EcoProfile of recycled ABS pellets NL, gate-to-gate, post-consumer

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LCA method overview	
Background database	Ecoinvent v3.10
Dataset type	Cut-off, unit processes
Declared unit	'Production of 1 kg of mechanically recycled ABS pellets'
ISO conformity	ISO 14040 and 14044 structure, internal review
LCIA method	Environmental Footprint 3.1
Software	openLCA 2.4
System boundary	Gate-to-gate

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1 BACKGROUND INFORMATION

- The primary purpose of this document is to present an average life cycle inventory (LCI) and impact assessment (LCIA) for mechanical recycled acrylonitrile-butadiene-styrene (rABS) pellets 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.

- rABS is a versatile material known for its wide array of applications in electronics, toys and the automotive industry. The usage of mechanically recycled ABS reduces the use of fossil fuels and energy compared to the production of primary ABS.

- Mechanical recycling of WEEE plastics waste involves collection, sorting, shredding, sorting to remove non-plastics (via magnetic separation and eddy-current separation), grinding and extrusion to produce rABS pellets. Density separation can be used to removed material with brominated flame retardants.

- The documentation of the method followed in the herein presented EcoProfile follows the main principles of the ISO 14040-14044 standards and was internally reviewed by PlasticRecyclersEurope and experts from the VTT Technical Research Centre of Finland. It is intended for LCA practitioners and sustainability researchers and stakeholders in the field of plastic recyclates.

- Details for the methodology used for this EcoProfile can be found in the accompanying methodology publication. Datasets can be downloaded from openLCA Nexus in JSON-LD and ILCD formats.

2 MODEL DESCRIPTION

- This EcoProfile represents an average of European industry for mechanical rABS production, adapted to a regional process located in the Netherlands through the method described in the accompanying methodology document. Data was collected from 3 sites in 2022 in France, the Netherlands and the United Kingdom, represents the recycling of a mix of household wastes and ELV-WEEE wastes, and 29.6% of the European installed mechanical recycling capacity of those waste streams. The European coverage has been calculated per waste-stream, as displayed in Table 2 of the accompanying methodology document.

- The herein generated EcoProfile embodies a life cycle inventory in a 'gate-to-gate' fashion for the production of ABS plastic recyclate pellets. The product under investigation is **1 kg of recycled ABS pellets**. The main production steps in mechanical recycling are included in the system boundaries of the EcoProfile are visualised in Figure 1.

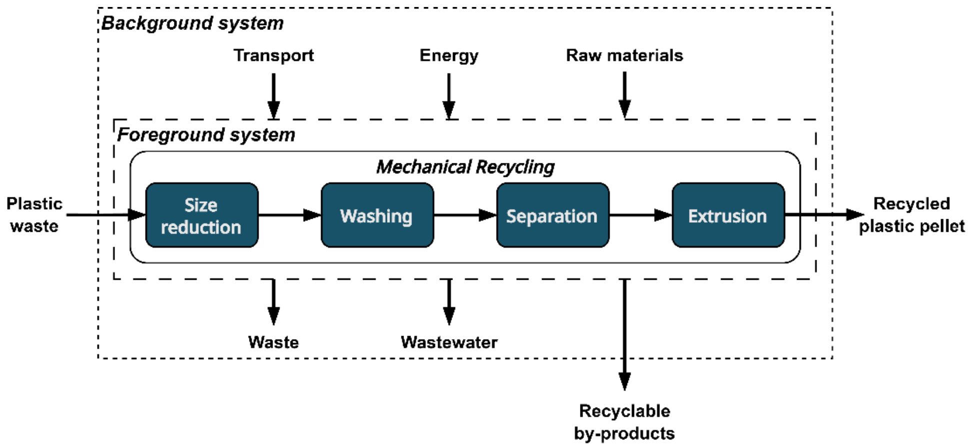

Figure 1: System description and boundaries. Following the PRE recycling scheme.

- The functional unit of the rABS EcoProfile is '**Production of 1 kg of mechanically recycled ABS pellets, obtained from WEEE waste, at gate, unpackaged, representing Dutch production**' where the reference flow of the rABS EcoProfile provided is '**1 kg of rABS pellets, unpacked**'.

