PRIMUS

Applying openLCA's advanced features to increase transparency and reliability of secondary plastics datasets

Max F. Bringmann, Jonas Hoffmann

GreenDelta GmbH

April 2025

Funded by the European Union

HORIZON EUROPE GA No. 101057067

Introduction

- Plastics are ubiquitous materials in our society
  - 57.2 Mt of annual production in EU
  - 25.8 Mt of waste, annually (<30% recycled)
- Typically, fossil supply chain
- Data for environmental assessments
  - PlasticsEurope's EcoProfiles
  - **Aggregated LCI** data in popular databases
  - Until recently, lack of recycled plastics data
- **A higher degree of transparency is needed**

PRIMUS

WWW.PRIMUS-PROJECT.EU

- European **research project on plastic recyclates** "Reforming secondary plastics for added-value products"
- **Four demo-cases**:
  - Automotive interior
  - Automotive cooling circuit
  - Refrigerator
  - Washing machine door seal
- **Recyclate EcoProfiles**

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The EcoProfile publishing approach

PRIMUS

Eco-Profile Methodology for Plastic Recyclates

Max Bringmann, Julia C., Jonas Hoffmann, Andreas Ciroth, GreenDelta GmbH

January 2024

LCA method overview	
Data	Ecoinvent v3.10
Dataset type	Cut-off, unit process
Functional unit	1 kg of Polymer Recyclates
ISO conformity	ISO 14040 and 14044 structure, no review
LCIA method	Environmental Footprint 3.1
Software	openLCA 2.1.1
System boundary	Cradle-to-Gate

Funded by the European Union's Horizon Europe Programme under Grant Agreement No. 101057067

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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 recyled rPET 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 PRE recycling scheme.

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ILCD handbook

International Reference Life Cycle Data System

EUR 24709 EN - 2010

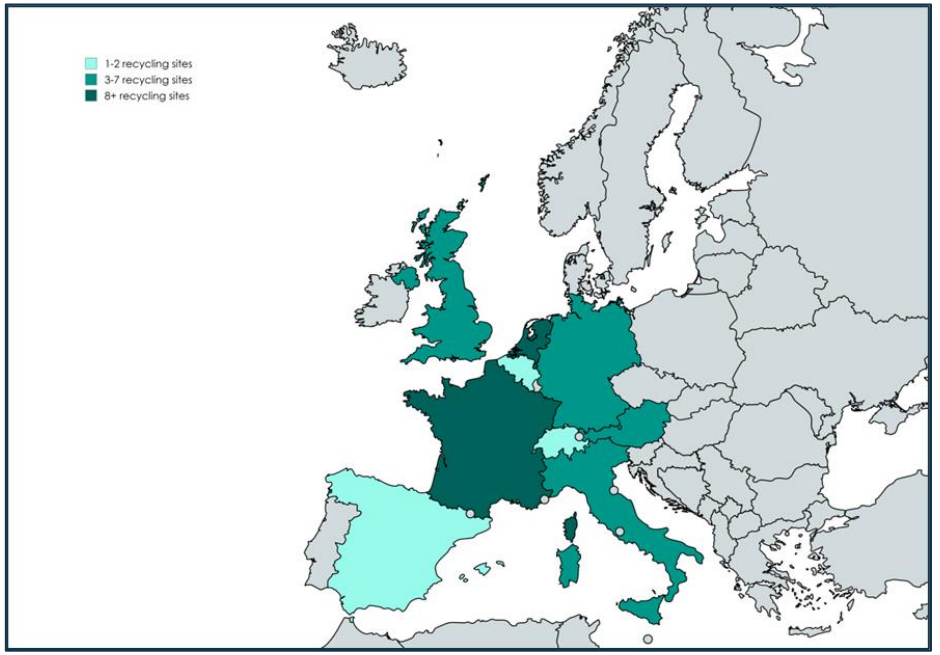
Specific guide for Life Cycle Inventory data sets

