

From Waste to Sustainability Data: How to Build FAIR LCA Data for Plastic Recyclates

GreenDelta GmbH
Dr. Jonas Hoffmann



GreenDelta and the Team



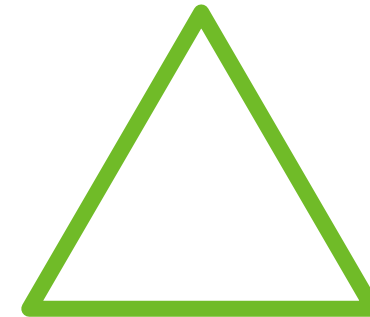
- Funded in 2004 by Dr. Andreas Ciroth
- 25-30 Employees (Engineers, Developers, Economist, ...)
- International (DE, IT, FR, SP, RU, IN, EGY, CHN)
- Offices in Berlin Moabit
- Very active in research projects (DE and EU)

“The art of sustainability consulting”

Sustainability consultancy and research
environmental LCAs, resource criticality, social LCAs, Life Cycle Costing,
Circular Economy



Database development and
distribution



Software development,
especially open source

- A free and (yet) professional approach to Life Cycle Assessment: powerful, feature-rich, (comparatively) easy to use, technically up-to-date
- Developed by GreenDelta since 2006
- Completely Open Source (Mozilla Public License)

How to determine sustainability?

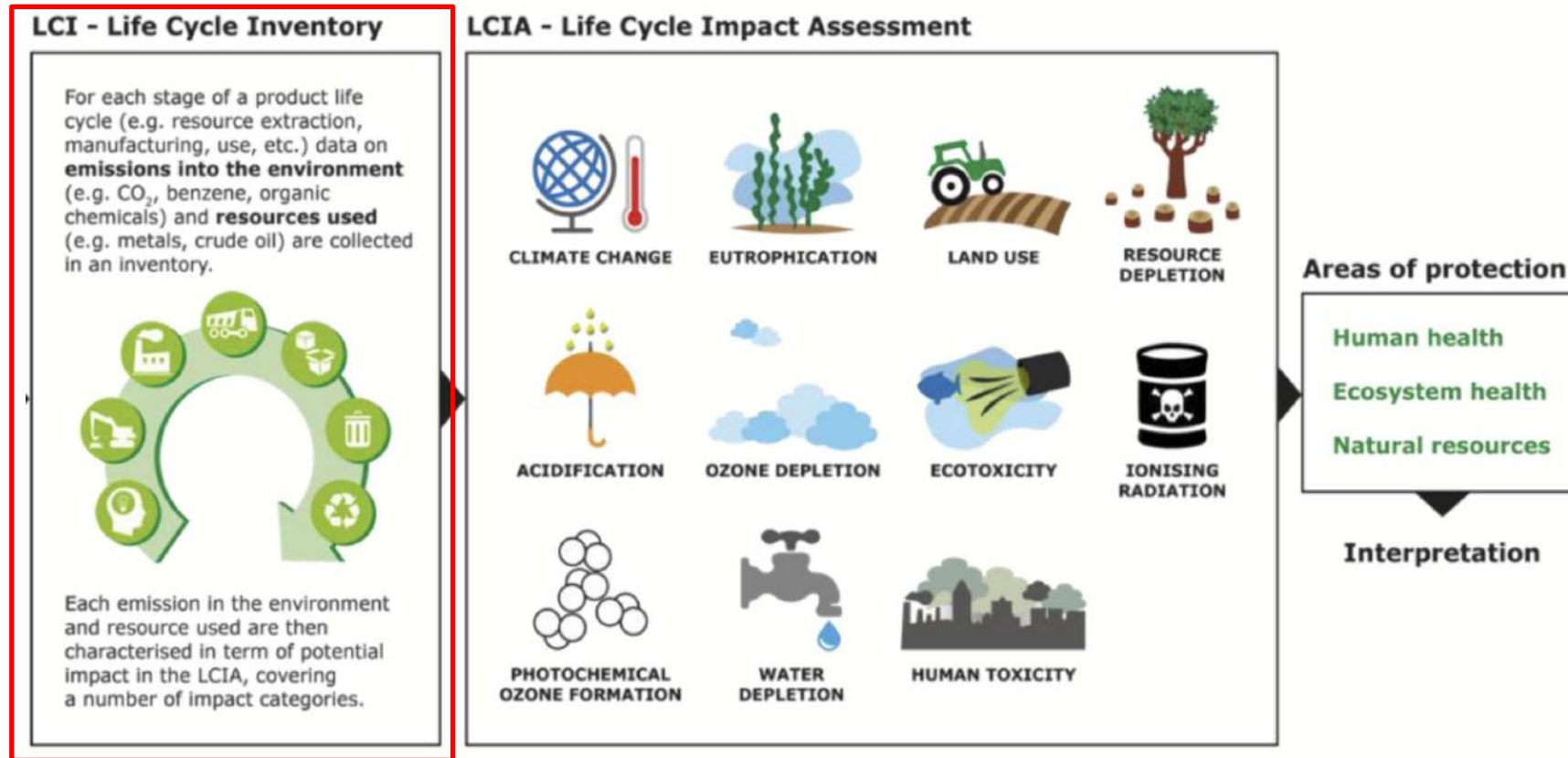
- **Definition (ISO 14044):** *'life cycle assessment (LCA) is a compilation and evaluation of the inputs, outputs and the potential environmental (or social) impacts of a product system throughout its life cycle (cradle-to-grave).'*



Quantitative Measure!

