FREQUENTLY ASKED QUESTIONS

Life Cycle Assessment (LCA)

SMIT & ZOON

Introduction

Within the broader sustainability context, understanding and managing the environmental impacts of leather, its inputs and related processes, is an increasingly important focus for the leather industry. Life Cycle Assessment (LCA) is a recognized scientific method to quantify selected environmental impacts of product and services throughout their life cycle.

At Royal Smit Zoon (RSZ), we believe that product environmental impact data resulting from an LCA (i.e. LCA data) are crucial for a future-proof leather value chain. By providing reliable, high-quality chemical input data and generating portfolio-level hotspot insights, we enable more informed decision-making to facilitate innovation. These data support production companies like ours, as well as tanneries, brands, and OEMs, in better understanding and managing environmental impacts in leather production and meeting industry and regulatory data requirements faster and with greater confidence.

In practice, requests for LCA data are rapidly increasing, often driven by brands and OEMs. At the same time, many find the concept of LCA not always straightforward: What is an LCA? What is required to conduct one? What is it used for? And how does it differ from a carbon footprint?

In this Frequently Asked Questions (FAQ) document, we address these questions and clarify key LCA-related terminology in a clear and practical way. With this FAQ, we share our knowledge and aim to clarify key LCA concepts and terminology to support a clear and practical understanding of how environmental impacts can be quantified and used in the leather value chain.

For a broader perspective on environmental sustainability topics, we refer to our earlier FAQ paper: FAQ: Understanding the Concept of Environmental Sustainability in the Leather Value Chain

What is a Life Cycle Assessment (LCA)?

Life Cycle Assessment (LCA) is a recognized scientific method used to quantitively analyze (quantify) the environmental impacts of products/services throughout their life cycle. For this purpose, specific calculation tools are being applied that should conform the standards ISO 14040 "Environmental management – Life cycle assessment – Principles and Framework" and ISO 14044 "Environmental management – Life cycle assessment- Requirements and guidelines". In LCA, the total life cycle of a product or activity is considered; from the acquisition of resource materials onto the waste and waste treatment stage, also referred to from Cradle to grave. At Royal Smit & Zoon (RSZ), our product LCAs focus specifically on a "cradle-to-gate" scope, meaning covering environmental impacts up to the product leaving the factory gate.

When to carry out an LCA study?

LCA is to be conducted whenever robust environmental information is needed for internal decision making, external communication and/or (regulatory) compliance. Ideally product related LCA study is to be carried out as early as possible in product development and updated throughout the product life cycle to support optimization, impact management, reporting, and credible communication.

How to carry out an LCA study?

An LCA study comprises the following 4 steps (see Figure):

Step 1. Goal and scope definition. This also includes the definition of system boundaries. System boundaries determine which unit processes to be included in the LCA study. For example, whether the study will be "Cradle to gate" or "Cradle to grave" (see below) will be defined in this step.

Step 2. LCI – Life Cycle Inventory analysis. In this step, information on the use of resource (raw) materials and energy that are used within the life cycle, as well as the emission of (harmful) substances throughout the life cycle, is being collected.

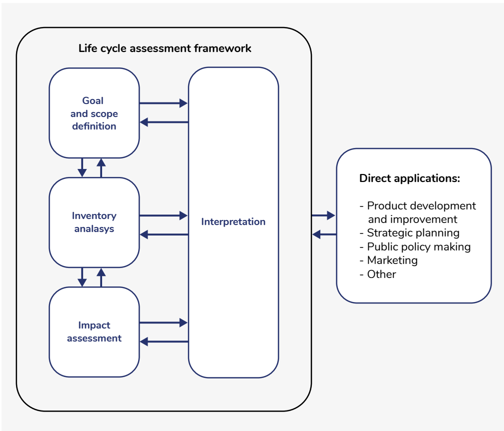

Figure 1. The four phases of an LCA study.[11]

Step 3. LCIA - Life Cycle Impact Assessment (LCIA). In this step, the inventory data (Life Cycle Inventory results) are converted to environmental impacts. Based on the LCIA, a profile on the environmental impact caused by the product or activity is created.

Step 4. Interpretation.