- Generally, a complete LCI was aimed for, though some neglectable amounts of secondary outputs had to be cut-off. For multi-output processes physical allocation was used as described in our methodology.

- The collected primary data was combined with secondary data (for transport, energy, chemicals, and water) from the ecoinvent 3.10 cut-off LCA database. The life cycle inventory and impacts were calculated using the CED, EF 3.1 and PLEX methods.

3 LCI RESULTS

Table 1. Summary of material and energy in- and outputs of an exemplary secondary material production process for recycled ABS pellets with a gate-to-gate boundary

Incoming Material	**Flow Quantities per 1 kg**
Mixed plastic waste including impurities[1]	1.70 kg
Material inputs	
calcium carbonate, precipitated	1.15E-03 kg
chemical, organic	4.40E-04 kg
polyaluminium chloride	1.30E-04 kg
sodium chloride, powder	3.43E-02 kg
sodium hydroxide, without water, in 50% solution state	4.96E-05 kg
Talcum powder	7.00E-04 kg
Water consumption	
tap water	0.216 kg
Energy	
electricity, low voltage	1.91 MJ
Infrastructure	
waste preparation facility	2.00E-09
Transportation	
transport, freight, lorry, unspecified	4.24E-02 t*km
Solid Waste	
municipal solid waste	0.133 kg
raw sludge	5.08E-02 kg
waste plastic, mixture	0.377 kg
waste polyurethane	5.76E-02 kg
Secondary material outputs	
Waste fraction - metal - recycling cut-off	6.16E-02 kg
Wastewater treatment	
wastewater, average	2.82E-05 kg
Probability to litter plastic	
plastic litter	1.61E-03 kg

Table 2. Primary energy demand by carrier using CED method for an exemplary secondary material production process for recycled ABS pellets with a gate-to-gate boundary

Energy carrier	**Total energy input for 1kg of rABS pellets**
Gas, natural	4.54 MJ-Eq
Oil, crude	4.12 MJ-Eq
Coal, hard	1.76 MJ-Eq
Uranium	0.83 MJ-Eq
Coal, brown	0.25 MJ-Eq
Energy resources: non-renewable	11.53 MJ-Eq
Energy resources: renewable	1.58 MJ-Eq
Total	13.11 MJ-Eq

[1] This value expresses an aggregation of all polymer waste streams contributing to the EcoProfile inputs. Please find the disaggregated input values per-waste stream in the disaggregated datasets.

4 LCIA RESULTS

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

Impact Category	**Impact assessment**[2]	**Unit**
Acidification	1.08E-03 ± 1.05E-04	mol H+-Eq
Climate change	1.39 ± 0.12	kg CO2-Eq
Ecotoxicity: freshwater	3.40 ± 0.31	CTUe
Energy resources: non-renewable	3.83 ± 0.33	MJ, net calorific value
Eutrophication: freshwater	8.04E-05 ± 7.94E-06	kg P-Eq
Eutrophication: marine	4.72E-04 ± 3.51E-05	kg N-Eq
Eutrophication: terrestrial	3.71E-03 ± 2.92E-04	mol N-Eq
Human toxicity: carcinogenic	1.16E-09 ± 2.53E-10	CTUh
Human toxicity: non-carcinogenic	7.41E-09 ± 7.21E-10	CTUh
Ionising radiation: human health	2.80E-02 ± 2.53E-03	kBq U235-Eq
Land use	2.46 ± 1.15	dimensionless
Material resources: metals/minerals	4.01E-06 ± 6.25E-07	kg Sb-Eq
Ozone depletion	8.17E-09 ± 7.07E-10	kg CFC-11-Eq
Particulate matter formation	7.40E-09 ± 8.38E-10	disease incidence
Photochemical oxidant formation: human health	1.05E-03 ± 7.92E-05	kg NMVOC-Eq
Plastic litter	2.28E-02 ± 2.96E-03	kg
Water use	0.150 ± 0.011	m3 world Eq deprived

[2] The uncertainty value presented here has been calculated based on the foreground data. Details are described in the methodology.