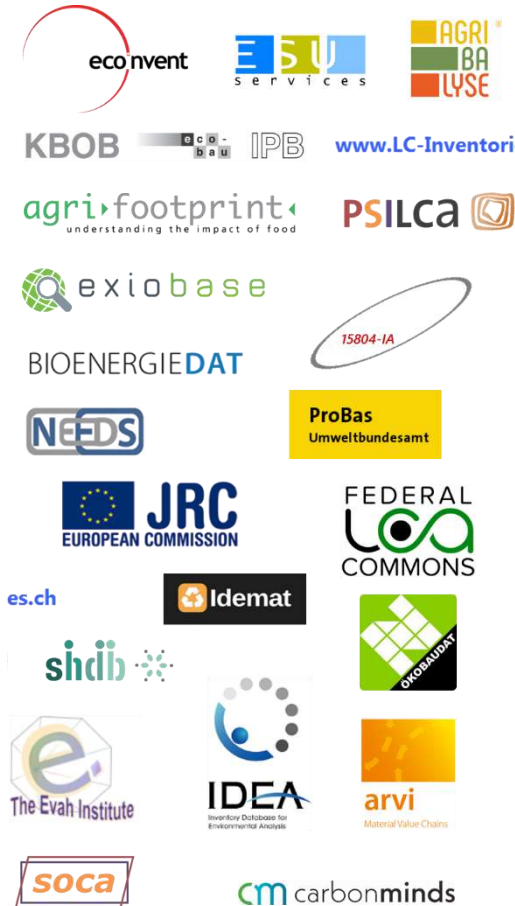
European Commission, Joint Research Centre, Cristobal-Garcia, J., Pant, R., Reale, F. et al., Life cycle assessment for the impact assessment of policies, Publications Office, 2016, <https://data.europa.eu/doi/10.2788/318544>

How to determine sustainability?

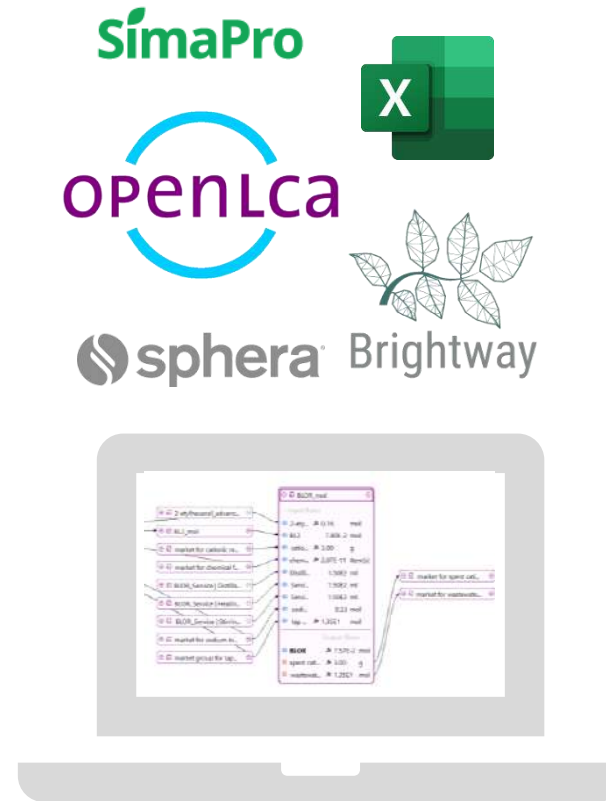


European Commission, Joint Research Centre, Cristobal-Garcia, J., Pant, R., Reale, F. *et al.*, Life cycle assessment for the impact assessment of policies, Publications Office, 2016, <https://data.europa.eu/doi/10.2788/318544>.

How to LCA: Databases, software and data formats



databases



software



data formats

How to LCA: Databases, software and data formats

LCA software:

- They differ in business models
 - Software is purchaseable, databases for free
 - Software is free, database purchaseable
- Very often not open-source
- Very often outdated, barely maintained
- Some connect data with UUIDs some with names



How to LCA: Databases, software and data formats



databases

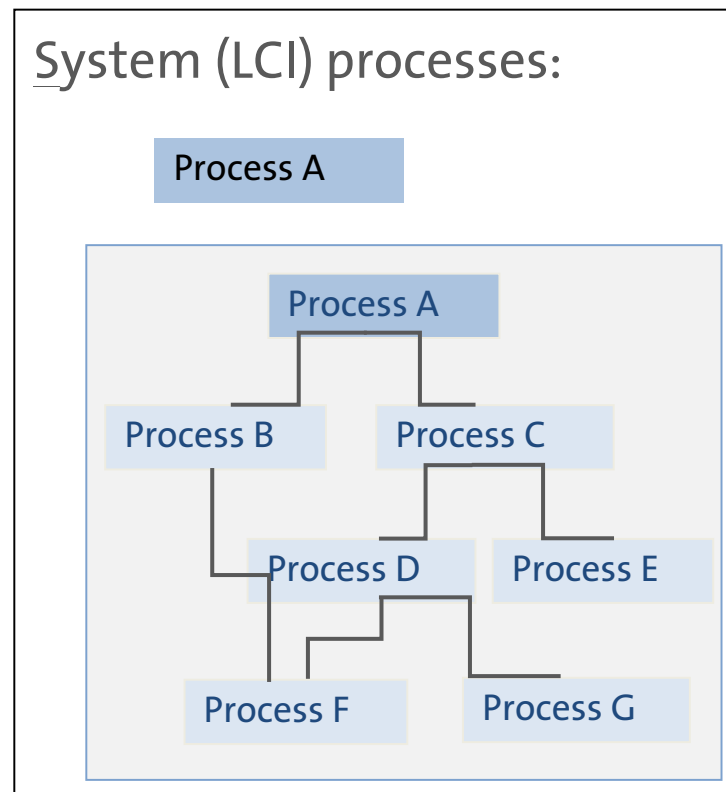
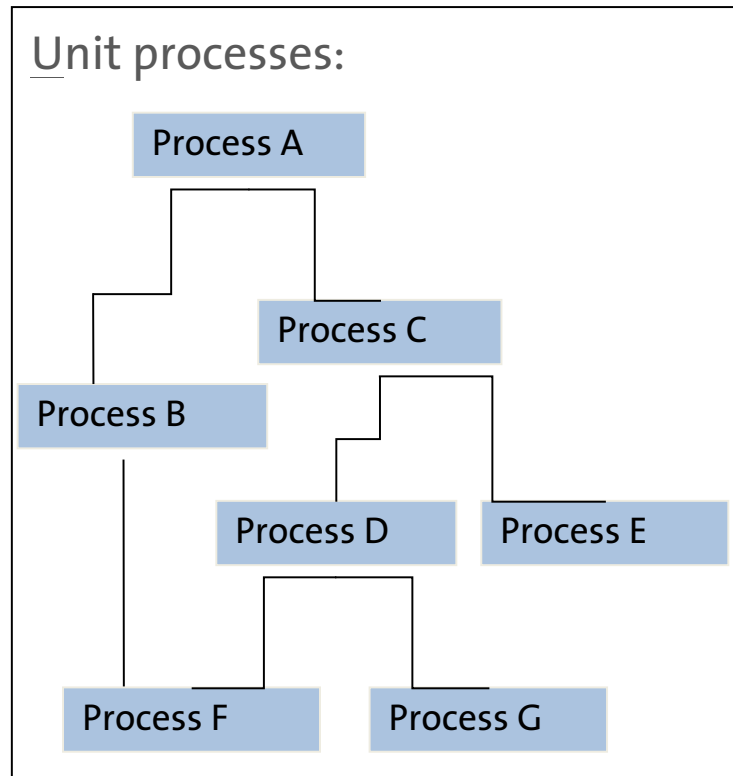
- Databases can cover general or specific products or processes
 - Unit vs. System process databases
 - General databases (ecoinvent, EF)
 - Specific (CarbonMinds, AgriBalyse)
 - Regional context (EF, LCA Commons, HiQLCD, ProBas, Ökobaudat)
- Check their assumptions! And mix LCI datasets or databases only with care (different assumptions)
- Finally: Good data is never for free!