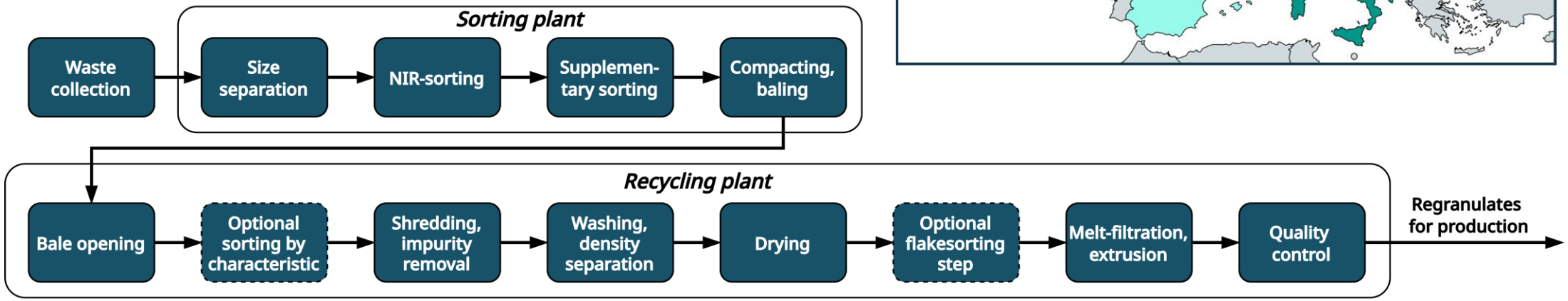
Datasets

HORIZON EUROPE GA No. 101057067

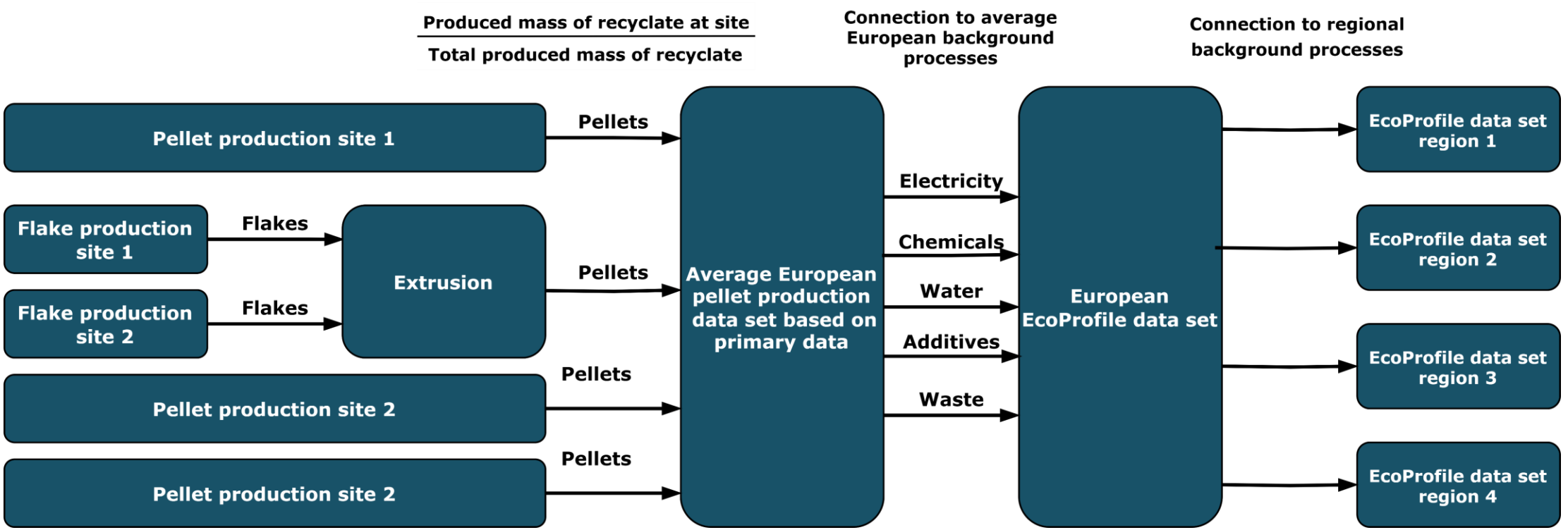
Scope of the EcoProfiles

- **Collected by Plastics Recyclers Europe**
- **23 sites in Europe, in 9 countries**
- **Representativeness of 2.86% - 29.6%**
- **Recycling of ABS, HIPS, PP, PVC, PET and PE**