Many LCA related terms can be found in the document: '[JRC Science and Policy Reports: Indicators and targets for the reduction of the environmental impact of EU consumption: Overall environmental impact (resource) indicators Deliverable 3 by the European Commission 2014]'.

Cradle-to-gate LCAs

“Cradle-to-gate” defines the scope of a LCA study as an assessment of a partial product life cycle from resource acquisition (“Cradle”) to the factory gate (i.e., before transportation to the customer). The use phase and disposal phase of the product are omitted in this case. Cradle-to-gate assessments are sometimes the basis for environmental product declarations (EPD) for business-to-business EPDs (see below). When a value chain (such as leather) involves multiple parties in a sequential manner, each downstream factory gate can be assigned as the “gate” associated with the specified study. Figure 2 illustrates the differences between different life cycle models that might be included in the scope of an LCA study.

Figure 2. Schematic product life cycle models.

Many raw material or chemical producers would choose to perform “cradle-to-gate” assessments due to several reasons including, but not limited to: to: 1. Their product is part of a supply chain and will enter the gate of the next production phase of which they have no or little control over; 2. They do not have control over the usage and disposal of their products; 3. There might be a general lack of knowledge on the end-of-life scenario of some products.

As a leather chemical supplier, RSZ therefore specifically focuses on “cradle-to-gate” LCAs for its products. In this way, RSZ provides robust and reliable assessment of its own manufacturing impacts while avoiding the big uncertainties of modeling downstream life cycle stages.

What is an Environmental Product Declaration (EPD)?

An Environmental Product Declaration (EPD) is an independently verified and registered document communicating transparent and comparable information about the Life-Cycle environmental impact of products. An EPD is a voluntary declaration of the life-cycle environmental impact, it does not imply that the declared product is environmentally superior to alternatives.

What is Product Carbon Footprint (PCF)?

According to ISO 14067: 2018: Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification, Product Carbon Footprint (PCF) is generally defined as the total greenhouse gas (GHG) emissions with a product over its life cycle, typically expressed in CO_2 equivalents. Carbon footprint, however, is only one of the environmental categories that are covered by a standard LCA study.

Are there any (chemical industry) guidelines for PCF calculations?

Yes, there are. ISO 14067:2018 – Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification is the international LCA-based standard that defines how to quantify and report the product carbon footprint (CO_2e) across the life cycle, focusing solely on climate change and ensuring methodological consistency and transparency.
In addition, as part of the joint initiative "Together for Sustainability" (TfS), many companies from the chemical industry have agreed on a global guideline for calculating product carbon footprints (PCFs). The Tfs guideline (Scope 3 GHG emissions programme - TFS Initiative) for Product Carbon Footprint provides specific calculation instructions for emissions from "Cradle-to-gate" for chemicals. It harmonizes PCF calculation approaches across the industry and is applicable to the vast majority of chemical products.

Are there any leather industry guidelines for LCAs?

Yes, there are. Very recently, United Nation's Industrial Development Organization (UNIDO) launched 'Guidelines for Assessing the Environmental Footprint of Leather: Recommendations for Harmonization'. RSZ is proud to have contributed to- and be part of the advisory group of this important global sector initiative aimed at harmonizing leather environmental footprint assessment.

What is the key difference between the (chemical industry) PCF guidelines and leather industry LCA guidelines?

(Chemical) PCF guidelines focus exclusively on greenhouse gas (GHG) emissions (carbon footprint) and do not cover other relevant environmental impacts such as water use, eutrophication, or toxicity. While these PCF standards (e.g. TfS) are appropriate for carbon reporting in the chemical sector, they are insufficient for assessing impacts across the leather value chain and For leather manufacturing, broader LCA guidelines are required, as multiple environmental impact categories are material such as water use, eutrophication, toxicity, etc. Therefore, chemical suppliers operating within the leather value chain should apply leather-specific LCA guidance that captures the full range of environmental impacts — not just climate change.
In addition to the above, the UNIDO guidelines also underlies the wider sustainability context in establishing such a document thus covers important related topics including legislative actions like ESPR, EUDR, CSRD and the SBTi initiative. An overview of the full list of environmental impact categories are listed in the appendix of this document.

Which data are currently available at Royal Smit & Zoon?