How to LCA: Databases, software and data formats

ecoinvent



EF 4.0 DB



carbonminds

PLASTICS
EUROPE
Enabling a sustainable future

GaBi
Database Content



EF 3.1 DB

Aggregation enables disclosure

GreenDELTA

How to LCA: Databases, software and data formats

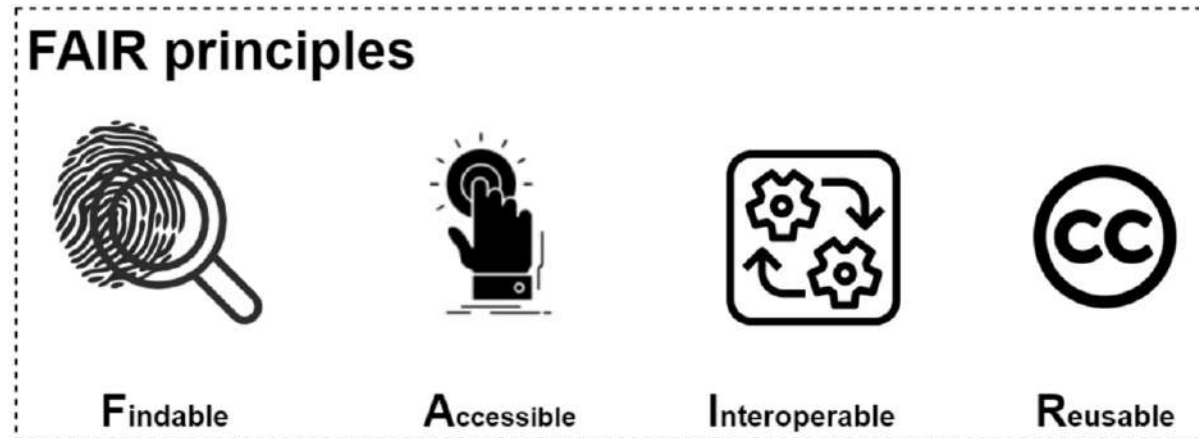
Scheme	Used By	Data format	Notes
ILCD	EF, LCDN, soda4LCA Nodes, GLAD, Sphera/Gabi	XML	Contains process, flow, unit data in schema-compliant XML files
ILCD+EPD	EPDs (from InData)	XML	Adaptation of ILCD for EPDs with mandatory fields and rules for interoperability
EcoSpold v1	ecoinvent2, UVEK, still in use for new data sets	XML	Older format; still widely used in research and legacy datasets
EcoSpold v2	Ecoinvent3, brightway	XML	Modular and improved (parameters, unique IDs, etc.); reflects ecoinvent's specific needs
olca scheme	openLCA, Nexus	JSON + Linked Data (JSON-LD)	implements ILCD and ISO 14048 concepts; supports linking, formulas, parameters, product system etc.
SimaPro CSV	SimaPro	CSV	Tabular import/export format for processes, flows, and results; used for interoperability and data exchange

Quite ancient but harmonized

Data formats



FAIR data in LCA



Ghose A. Int. J. Life. Cycle Assess. 2024; 29, 733–744

Findable LCA data

You can find data:

- Search engines for datasets in databases:
 - GLAD search engine
 - openLCA Nexus
- Individual datasets (exchange):
 - Scientific publication (PDFs, .xls)
 - European Platform on LCA (JRC)
 - Zenodo
 - Or not (proprietary data, aggregation)

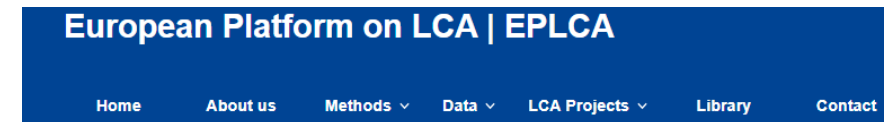


There is no overarching search engine (like SciFinder etc.)

