

Sustainability Insights from PRIMUS: Advancing High-Value Recycled Plastics

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PRIMUS Scope and Big goals

ADDRESSING THE BARRIERS FOR HAVING HIGH RECYCLED CONTENT IN TECHNICAL PLASTICS

PRIMUS promotes the usage, **acceptance and safety of plastic recyclates** to be used in added value product made of technical plastics and elastomers, focusing on **traceability of materials to increase transparency** in the plastics value chain.

01 Create quality and safe recyclates through technological innovations

02 Support the use of recycled plastics as safe raw materials with **traceability**

03 Demonstrate application with 4 novel added-value demo cases in automotive and home appliances

04 Support recyclates market with

- 1) Advanced mechanical recycling,
- 2) Debromination of plastics
- 3) Chemical analytics



Methodologies and achievements

4 PLASTIC FORMULATION FOR TARGETED APPLICATIONS & PROCESS

Industrial Applications:

- **Pilot 1: r-PC/ABS** for automotive interior
- **Pilot 2: r-PP/EPDM** (r-TPV), automotive cooling circuits
- **Pilot 3: r-HIPS** refrigerator inner liners, 70% recycled content
- **Pilot 4: r-EPDM rubber**, washing machine door gasket
- **Are they even more sustainable?**

Pilot 1. Automotive interior

Upgrading recycled PC/ABS material suitable for automotive interior application using injection moulding technology.



Pilot 2. Automotive cooling circuit

Upgrading of recycled PP and EPDM to react together during the Thermoplastic Elastomer Vulcanisate (TPV) to reach a TPV compound suitable for an automotive application.



4
demo
cases



Pilot 3. Refrigerator to refrigerator - Food contact demonstration

Upgrading of recycled HIPS from refrigerator liners. Upgrading towards food contact applications, safety and migration tests.



Pilot 4. Washing machine door seal

Upgrading of sulphur crosslinked EPDM from end-of-life cycle washing machine seals, to get recycled EPDM polymer suitable to produce a new technical washing machine door seal.



All round sustainability methodology

- Environmental Life Cycle Assessment (LCA)
- Social LCA
- Circularity indicators
- Plastic littering risk
- ... combined!**
- System Dynamics



Results can be found <https://www.primus-project.eu/general-publications/>

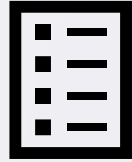


All round sustainability methodology

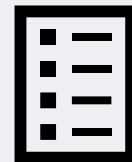
4 DEMO Cases



LCSA



PRE members (>22 sites)



