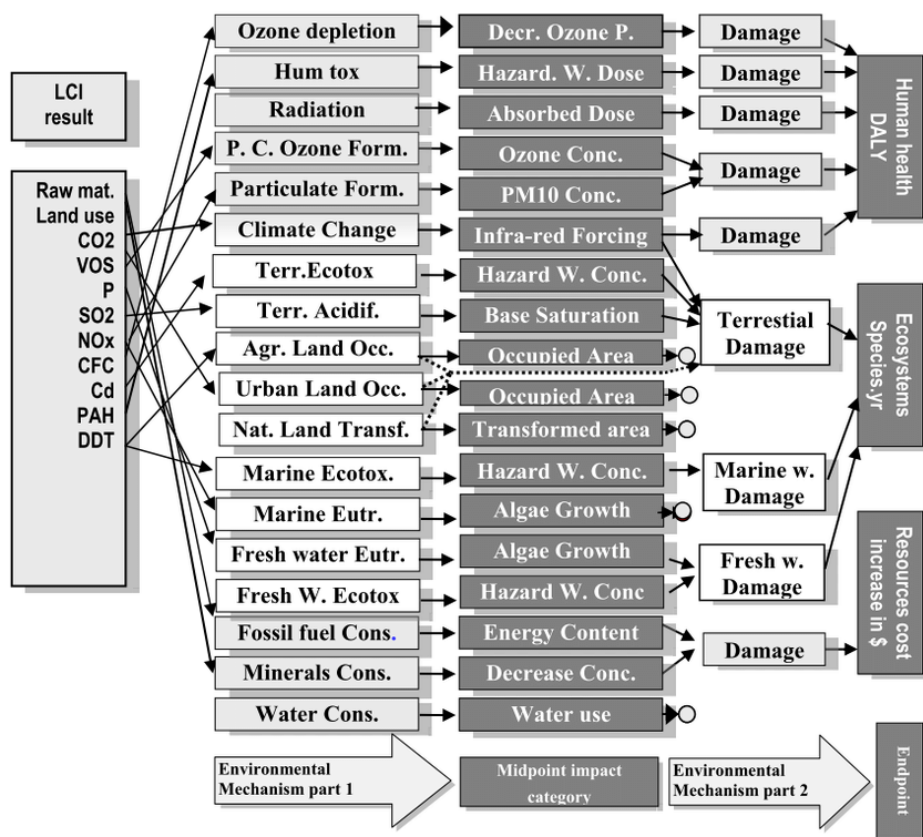


Figure 3: ReCiPe methodology, mid- and endpoints; Venkatesh (2016)

### PEF vs. ReCiPe: which one should I use?

Both PEF and ReCiPe are science-based methodologies developed for life cycle assessment, but they have different origins, components, and focus areas. PEF, driven by the European Commission, places a strong emphasis on benchmarking, sector-specific customization, and



regulatory compliance within the European context. On the other hand, ReCiPe emphasizes scientific robustness, cultural perspectives and offers flexibility. Each methodology brings its strengths and considerations to the table, catering to different aspects of environmental impact assessment and sustainability measurement. Let's dive deeper into these differences and their implications:

### **1. Impact categories and characterization factors**

PEF covers 16 midpoint impact categories, whereas ReCiPe comprises 18 midpoint impact categories and 3 endpoint impact categories. Additionally, ReCiPe integrates three cultural perspectives as scenario analyses for a more comprehensive environmental impact evaluation.

### **2. Time of development**

As PEF's development is ongoing, its data and requirements will be highly relevant and aligned with the latest scientific knowledge. ReCiPe, on the other hand, updated its current version in 2016. This version offers several improvements but is almost a decade old.

### **3. Customization and flexibility**

PEF emphasizes sector-specific customization through the introduction of Product Environmental Footprint Category Rules (PEFCR). ReCiPe is described as having more flexibility and adaptability to customization.

### **4. Benchmarking and comparability**

PEF introduces a benchmark for comparing environmental impacts to a predefined standard, thus providing a basis for comparability, whereas ReCiPe does not explicitly mention a benchmarking feature. Being able to compare or benchmark your business against competitors or a certain standard allows you to make informed and data-driven decisions and identify improvement areas in the product and its whole cycle.

### **5. Regulations and policy compliance**

PEF is optional in the EU, but regulatory compliance is expected once the Transition Phase is finalized and influenced by (other) EU policies. As PEF is created in alignment with the EU Green Deal and Taxonomy, it is expected to be tailored to EU regulations. Regarding ReCiPe, there is no clear regulatory framework or information provided on its regulatory status.



## Key takeaways

- PEF – or the Product Environmental Footprint – is an LCA-based methodology created by the European Commission to standardize the various life cycle assessment methods and to urge European companies to become more sustainable and transparent.
- ReCiPe – not a new kid on the block – is a still very relevant LCA methodology that has since 2008 become entrenched in the scientific community as a very detailed and flexible method to assess the environmental impact of your product.
- PEF will most likely be playing an important role in the development and implementation of other EU regulations, such as the EPD, the CSRD, and the EU Taxonomy. Furthermore, it can become the fundamental base of several standards, just as the Eco-score.
- In order to choose between the two methodologies, it is necessary to clearly define the purpose of your business' LCA study, whether or not it will be used internally or externally, and if the LCA needs to be compliant with certain regulations.

Are you inspired by the topic of LCAs or curious to know more about Digit Mint and its LCA tool? Stay tuned for our next paper of this LCA Whitepaper Series or do not hesitate to contact Peter-Jan Roose or Vincent Govaers!



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