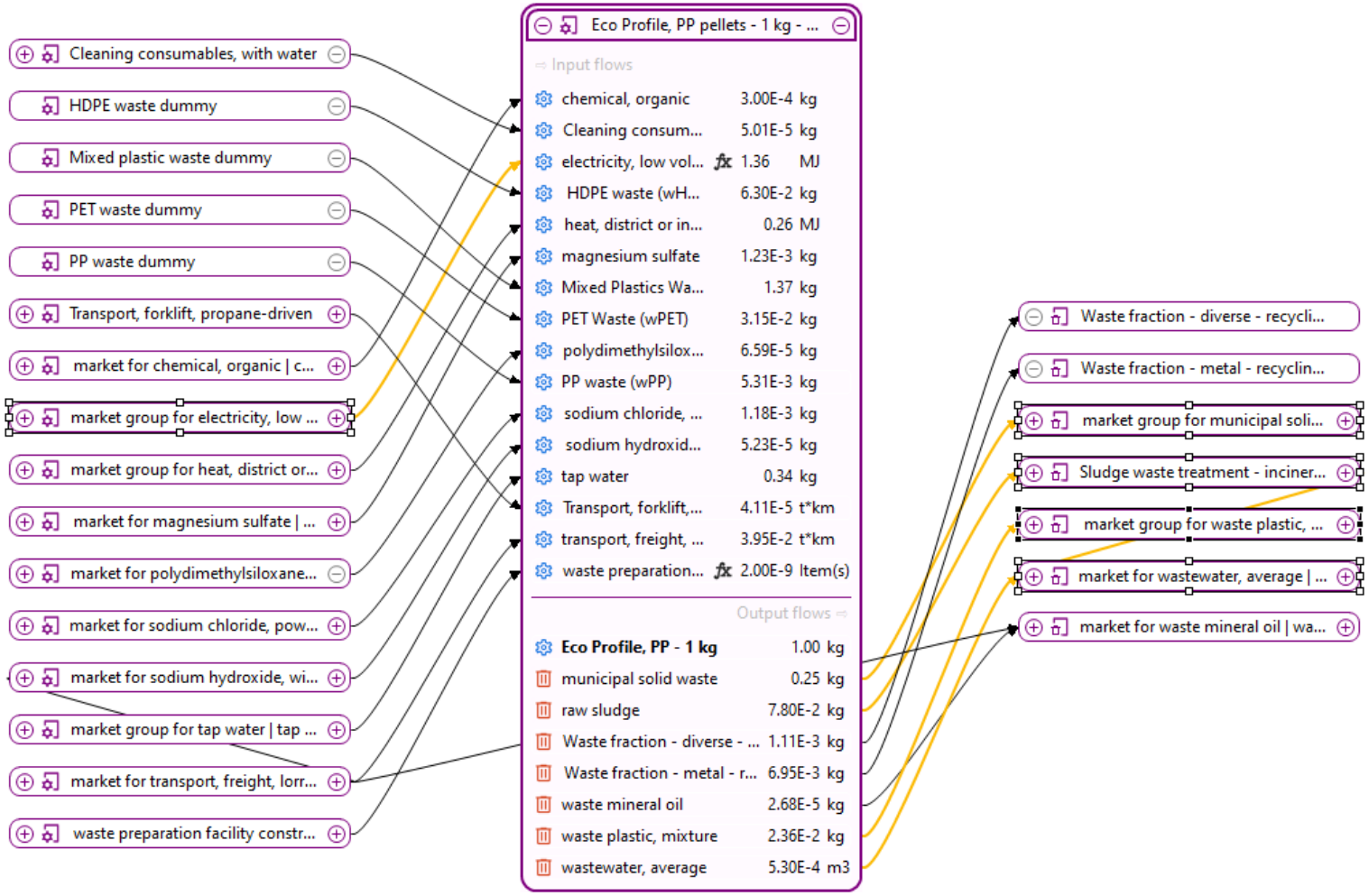




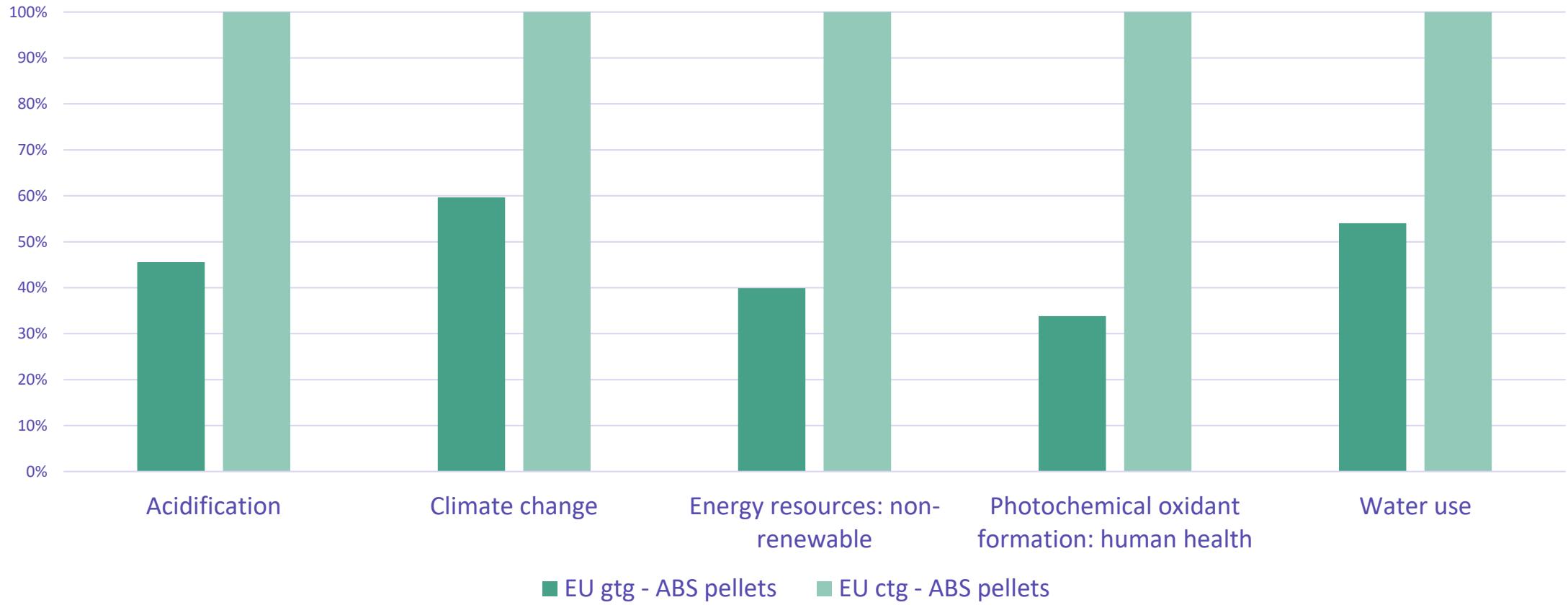