EcoProfile methodology



GreenDELTA

Demo Cases & EcoProfiles



Sustainability Tooling and Traceability



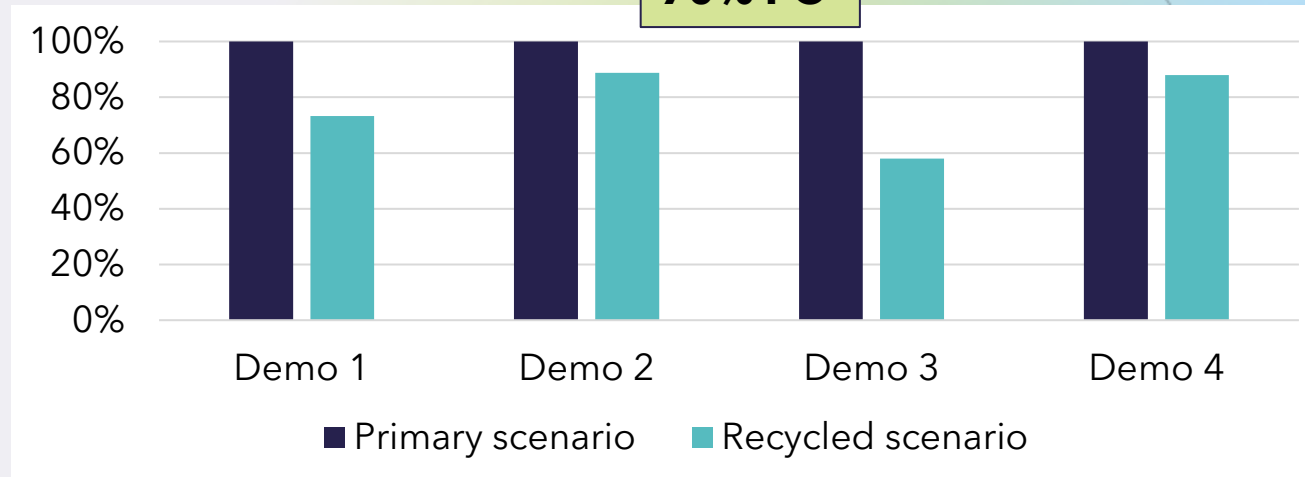
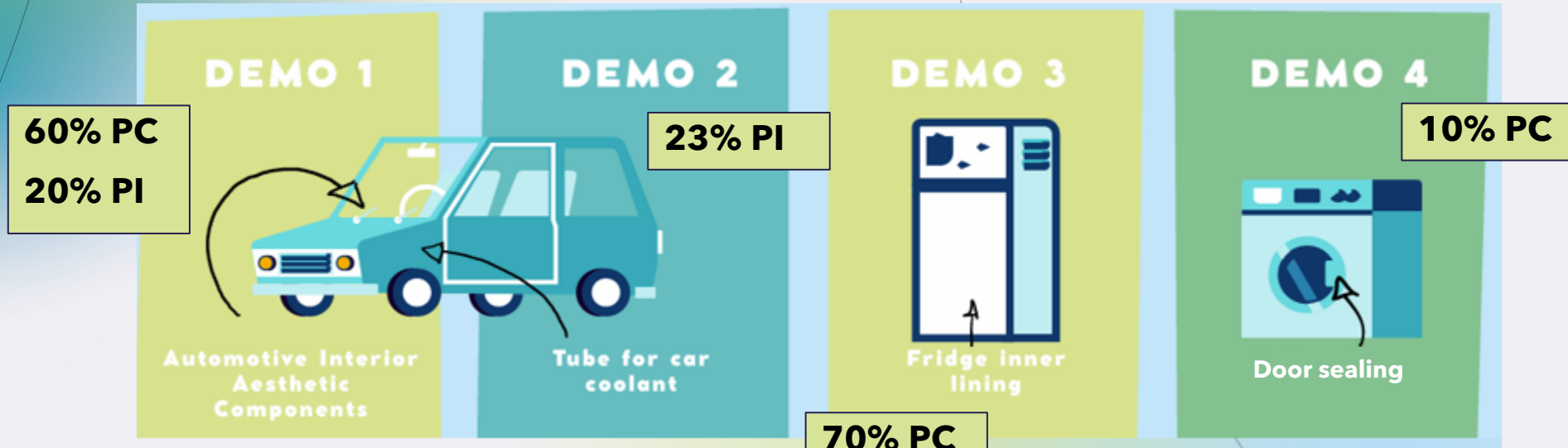
Demo cases

How sustainable are the recyclates?



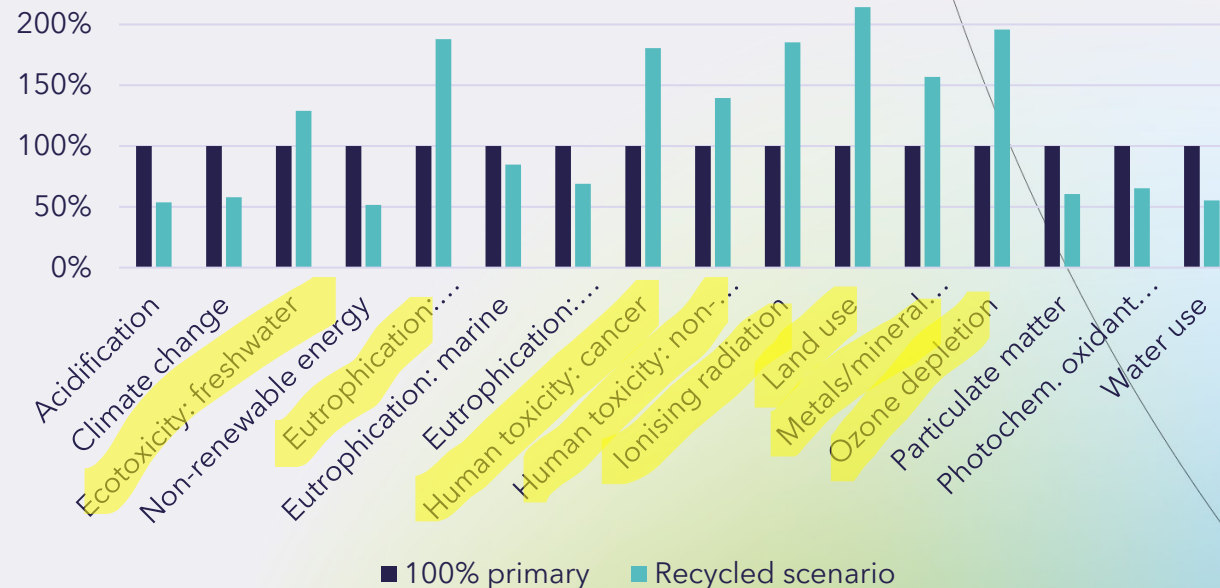
Methodology applied to 4 demonstrator cases