LCA data is findable



Findable

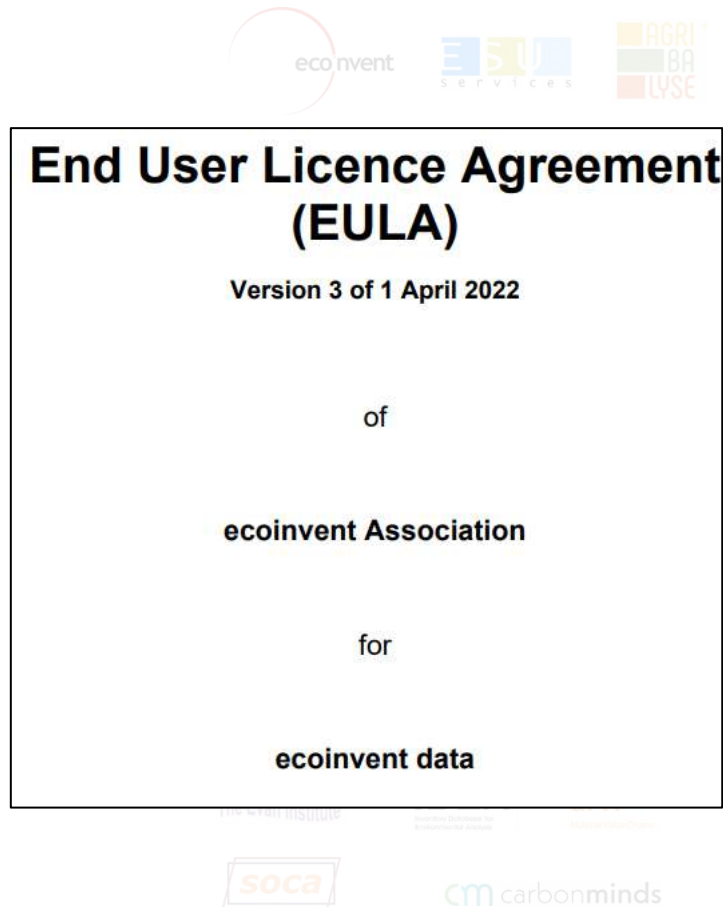


FM_Central Europe.xlsx
md5:a65bd97701eb2facc645e45adb0b87cb ⓘ

FM_Mediterranean Europe.xlsx
md5:751f83415c5f7d3cd18204bd78c6f825 ⓘ

FM_North Europe.xlsx
md5:a2f9d16c84fe24b882431235bc5cc041 ⓘ

Accessible LCA data



databases



Accessible

Every database comes with an EULA:

- LCA databases (ecoinvent, Gabi) prohibit sharing any raw data
- LCA databases also limit to publish the amount of calculated data:
 - Not allowed to share own calc. inventories that have been calculation with the background data
 - sharing models and data that contain parts of these difficult

LCA data is licensed

Reusability of LCA data



Reusable

- Reusability of datasets depends on clear and correct licensing
 - such as **Creative Commons** for general outputs
 - but also commercial licenses for exploitation of outputs
- However, reusability is also linked to documentation/data format
 - ILCD format is the closest thing to useable exchange format
 - Lack of traceability and clarity for modelling
 - Use of System processes
 - Lack of documentation
- But data quality is often tracked



**LCA data is often reuseable
and comes with data quality**

Reusability of LCA data



Reusable

- Data quality systems can be used on flow or process level

The screenshot shows the ecoinvent Data Quality System interface. The 'Data quality' section is highlighted with a blue box. It includes fields for 'Process schema' (ecoinvent Data Quality System), 'Data quality entry' (1; 2; 2; 2; 1), 'Flow schema' (ecoinvent Data Quality System), and 'Social schema' (- none -). Below the interface is a table representing the data quality matrix.

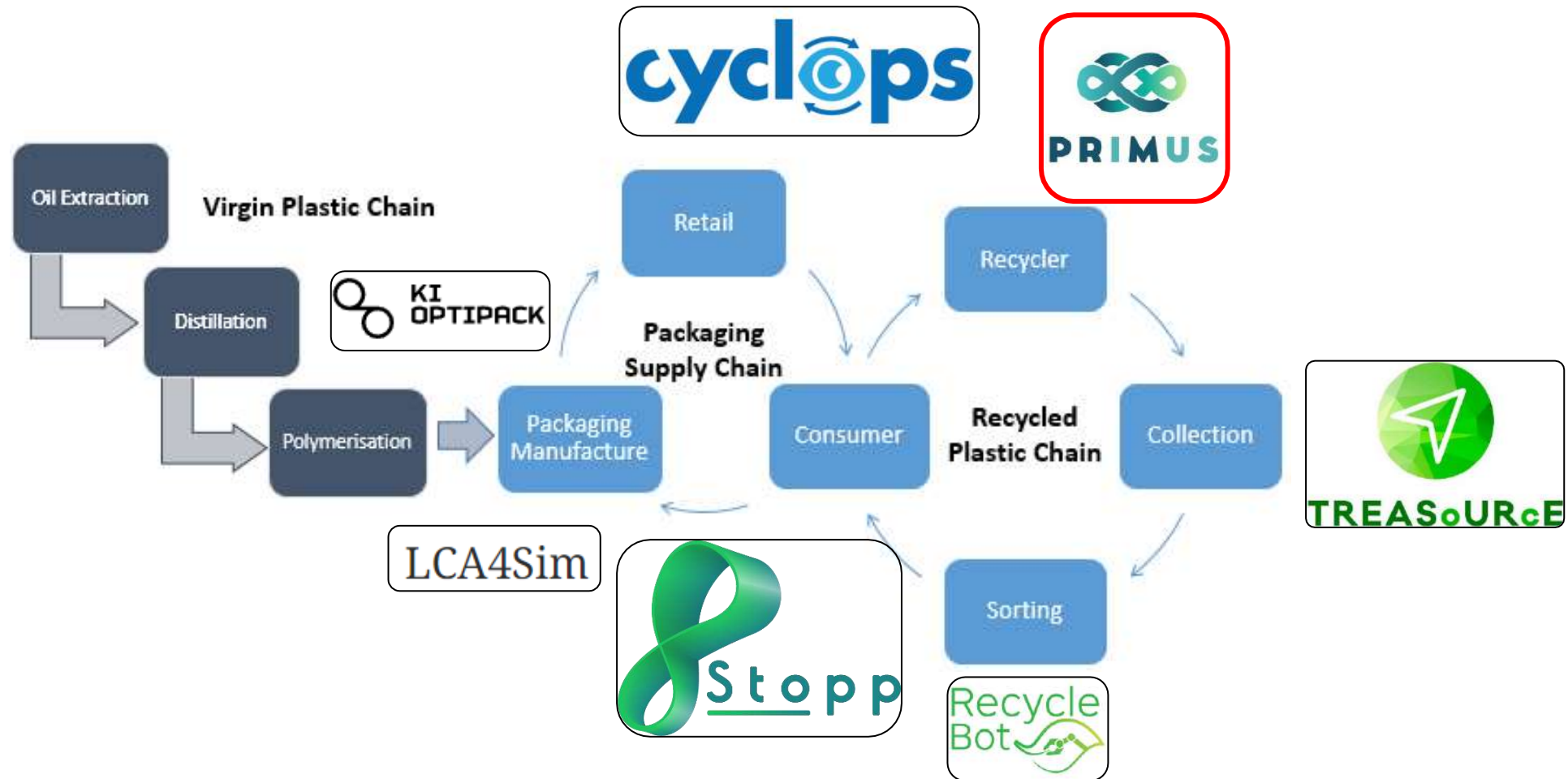
Criteria	1	2	3	4	5	Score
Reliability						
Completeness						
Time						
Geography						
Technology						