EcoProfiles - Regionalization



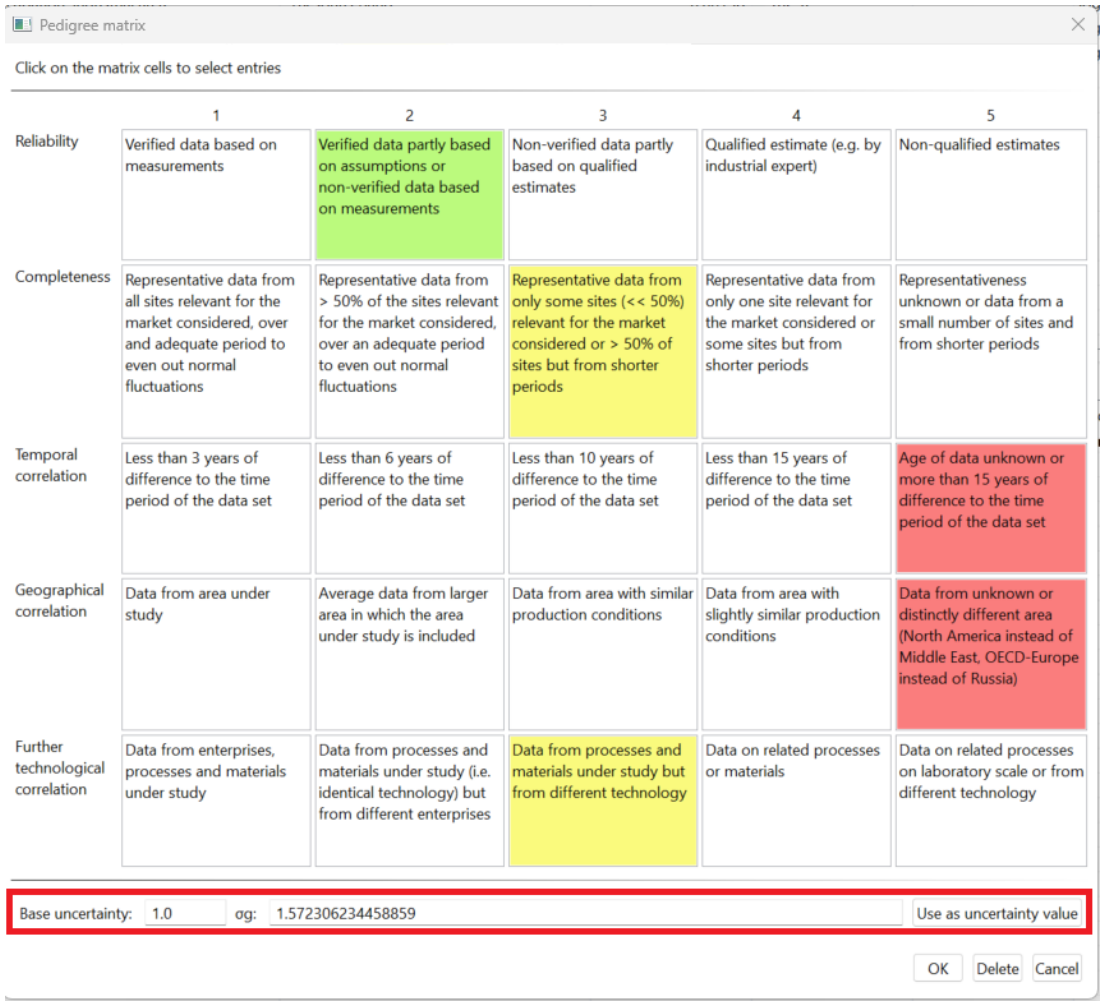
EcoProfiles – Regionalization – openLCA



LCIA Results (EF 3.1) for rABS pellets, climate change



What is the relevance of the results?