By the end of 2025, "cradle-to-gate" LCAs are available for all RSZ wet-end products and sustainable tanning agents (e.g. Zeology) produced in the Netherlands. This corresponds to approximately 50% of our core-range products. RSZ's LCAs are calculated according to ISO 14040/14044 standards and the Environmental Footprint (EF) methodology, with a cradle-to-gate scope. Calculations are built on high-quality, primary data including operational data, product recipes, analytical results and supplier information, supported by a commercial software and recognized secondary datasets from Ecoinvent database when necessary. In addition to calculating LCAs for our commercial core-range products, we have also calculated the LCAs of the related intermediates. This means that primary LCA data for our intermediates are used as direct inputs in the LCA calculations of the final products.

Product-specific LCA data may be shared selectively under appropriate confidentiality and scope conditions. For questions on the LCA of specific products, please reach out to your sales contact or via LCAquestions@smitzoon.com.

When will LCA data be available for RSZ products not yet covered?

LCAs are a key topic in our 'Drops of Difference' Sustainability Strategy. Our ambition is to have full LCA data available for 90% of RSZ' core-range products by 2030. We have made a multi-year plan to build our in-house capability and make the LCA data of most of the core-range products that are not yet covered to date available in the coming years.

What can the LCA data of RSZ products be used for?

Our LCA data can be used for LCA studies of leather or leather-containing consumer articles made with RSZ products. It also supports impact management by identifying hotspots, guiding product and process improvements, and enabling more informed sustainability decisions across the value chain.

How are the LCA data of chemical products typically communicated?

For (leather) chemicals, the LCA data is typically communicated per unit mass/weight of product sold (e.g. per kg or per ton).

Is product LCA data fixed?

A short answer to this question is no. The LCA of a product is calculated based on all product related information starting from raw material acquisition and usually involves multi-stage and multi-company operations according to the time and geological coverage defined by the scope of the study. Consequently LCA data and results are not fixed; they are model based and dependent on the goal & scope, data quality, and temporal and technological conditions at the time of calculation. Moreover, LCA studies often involve methodological assumptions and expert judgement by the practitioner, and their outcomes are highly dependent on the quality of the underlying data, which further increases the potential for variability in the results. LCA data should therefore not be interpreted as a permanent product specification or as directly comparable unless scope, method, database version and data quality are aligned.

The data we provide to customers always include the scope, time coverage and model applied in our calculations. In addition, we make every effort to ensure that assumptions are applied consistently across production sites and over time.
Royal Smit & Zoon aims using LCAs as a tool for its product portfolio optimization by identifying hotspots, driving improvements and innovation.
For these reasons, RSZ regularly updates its LCA data so that in the longer term improvements will be reflected throughout our whole operations.

Will Royal Smit & Zoon provide support for the calculation of leather LCAs?

RSZ focuses on supplying chemical solutions for the leather industry, and is not a r manufacturer or producer of leather itself. RSZ will do its best to support customers' LCA efforts by providing high-quality chemical input data and sharing relevant expertise where possible. However, LCA studies require company-specific operational data and often involve sensitive know-how. Therefore RSZ firmly believes that ownership of product-level LCA calculations (for example leather or consumer articles) should remain with the company that manufactures or produces those products .

Does it make sense to calculate the LCA of leather producing recipes?

This is something we would not recommend. First of all, leather production recipes are usually complex, containing assisting chemicals (such as formic acid/sodium formate etc) and active ingredients (such as syntans, fatliquors, dyes). Usually RSZ does not have LCA data on all chemicals used in a recipe.
On top of that, a recipe LCA does not have a straightforward relationship with a leather LCA. As explained in the answer to the previous question, performing leather LCAs involve the collection of a lot of company-specific operational data (energy usage, waste generated), much more than what can be reflected in a recipe.
To summarize, a leather producing recipe is only one of the many input data categories that are necessary for the LCA calculations of leather/consumer articles. The recipe itself has a limited impact on the LCA of a leather/consumer article as there are so many other data needed, not only from a process point of view but also from a materials perspective.

Where can I find the latest insights on the LCA/ Environmental impacts of leather?

We recommend to take a look at the recent publications based on data from global leather manufacturing from the Leather Working Group (LWG) and Leather Naturally (LN)
LWG: Measuring the Environmental Impact of Leather
LN: A guide to life cycle assessments (lcas) to the leather industry

How to request LCA data from Royal Smit & Zoon?