Qualitative descriptors

For documenting data quality but also to quantify uncertainty.

LCA data has quality

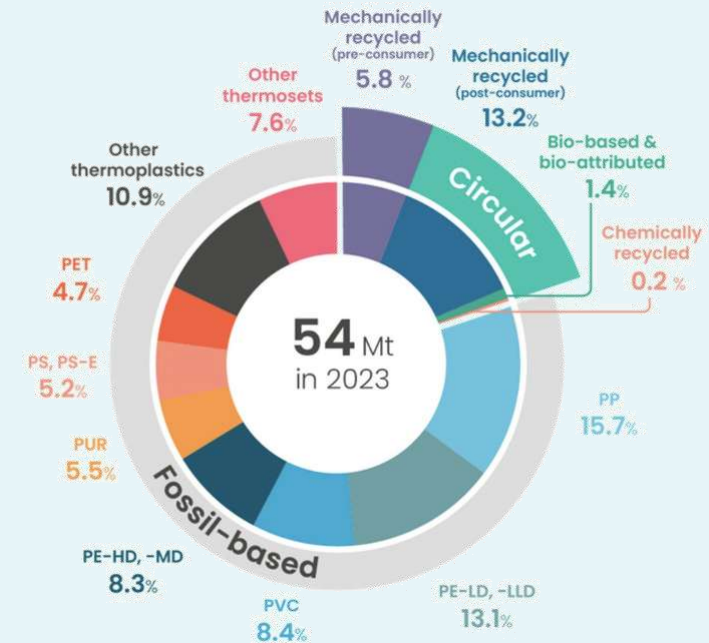
GreenDelta and Plastic



All plastic-related public-funded research projects

Background on LCA and Plastics

- By 2060, plastic production is projected to triple
 - contributing to 15% of global greenhouse gas emissions¹
- Performing **Life Cycle Assessments (LCAs)** of plastic products is crucial for understanding their **environmental impacts**
- **EcoProfiles** (PlasticsEurope) focus on **cradle-to-gate** analysis for plastics/chemicals to **provide LCI data (aggregated)**
 - European averaged production data (up to 100% coverage)
 - Examines all resource inputs and emissions to air and water during the production process (static data)
 - Assesses the environmental impacts using an LCIA method

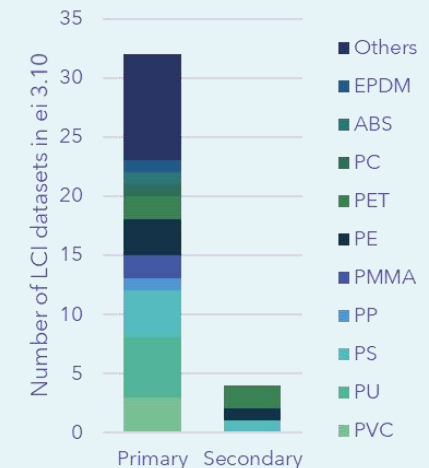
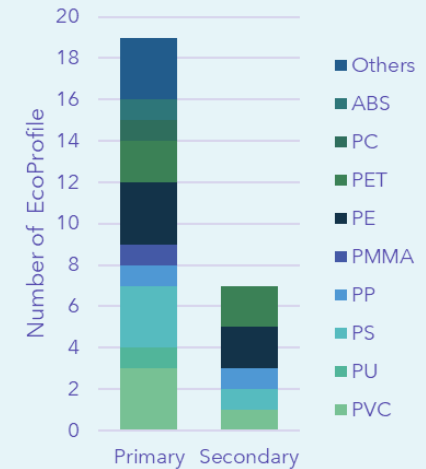


PlasticsEurope, Plastics – the fast Facts, 2024.

¹ World Economic Forum The New Plastics Economy—Rethinking the Future of Plastics (Ellen MacArthur Foundation, McKinsey & Company, 2016).