Applying the ecoinvent pedigree matrix

- Assess **data quality of exchanges / processes** in openLCA
  - **Reliability**: non-verified data → 2
  - **Completeness**: according to occurrence within the primary data 'market' → 1-4
  - **Temporal correlation**: Baseline year 2022 → 1
  - **Geographical correlation**: Extrapolation of primary data to larger area → 2
  - Further technical correlation → 1
- Allows to calculate **per-process uncertainty values**

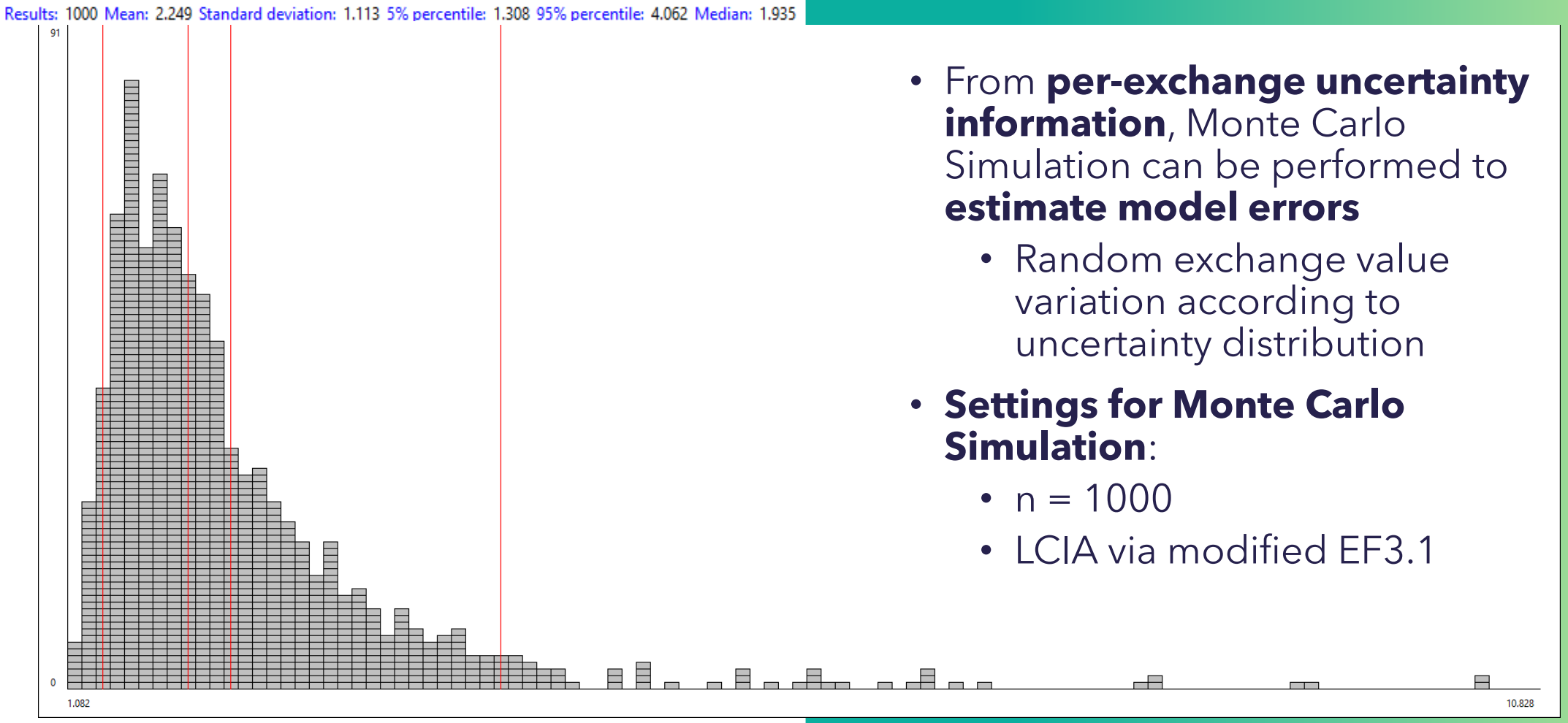
Applying the ecoinvent pedigree matrix

Inputs/Outputs - Eco Profile, PP pellets - 1 kg - gtg - disaggregated - RER

Inputs

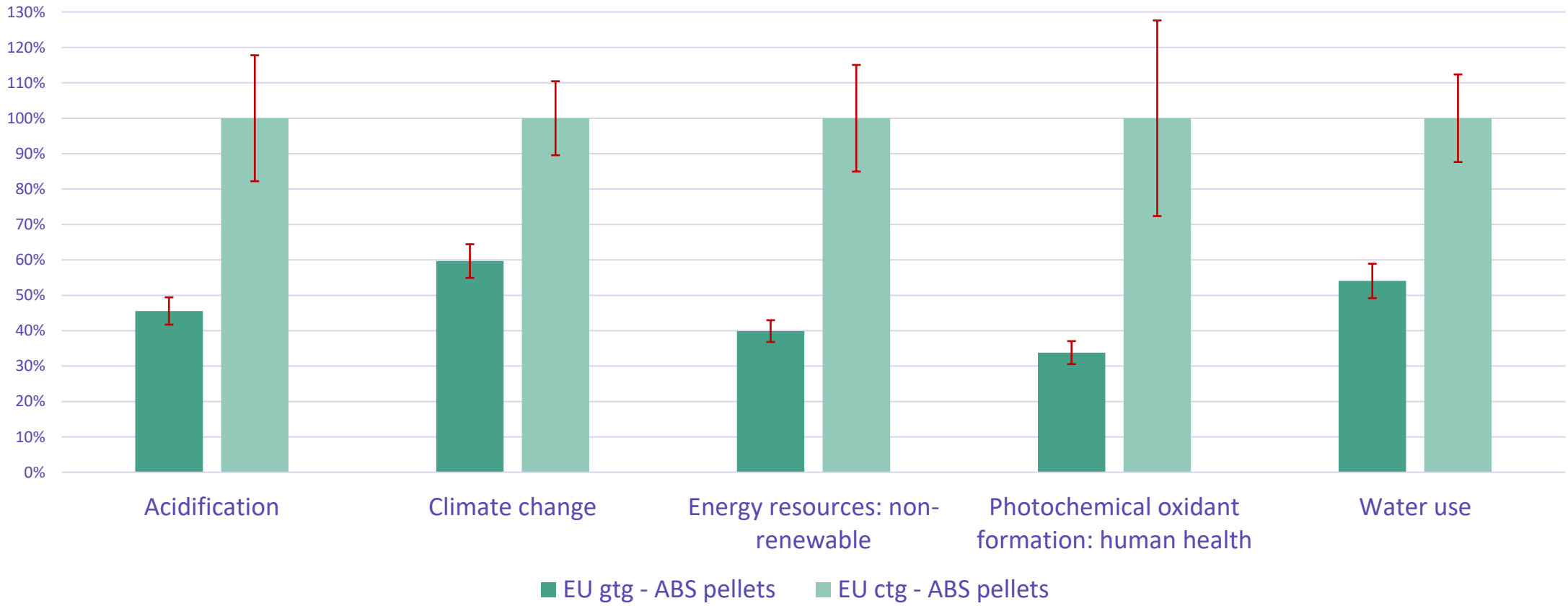
Flow	Category	Amount	Unit	Uncertainty	Data quality entry
chemical, organic	C:Manufacturing/20:Manufacture of chemicals a...	3.0E-4	kg	lognormal: gmean=0.000300000 gsigma=1.10954	(2; 4; 1; 3; 1)
Cleaning consumables, with water	PRIMUS/Additives	5.00758E-5	kg	lognormal: gmean=5.00758E-05 gsigma=1.10954	(2; 4; 1; 3; 1)
electricity, low voltage	D:Electricity, gas, steam and air conditioning sup...	0.02119+1.34115	MJ	lognormal: gmean=1.36234 gsigma=1.10954	(2; 4; 1; 3; 1)
HDPE waste (wHDPE)	PRIMUS/Plastic Inputs	0.06301	kg	lognormal: gmean=0.0630100 gsigma=1.10954	(2; 4; 1; 3; 1)
heat, district or industrial, natural gas	D:Electricity, gas, steam and air conditioning sup...	0.25844	MJ	lognormal: gmean=0.258440 gsigma=1.07476	(2; 3; 1; 3; 1)