Please reach out to your sales contact or via LCAquestions@smitzoon.com

Invitation

We kindly invite you to share your views on this FAQ overview and to collaborate in creating a sustainable leather value chain. Please contact your sales contact or via LCAquestions@smitzoon.com

APPENDIX 1

Overview of LCA Impact Categories (EN 15804+A2, EF 3.1)

Our current LCA calculations are based on European Commissions Environmental Footprint (EF) methodology EF 3.1 Below is a comprehensive list of impact categories including respective unit and definition as defined by EN 15804+A2 (nice graphical illustration available at The 19 impact categories explained), in line with the EU EF methodology. For further readings, you can find their indicator, unit and underlying life cycle impact assessment (LCIA) method in the following reference: JRC technical report 'Updated Characterization and Normalization factors for the Environmental Footprint EF 3.1 method' (JRC 130796, European Union 2023: https://doi.org/10.2760/798894).

1. GWP-total - Climate Change Total

Unit: kg CO_2-eq
Definition: Indicator of potential global warming due to emissions of greenhouse gases to the air. This is divided into three subcategories based on emission source:

- GWP-f - Climate Change - Fossil: From fossil resources
- GWP-b - Climate Change - Biogenic: From bio-based resources
- GWP-luluc - Climate Change - Land Use and Land Use Change (LULUC): From land use changes

The total climate change impact aggregates all three subcategories to provide a comprehensive measure of greenhouse gas contributions.

2. ODP - Ozone Depletion

Unit: kg CFC-11-eq
Definition: Indicator of emissions to air that cause destruction of the stratospheric ozone layer. This category assesses the impact of substances that deplete the protective ozone layer in the stratosphere, increasing harmful UV radiation reaching Earth's surface.

3. AP - Acidification

Unit: mol H+-eq
Definition: Indicator of the potential acidification of soils and water due to release of gases such as nitrogen oxides and sulfur oxides. Acidification contributes to environmental issues like acid rain, forest decline, and fish mortality in water bodies.

4. EP-fw - Eutrophication - Freshwater

Unit: kg PO_4-eq (phosphate equivalents)
Definition: Indicator of enrichment of freshwater ecosystems with nutritional elements due to emission of nitrogen or phosphorus-containing compounds. Excess nutrients promote algae growth, which can deplete oxygen and harm aquatic life.

5. EP-m Eutrophication - Marine

Unit: kg N-eq (nitrogen equivalents)
Definition: Indicator of enrichment of marine ecosystems with nutritional elements due to emission of nitrogen- containing compounds. Similar to freshwater eutrophication but specific to marine environments.

6. EP-T - Eutrophication – Terrestrial

Unit: mol N-eq
Definition: Indicator of enrichment of terrestrial ecosystems with nutritional elements due to emission of nitrogen-containing compounds. This affects soil quality and plant growth patterns on land.

7. POCP - Photochemical Ozone Formation
Unit: kg NMVOC-eq (Non-Methane Volatile Organic Compounds equivalents)
Definition: Indicator of emissions of gases that affect creation of photochemical ozone in the lower atmosphere (smog) catalyzed by sunlight. Also known as "summer smog," this impacts human health and vegetation.

8. ADP-mm - Depletion of Abiotic Resources - Minerals and Metals
Unit: kg Sb-eq (antimony equivalents)
Definition: Indicator of depletion of natural non-fossil resources, specifically minerals and metals. This measures the consumption of finite mineral resources based on their scarcity.

9. ADP-f - Depletion of Abiotic Resources - Fossil Fuels
Unit: MJ, net calorific value
Definition: Indicator of depletion of natural fossil fuel resources such as oil, coal, and natural gas. This measures the consumption of non-renewable energy resources.

10. WDP - Water Use (Water Deprivation)
Unit: m^3 world eq. deprived
Definition: Indicator of the relative amount of water used, based on regionalized water scarcity factors using the AWARE (Available WAter REmaining) method. This measures potential reduction of available water for human or ecosystem use, calculated relative to world average after meeting human and aquatic ecosystem demands.

11. PM - Particulate Matter
Unit: Disease incidence
Definition: Indicator of potential incidence of disease due to particulate matter emissions. This measures health impacts from inhalation of fine particles (PM2.5 and PM10) that can cause respiratory problems.