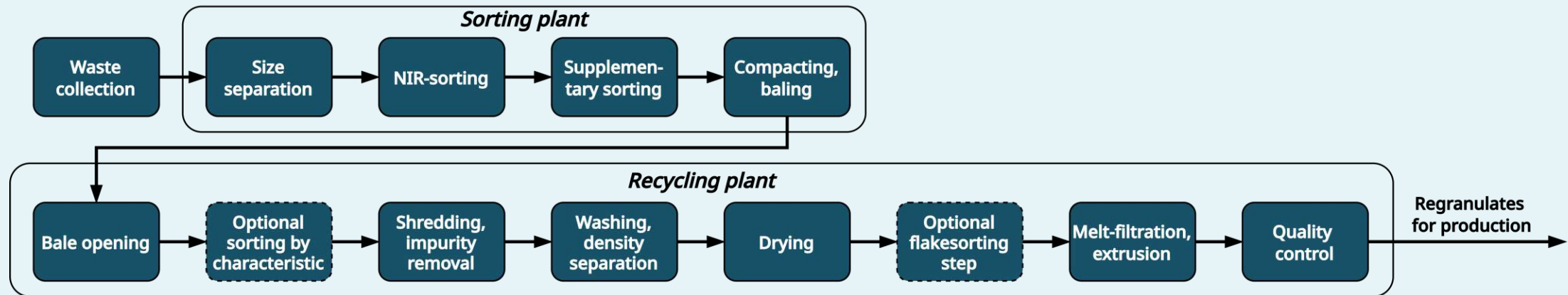
LCI data for plastic recyclates

- Existing EcoProfiles and LCI datasets focus on primary materials
 - Covering rPVC, rPE and rPET etc. from SRP (upon request)
 - Mostly secondary rPET and rHPDE (ei 3.11, license)
- Current EcoProfiles are aggregated, limiting updates and detailed supply chain analysis
- The **PRIMUS project addresses this by creating new EcoProfiles** for high-value recyclates (rABS, rHIPS, rPP) using European industry data
 - Data contributes to the circular economy and sustainable development
 - Enables environmental benchmarking against industry averages
 - Supports eco-design by informed decisions in product development



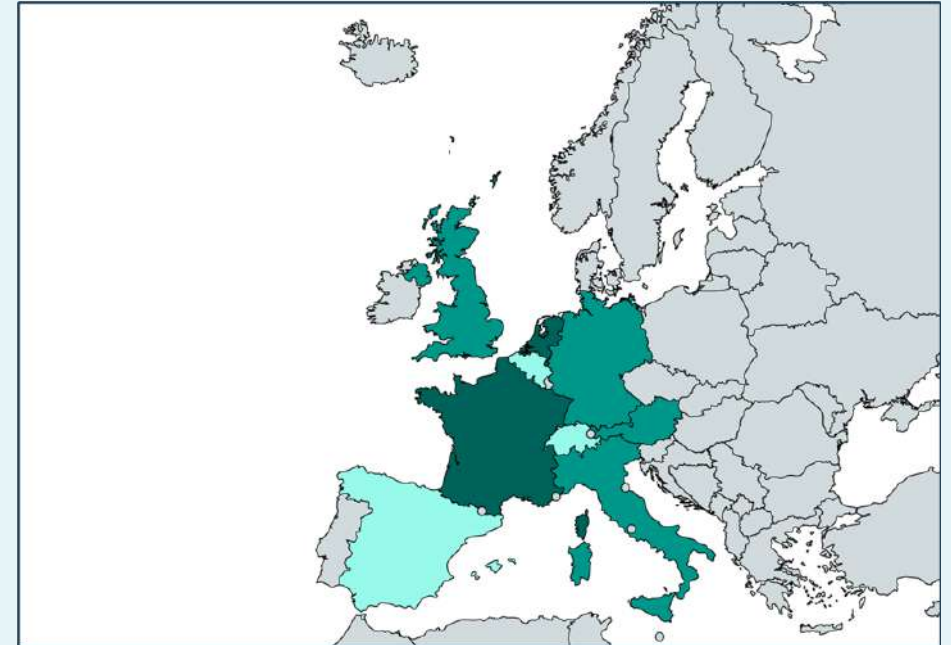
EcoProfiles for Recycled Plastics

- Mechanically recycled plastics produced in Europe
- The full list of polymers is: rABS, rHDPE, rHIPS, rLDPE, rMPO, rPET, rPP and rPVC
- We produced 50 EcoProfiles for recyclates