magnesium sulfate	B:Mining and quarrying/07:Mining of metal ores/...	0.00123	kg	lognormal: gmean=0.00123000 gsigma=1.10954	(2; 4; 1; 3; 1)
Mixed Plastics Waste (wMP)	PRIMUS/Plastic Inputs	1.37338	kg	lognormal: gmean=1.37338 gsigma=1.05819	(2; 2; 1; 3; 1)
PET Waste (wPET)	PRIMUS/Plastic Inputs	0.03148	kg	lognormal: gmean=0.0314800 gsigma=1.10954	(2; 4; 1; 3; 1)
polydimethylsiloxane	C:Manufacturing/20:Manufacture of chemicals a...	6.58547E-5	kg	lognormal: gmean=6.58547E-05 gsigma=1.10954	(2; 4; 1; 3; 1)
PP waste (wPP)	PRIMUS/Plastic Inputs	0.00531	kg	lognormal: gmean=0.00531000 gsigma=1.10954	(2; 4; 1; 3; 1)
sodium chloride, powder	B:Mining and quarrying/08:Other mining and qu...	0.00118	kg	lognormal: gmean=0.00118000 gsigma=1.10954	(2; 4; 1; 3; 1)
sodium hydroxide, without water, in 50% soluti...	C:Manufacturing/20:Manufacture of chemicals a...	5.23439E-5	kg	lognormal: gmean=5.23439E-05 gsigma=1.07476	(2; 3; 1; 3; 1)
tap water	E:Water supply; sewerage, waste management an...	0.3378	kg	lognormal: gmean=0.337800 gsigma=1.05819	(2; 2; 1; 3; 1)
Transport, forklift, propane-driven	PRIMUS/Other	4.10852E-5	t*km	lognormal: gmean=4.10852E-05 gsigma=1.10954	(2; 4; 1; 3; 1)
transport, freight, lorry, unspecified	H:Transportation and storage/49:Land transport a...	0.03948	t*km	lognormal: gmean=0.0394800 gsigma=1.05433	(2; 1; 1; 3; 1)