12. IR - Ionising Radiation - Human Health
Unit: kBq U-235-eq
Definition: Damage to human health and ecosystems linked to emissions of radionuclides, mainly from the nuclear fuel cycle. (Important note: This category does not consider effects from possible nuclear accidents, occupational exposure, radioactive waste disposal in underground facilities, or ionising radiation from soil, radon, or construction materials)

13. ETP-fw - Ecotoxicity - Freshwater
Unit: CTUe (Comparative Toxic Unit for ecosystems)
Definition: Impact on freshwater organisms of toxic substances emitted to the environment. This measures the potential harm to aquatic ecosystems from toxic pollutants.

14-15. HTP - Human Toxicity - Cancer and Non-Cancer Effects
Unit: CTUh (Comparative Toxic Unit for humans)
Definition: Impact on humans of toxic substances emitted to the environment, divided into two categories:
- HTP-c - Human Toxicity - Cancer: Evaluates potential impact of carcinogenic toxic emissions on human health
- HTP-nc - Human Toxicity - Non-Cancer: Assesses potential of non-carcinogenic toxic emissions to harm human health

16. SQP - Land Use (Soil Quality Potential) Unit: Pt (points)
Definition: Measure of changes in soil quality including biotic production, erosion resistance, and mechanical filtration capacity. This assesses impacts on land from activities like deforestation, agriculture, or construction that affect ecosystem services and habitat.

APPENDIX 2

List of Abbreviations

Abbreviation	Full Term	Description
LCA	Life Cycle Assessment	Evaluation of environmental impacts across life cycle of products or services
LCI	Life Cycle Inventory	Compilation of inputs and outputs
LCIA	Life Cycle Impact Assessment	Translation of inventory into impacts
GHG	Greenhouse Gas	A gas in the atmosphere that absorbs and emits infrared radiation (heat), thereby contributing to the greenhouse effect and influencing Earth's temperature.
GWP	Global Warming Potential	A metric that measures the relative warming impact of a GHG over a specified time period.
CO2e	Carbon Dioxide Equivalent	Standard metric aggregates emissions of multiple GHGs based on their GWP.
CF	Carbon Footprint	The total amount of GHG expressed in carbon dioxide (CO_2) equivalents.
PCF	Product Carbon Footprint	Total GHG emissions of a product
EF	Environmental Footprint	Harmonized EU LCIA method to quantify environmental impacts across multiple impact categories.
PEF	Product Environmental Footprint	EU LCA methodology to quantify and communicate the environmental impact of products.
PEFCR	Product Environmental Footprint Category Rules	product specific rules defining how to calculate and report the environmental footprint of products in a consistent and comparable way for a specific product group (such as leather, textile, etc.)
EPD	Environmental Product Declaration	Verified product environmental profile
OEM	Original Equipment Manufacturer	A company that produces components or products that are used in another company's final product.
SBTi	Science Based Targets initiative	A global framework enable companies to set GHG emission reduction targets aligned with science and the Paris Agreement.
TfS	Together for Sustainability	A global chemical industry initiative aiming at standardizing and improving sustainability practices across chemical supply chains.
ISO	International Organization for Standardization	who develops global standards to ensure quality, safety, and consistency of products, services, and processes.
UNIDO	United Nations Industrial Development Organization	A specialized agency of the United Nations focusing on promoting inclusive and sustainable industrial development worldwide.
LWG	Leather Working Group	A global, multi-stakeholder organization that drives best practices in leather manufacturing by developing standards and tools to promote responsible and sustainable leather production and sourcing across the leather value chain.
LN	Leather Naturally	A global non-profit industrial association acting as the voice of the leather sector through education and communication.

References & links

1. ISO14040: 2006: Environmental management - Life cycle assessment - Principles and framework.

2. ISO 14044: Environmental management - Life cycle assessment – Requirements and guidelines.

3. ISO 14067: 2018: Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

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9. FAQ from LCA datasource provider: FAQs - ecoinvent

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12. LN_White_Paper_LCA_st12-1.pdf

13. Scope 3 GHG emissions programme - TFS Initiative

14. Guidelines for Assessing the Environmental Footprint of Leather

More information

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