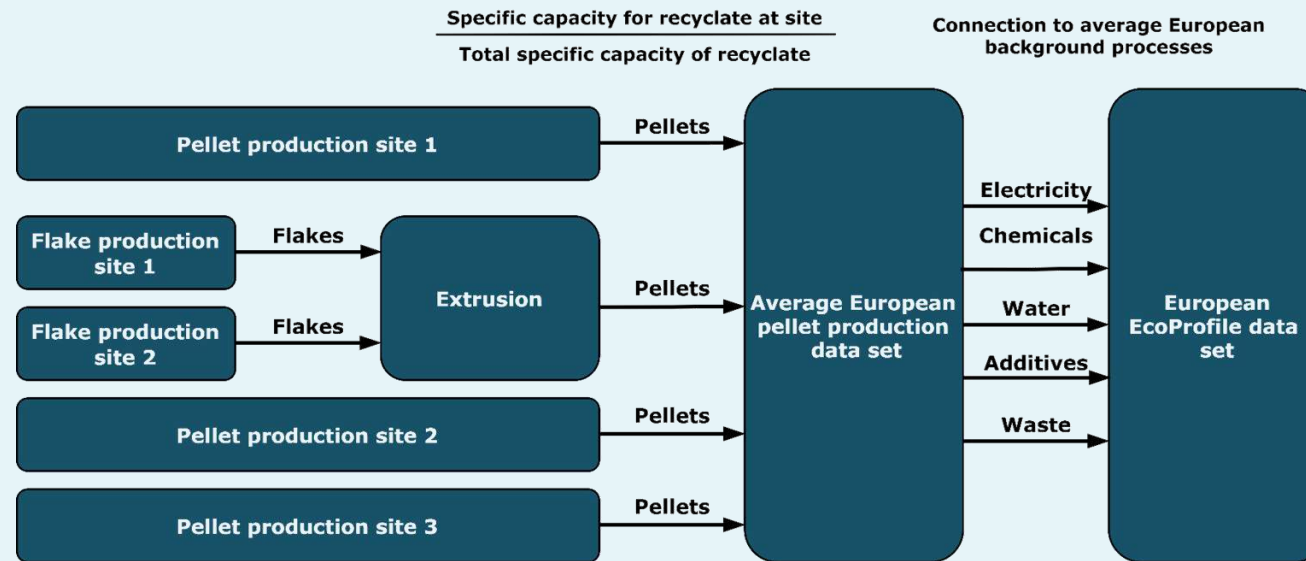


Data Collection

- 22 recycling sites in 9 European countries
- Coverage of 2.8 – 29.6%
- Polymers as **granulates** or **flakes**
 - Waste streams are comprised of **household, industrial, WEEE, ELV, and construction sectors**
 - **No data on quality**
 - **Washing chemicals, flotation, water, energy, transport**
- **Collection and Sorting is not primary data**



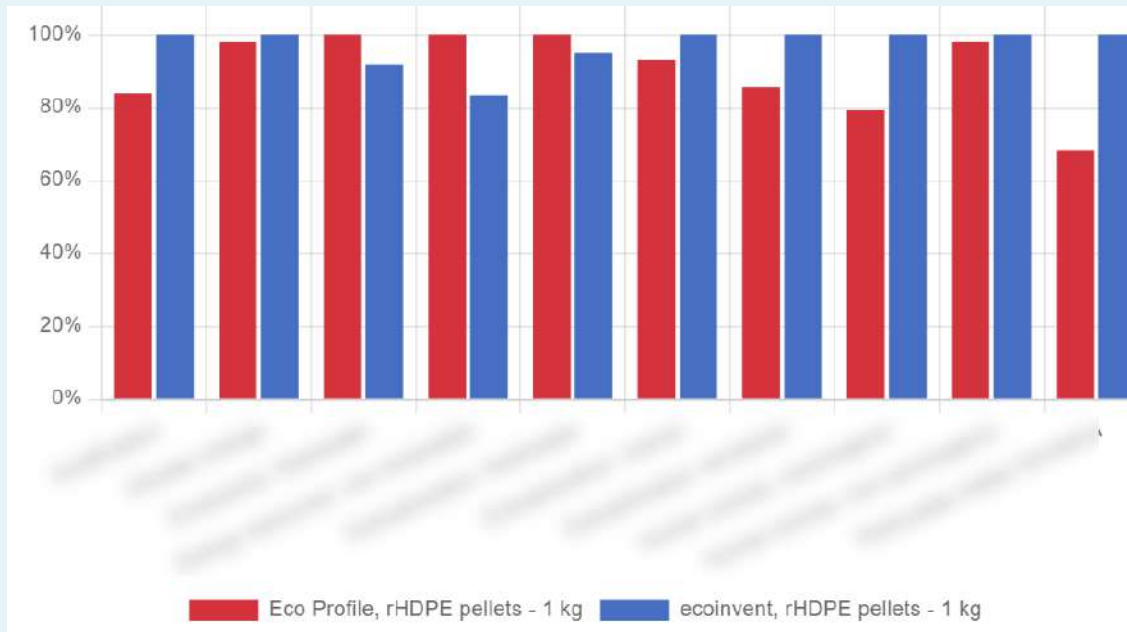
Aggregation and Regionalisation



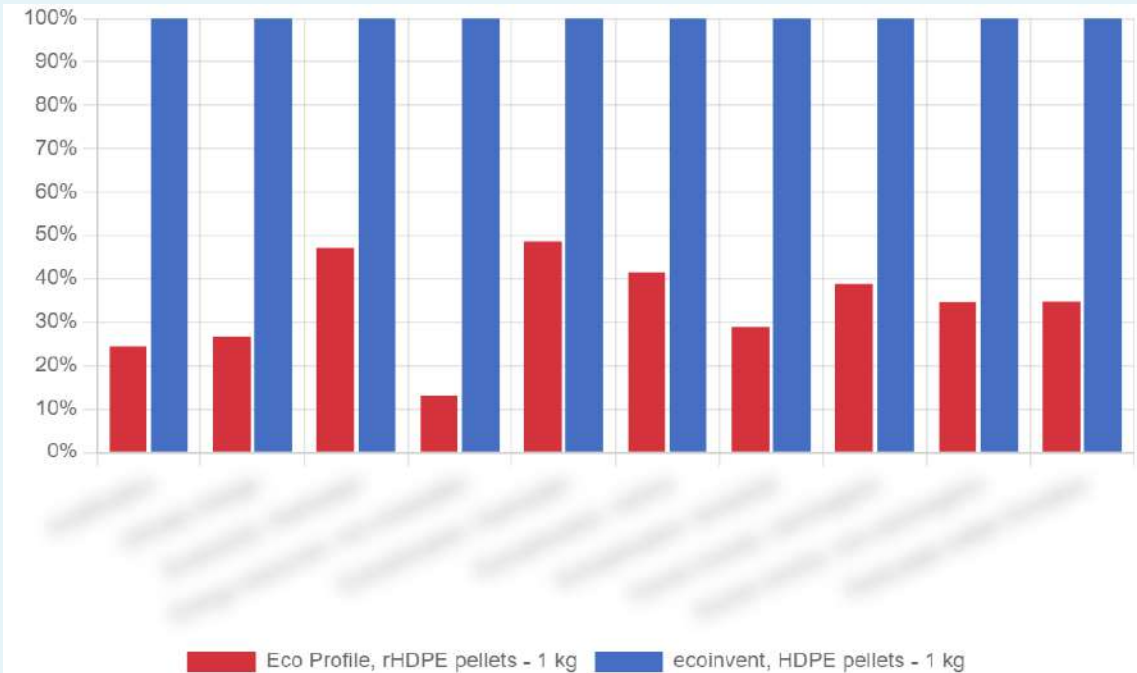
Partly-aggregated data!