Climate Change results:



Overall environmental LCA results

- General improvements in all impact categories
- Only Demo 3 shows a mix between improvements and worse results, mainly due to the large transportation distance of recycled content and intensive energy and nitrogen use in the specific demo recycling process.





EcoProfile datasets
*often in LCA, data availability is an issue:
We created European LCA datasets for recyclates*



ECOPROFILES

GreenDelta

One scientific methodology to assess environmental impacts for recyclates (externally reviewed)

Two classes of use cases:

- Recyclers will be able to compare
- LCA practitioners will be able to use

rMPO, rLDPE, rHDPE, rPET, rABS, rPS, rPP and rPVC

EcoProfile of re EU27+3, crad consumer

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March 2025



3 LCI RESULTS

Table 1. Summary of material and energy in- and out recycled PVC pellet

Incoming Material	Unit
Mixed plastic waste including impurities ¹	M
air filter, central unit, 600 m ³ /h	
Cleaning consumables, with water	
Colour masterbatch	
fleece, polyethylene	
lubricating oil	
magnesium sulfate	
polyethylene, low density, granulate	
polypropylene, granulate	
steel, low-alloyed	
Talcum powder	
waste collection lorry, 21 metric ton	S
extrusion, plastic film	
wire drawing, steel	Wat
tap water	
diesel, burned in building machine	
electricity, low voltage	
heat, central or small-scale, other than natural gas	I
waste preparation facility	
municipal waste collection service by 21 metric ton transport, freight, lorry 16-32 metric ton, EUR03	Ti
transport, freight, lorry 16-32 metric ton, EUR04	
transport, freight, lorry 16-32 metric ton, EUR05	
transport, freight, lorry 16-32 metric ton, EUR06	
transport, freight, lorry, unspecified	
municipal solid waste	
raw sludge	
waste plastic, mixture	Second:
Waste fraction - metal - recycling cut-off	Waste
wastewater, average	
plastic litter	Probab:

Table 2. Primary energy demand by carrier using process for recycled PVC

Energy carrier
Oil, crude
Gas, natural
Uranium
Coal, hard
Coal, brown
Energy resources: non-renewable
Energy resources: renewable
Total

¹ This value expresses an aggregation of all polymers the disaggregated input values per-waste stream in t

4 LCIA RESULTS

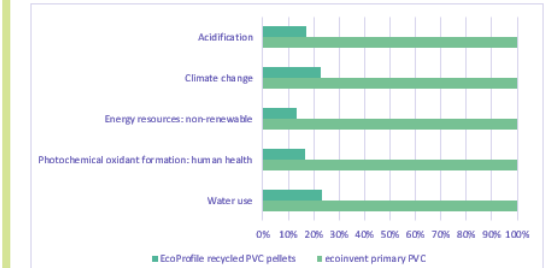


Figure 2: Comparison of primary² and secondary PVC pellet production impacts for selected impact categories.

