



# EcoProfile of recycled PP pellets EU27+3, gate-to-gate, post-consumer

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



## 1 BACKGROUND INFORMATION

- The primary purpose of this document is to present an average life cycle inventory (LCI) and impact assessment (LCIA) for mechanically recycled polypropylene (rPP) pellets as result of the Horizon Project PRIMUS. The project seeks to provide a comprehensive understanding of and data for the environmental impacts associated with mechanically recycled plastics.
- rPP is a widespread material known for its thermal and mechanical properties, commonly used in packaging, automobiles and consumer goods. The usage of mechanically recycled PP reduces the use of fossil fuels and energy compared to the production of primary PP.
- Mechanical recycling of WEEE plastics waste involves collection, sorting, shredding, sorting to remove non-plastics (via magnetic separation and eddy-current separation), grinding, cleaning, drying and extrusion to produce rPP pellets.
- 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 rPP production. Data was collected from 9 sites in 2022 in Austria, Belgium, France, Germany, the Netherlands and the United Kingdom, represents the recycling of a mix of household, industrial and commercial wastes as well as ELV-WEEE wastes, and 5.58% 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 PP plastic recyclate pellets. The product under investigation is 1 kg of recycled PP pellets. The main production steps in mechanical recycling are included in the system boundaries of the EcoProfile are visualised in Figure 1.

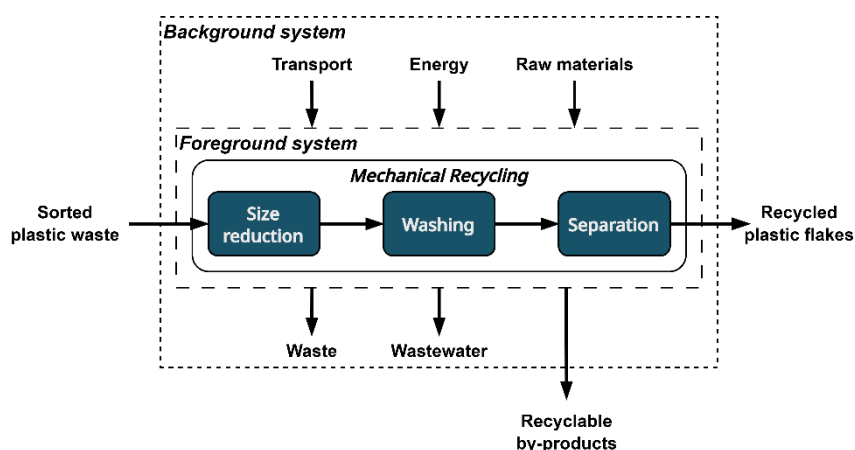


Figure 1: System description and boundaries. Following the PRE recycling scheme.

- The functional unit of the rPP EcoProfile is '**Production of 1 kg of mechanically recycled PP pellets, obtained from WEEE and household waste, at gate, unpackaged, representing 5.58% of European production**' where the reference flow of the rPP EcoProfile provided is '**1 kg of rPP 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 and EF 3.1 method.

### 3 LCI RESULTS

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

| <b>Incoming Material</b>                               | <b>Flow Quantities per 1 kg</b> |
|--|---------------------------------|
| Mixed plastic waste including impurities <sup>1</sup>  | 1.47 kg                         |
| <b>Material inputs</b>                                 |                                 |
| chemical, organic                                      | 3.00E-04 kg                     |
| Cleaning consumables, with water                       | 5.01E-05 kg                     |
| magnesium sulfate                                      | 1.23E-03 kg                     |
| polydimethylsiloxane                                   | 6.59E-05 kg                     |
| sodium chloride, powder                                | 1.18E-03 kg                     |
| sodium hydroxide, without water, in 50% solution state | 5.23E-05 kg                     |
| <b>Water consumption</b>                               |                                 |
| tap water  | 0.338 kg                        |
| <b>Energy</b>  |                                 |
| electricity, low voltage                               | 1.36 MJ                         |
| heat, district or industrial, natural gas              | 0.258 MJ                        |
| <b>Infrastructure</b>                                  |                                 |
| waste preparation facility                             | 2.00E-09 Item(s)                |
| <b>Transportation</b>                                  |                                 |
| Transport, forklift, propane-driven                    | 4.11E-05 t*km                   |
| transport, freight, lorry, unspecified                 | 3.95E-02 t*km                   |
| <b>Solid Waste</b>                                     |                                 |
| municipal solid waste                                  | 0.255 kg                        |
| raw sludge   | 7.80E-02 kg                     |
| waste mineral oil                                      | 2.68E-05 kg                     |
| waste plastic, mixture                                 | 2.36E-02 kg                     |
| <b>Secondary material outputs</b>                      |                                 |
| Waste fraction - diverse - recycling cut-off           | 1.11E-03 kg                     |
| Waste fraction - metal - recycling cut-off             | 6.95E-03 kg                     |
| <b>Wastewater treatment</b>                            |                                 |
| wastewater, average                                    | 5.30E-04 m <sup>3</sup>         |
| <b>Probability to litter plastic</b>                   |                                 |
| plastic litter   | 1.26E-03 kg                     |