Validation and Benchmarking using projects

Validation (ecoinvent 3.11):



Benchmarking:



Next to the validation, the methodology and EcoProfiles were externally reviewed!

What is Available?



EcoProfile Methodology for Plastic Recyclates

Jonas Hoffmann, Max Bringmann, Andreas Ciroth
GreenDelta GmbH
March 2025
Version 1.2

LCA method overview	
Background database	Ecoinvent v3.10
Dataset type	Cut-off, unit processes
Declared unit	Production of 1 kg of mechanically recycled polymer pellets (or flakes) [t]
ISO conformity	ISO 14040 and 14044 structure, internal review
LCA method	Environmental Footprint 3.1
Software	openLCA 2.4
System boundary	Cradle-to-gate and gate-to-gate



1 BACKGROUND INFORMATION

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The primary purpose of this document is to present the Eco-profile for recycled polyethylene terephthalate (rPET) granulate as result of the Horizon Project PRIMUS. The project seeks to provide a comprehensive understanding and data of the environmental impacts associated with mechanically recycled plastics.

Mechanical recycling involves the collection and sorting of post-consumer PET containers, such as bottles and packaging, followed by shredding to give PET flakes, washing, (density separation) and extrusion to produce rPET granulate.

rPET is a versatile material known for its wide array of applications in packaging, textiles, and beyond. It serves as a key ingredient in the production of new beverage bottles, food containers, and personal care product packaging. The usage of mechanically recycled PET resin reduces the use of fossil fuels and energy compared to the sourcing and production of chemical recycled and primary PET.

The herein presented Eco-profile follows the ISO 14040-14044 (SOURCE) standards and was internally reviewed by PlasticRecyclersEurope and experts from the Finnish research company VTT and is intended for LCA practitioners and sustainability researchers, stakeholders in the field of plastic recyclates

Data sets published with this report represent aggregated data from this collection. Details for the methodology used for this Eco-profile can be found in the accompanying methodology publication.

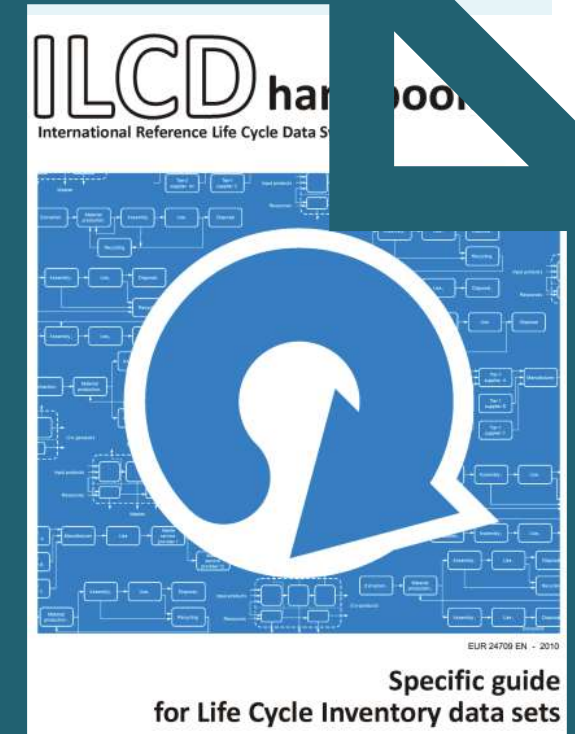
2 MODEL DESCRIPTION

This Eco-profile represents an average of European industry for mechanical rPET production. Data was collected in 2022 in France, Germany, Italy, Switzerland and Spain, represents the recycling of 100% household wastes, and X% of the European installed mechanical recycling capacity.

The herein generated Eco-profile represents a life cycle inventory in a 'gate-to-gate' fashion for production of PET plastic recyclate granulate. The product under investigation is recycled PET granulate. The main production steps in mechanical recycling of this granulate included in the system boundaries of the Eco-Profile are visualised in Figure 1.



Figure 1: System description and boundaries. Following the PET recycling scheme



Datasets

New EcoProfiles for recycled plastics – What do they look like?

Name	Compatability	Filesize	Info
Recycled Plastics EcoProfiles ILCD v1		12.8 MB	Inventory for recycled plastics coming from Europe.
Recycled Plastics EcoProfiles JSON-LD v1		14.4 MB	Inventory for recycled plastics coming from Europe.
Recycled Plastics EcoProfiles PDFs v1		14.0 MB	zip file with all EcoProfile datasets in PDF format

<https://nexus.openlca.org/database/EcoProfiles%20Recycled%20Plastics%20>

What can we learn from the LCA sector?

FAIR Data in LCA:

- LCA is done using specific LCA software, databases and often individual data sets
- There are harmonized data formats already in use (e.g., ILCD, EcoSpold, JSON-LD)
- Technically, LCA data can be shared securely, with fully aggregated sensitive data
- Data quality accompanies all datasets, and rigorous quality assessment is mandatory

Plastic Data in LCA:

- Dominated by aggregated data for primary plastics provided by PlasticsEurope
- Within the PRIMUS project, we developed a method to produce EcoProfiles for **recycled plastics**
- By partly-aggregating the datasets, we kept also allowed data granularity and updatability
- They are free to use and come with excessive documentation on openLCA's Nexus

GreenDelta

sustainability consulting + software



Thanks

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