Table 3. Life cycle impacts of the cradle-to-gate rPVC model related to 1 kg of pellets

Impact Category	Impact assessment ¹	Unit
Acidification	2.08E-03 + 3.65E-04	mol H ⁺ -Eq
Climate change	0.674 + 0.098	kg CO2-Eq
Ecotoxicity: freshwater	4.60 + 0.79	CTUa
Energy resources: non-renewable	7.65 + 2.13	MJ, net calorific value
Eutrophication: freshwater	2.20E-04 + 2.88E-05	kg P-Eq
Eutrophication: marine	7.20E-04 + 8.67E-05	kg N-Eq
Eutrophication: terrestrial	4.90E-03 + 8.28E-04	mol N-Eq
Human toxicity: carcinogenic	3.33E-09 + 1.39E-09	CTUh
Human toxicity: non-carcinogenic	8.09E-09 + 1.14E-09	CTUh
Ionising radiation: human health	0.113 + 0.013	kBq U235-Eq
Land use	3.70 ± 1.69	dimensionless
Material resources: metals/minerals	4.10E-06 + 1.00E-06	kg Sb-Eq
Ozone depletion	7.54E-09 + 2.35E-09	kg CFC-11-Eq
Particulate matter formation	2.70E-08 + 4.60E-09	disease incidence
Photochemical oxidant formation: human health	1.88E-03 + 4.60E-04	kg NMVOC-Eq
Plastic litter	2.34E-02 + 2.37E-03	kg
Water use	0.189 ± 0.038	m ³ world Eq deprived

² For this comparison, the ecoinvent v3.10 process "acrylonitrile-butadiene-styrene copolymer production | acrylonitrile-butadiene-styrene copolymer | Clupol, U - RER" was used.

³ The uncertainty value presented here has been calculated on the foreground data. Details are described in the methodology.

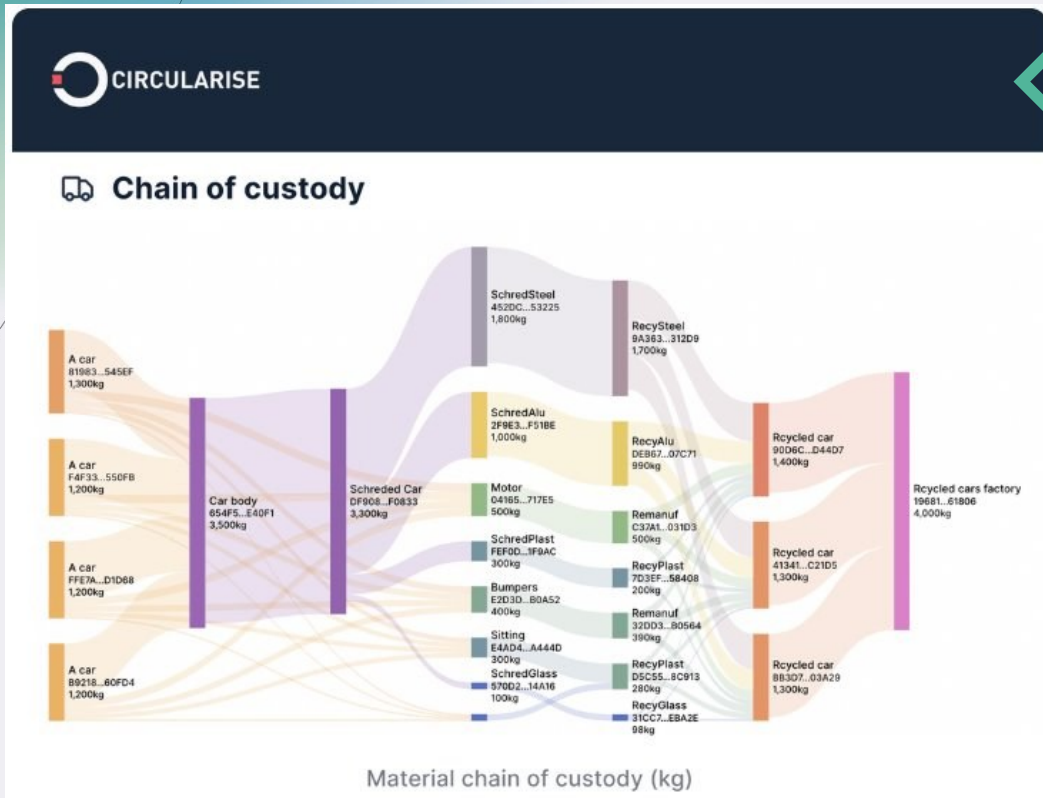


LCA tool and connection to traceability system



PRIMUS Expert LCA tool

Connects with circularise traceability system



PRIMUS Expert Tool - 2_PRIMUS master database, ecoinvent v3.10 Cutoff, Circularity 2.1, criticality, plastic litter, social oica V2.3