waste preparation facility	F:Construction/42:Civil engineering/429:Construc...	1.0/500000000	Item(s)	lognormal: gmean=2.00000E-09 gsigma=2.28109	(5; 5; 5; 5; 5)

openLCA's Monte Carlo Simulation



- From **per-exchange uncertainty information**, Monte Carlo Simulation can be performed to **estimate model errors**
  - Random exchange value variation according to uncertainty distribution
- **Settings for Monte Carlo Simulation**:
  - n = 1000
  - LCIA via modified EF3.1

LCIA Results (EF 3.1) for rABS pellets, climate change – with standard deviation of MCS



Uncertainties contextualise results!

Future timeline of the EcoProfiles

- Publish **Data as ILCD** (.xml and .json) and models (.zolca)
  - Most likely in **May / June**
  - Reports include **process inventory** (cradle-to-gate; gate-to-gate)
  - **Comparison to primary impacts** where applicable
  - **CED, PLEX + EF3.1 impacts** with uncertainty
  - **50 total** EcoProfile reports
    - 28 average EU reports, 22 regionalised according to primary data providers' locations

Conclusions

- **openLCA supports the production of EcoProfiles** in various ways




- **Increasing credibility of LCIA results helps public perception**
  - Background uncertainty data is often incorrect or missing
- **Foreground DQ is a step in the right direction**, not the end of the road
  - Missing exchanges
  - LCIA method uncertainty