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

| <b>Energy carrier</b>                  | <b>Total energy input for 1kg of rPP pellets</b> |
|--|--|
| Uranium                                | 1.42 MJ-Eq                                       |
| Gas, natural                           | 1.11 MJ-Eq                                       |
| Coal, hard                             | 0.40 MJ-Eq                                       |
| Coal, brown                            | 0.39 MJ-Eq                                       |
| Oil, crude                             | 0.31 MJ-Eq                                       |
| <b>Energy resources: non-renewable</b> | 3.64 MJ-Eq                                       |
| <b>Energy resources: renewable</b>     | 0.82 MJ-Eq                                       |
| <b>Total</b>                           | 4.45 MJ-Eq                                       |

<sup>1</sup> 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 rPP model related to 1 kg of pellets

| <b>Impact Category</b>                               | <b>Impact assessment<sup>2</sup></b> | <b>Unit</b>                      |
|--|--------------------------------------|----------------------------------|
| <i>Acidification</i>                                 | 9.63E-04 ± 1.15E-04                  | mol H <sup>+</sup> -Eq           |
| <i>Climate change</i>                                | 0.450 ± 0.029                        | kg CO <sub>2</sub> -Eq           |
| <i>Ecotoxicity: freshwater</i>                       | 2.42 ± 0.20                          | CTUe                             |
| <i>Energy resources: non-renewable</i>               | 3.47 ± 0.35                          | MJ, net calorific value          |
| <i>Eutrophication: freshwater</i>                    | 1.37E-04 ± 1.46E-05                  | kg P-Eq                          |
| <i>Eutrophication: marine</i>                        | 3.69E-04 ± 2.56E-05                  | kg N-Eq                          |
| <i>Eutrophication: terrestrial</i>                   | 1.87E-03 ± 1.93E-04                  | mol N-Eq                         |
| <i>Human toxicity: carcinogenic</i>                  | 7.81E-10 ± 2.44E-10                  | CTUh                             |
| <i>Human toxicity: non-carcinogenic</i>              | 4.77E-09 ± 5.82E-10                  | CTUh                             |
| <i>Ionising radiation: human health</i>              | 8.06E-02 ± 9.16E-03                  | kBq U235-Eq                      |
| <i>Land use</i>                                      | 1.68 ± 1.14                          | dimensionless                    |
| <i>Material resources: metals/minerals</i>           | 2.18E-06 ± 5.78E-07                  | kg Sb-Eq                         |
| <i>Ozone depletion</i>                               | 7.90E-08 ± 8.17E-09                  | kg CFC-11-Eq                     |
| <i>Particulate matter formation</i>                  | 8.49E-09 ± 8.70E-10                  | disease incidence                |
| <i>Photochemical oxidant formation: human health</i> | 6.33E-04 ± 5.63E-05                  | kg NMVOC-Eq                      |
| <i>Plastic litter</i>                                | 2.14E-02 ± 2.18E-03                  | kg                               |
| <i>Water use</i>                                     | 0.101 ± 0.010                        | m <sup>3</sup> world Eq deprived |

<sup>2</sup> The uncertainty value presented here has been calculated on the foreground data. Details are described in the methodology.