Database Tools Help

Location

- 1_ecoinvent v3.10 Cutoff Unit-Processes 2024-06-19 - PRIMUS_database_CIRCULARISEtest20241029 oica V2.3
- 2_PRIMUS master database, ecoinvent v3.10 Cutoff, Circularity 2.1, criticality, plastic litter, social oica V2.3

Projects

- Product systems
- Processes
 - A-Agriculture, forestry and fishing
 - B-Mining and quarrying
 - C-Manufacturing
 - D-Electricity, gas, steam and air conditioning supply
 - E-Water supply, sewerage, waste management and remediation activities
 - F-Construction
 - G-Wholesale and retail trade; repair of motor vehicles and motorcycles
 - H-Transportation and storage
 - I-Accommodation and food service activities
 - J-Information and communication
 - M-Professional, scientific and technical activities
 - N-Administrative and support service activities
 - Recycled content cut-off
 - S-Other service activities
- Flows
 - EPDs
 - Results
- Indicators and parameters
 - Impact assessment methods
 - ecoinvent 3.10 LCIA Methods
 - Circularity (GreenDelta, 2024)
 - plastic litter
 - SH2E Criticality Indicator
 - Social Impacts Weighting Method
 - Impact categories
 - Social indicators
 - Global parameters
 - Data quality systems
 - Background data

2_PRIMUS master database, ecoinvent v3.10 Cutoff, Circularity 2.1, criticality, plastic litter, social oica V2.3, CIRCULARISE

Welcome

PRIMUS

Recycled Plastic Sustainability Toolkit for LCA Experts

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

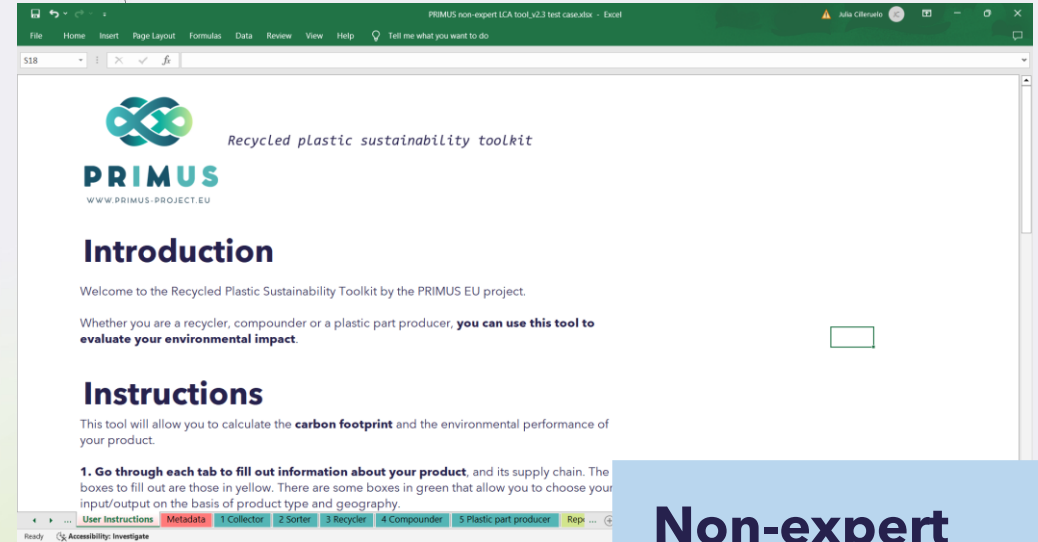
Developed By **GREENDELTA**



PRIMUS Sustainability Tools



Expert LCA tool



Non-expert LCA tool



Final remarks and findings

- **Demo cases:**

- In all cases, a reduction of the environmental footprint was achieved
- Further reduction was often limited by the technical performance of the recycle

- **EcoProfiles:**

- A **methodology** for recyclates was created and externally reviewed
- From **8 core datasets** for recyclates, 50 EcoProfiles were created
- You can download the reports/datasets at openLCA Nexus (<https://nexus.openlca.org/database/EcoProfiles%20Recycled%20Plastics%20>)
- Within the **STOPP project**, a novel versions of EcoProfiles for **polyolefins** will be created

- **Traceability:**

- Connection with a DPP tool and LCA software was established





Thank you!

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Funded by
the European Union