**Supporting Information for**

Life Cycle Assessment of Polyethylene Packaging and Alternatives on the European Market

Manfred TACKERa\*, Tasja HAFNER-KUHNa, Andrin GSTÖHLa; Experience NDUAGUb, Eric VOZZOLAc, Timothee W. ROUXc, Rafael AURASd

a Circular Analytics TK GmbH, Canovagasse 7/1/14, 1010 Wien, AUSTRIA

b ExxonMobil Technology and Engineering Company, 1545 Route 22 East, Annandale, NJ 08801, USA

c Exxon Mobil Corporation, 22777 Springwoods Village Pkwy Spring, TX 77389, USA

d School of Packaging, Michigan State University, East Lansing, MI 48824, USA

\*Corresponding author: Manfred Tacker

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1. Materials and Methods
2. Datasets used

In table S1 the following abbreviations apply: RER: Rest of Europe, RoW: Rest of the world, GLO: Glob-al, CH: Switzerland, DE: Germany, IN: India, AT: Austria, GB: Great Britain.

1. ecoinvent Data Sets (\* Release year of ecoinvent 3.8. Several different data sets were used.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | Name | Ecoinvent data set | Region | Reference period |
| Material | Aluminium, wrought alloy EU | market for aluminium, primary, ingot | aluminium, primary, ingot | IAI Area, EU27 & EFTA | 2010-2021 |
| APET, granulate | polyethylene terephthalate production, granulate, amorphous | polyethylene terephthalate, granulate, amorphous | Cutoff, U | RER | 1999-2021 |
| Corrugated board base paper: fluting medium | containerboard production, fluting medium, semichemical | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| Corrugated board base paper: Kraftliner | containerboard production, linerboard, kraftliner | containerboard, linerboard | Cutoff, U | RER | 2009-2021 |
| Corrugated board base paper: Testliner | containerboard production, linerboard, testliner | containerboard, linerboard | Cutoff, U | RER | 2009-2021 |
| Cotton fibre | fibre production, cotton, ginning | fibre, cotton | Cutoff, U - IN | IN | 2016-2021 |
| Folding Boxboard | folding boxboard production | folding boxboard/chipboard | Cutoff, U | RER | 2018-2021 |
| Glass, brown | packaging glass production, white | packaging glass, white | Cutoff, U, incl. recycling content | DE | 1996-2021 |
| Glass, green | packaging glass production, white | packaging glass, white | Cutoff, U, incl. recycling content | DE | 1996-2021 |
| Glass, white | packaging glass production, white | packaging glass, white | Cutoff, U, incl. recycling content | DE | 1996-2021 |
| HDPE, granulate | polyethylene production, high density, granulate | polyethylene, high density, granulate | Cutoff, U | RER | 2011-2021 |
| Kraft paper mixed | kraft paper production | kraft paper | Cutoff, U | RER | 2015-2021 |
| LDPE, granulate | polyethylene production, low density, granulate | polyethylene, low density, granulate | Cutoff, U | RER | 2011-2021 |
| LLDPE, granulate | polyethylene production, linear low density, granulate | polyethylene, linear low density, granulate | Cutoff, U | RER | 2011-2021 |
| Paper Sack, excl. plastic | paper sack production | paper sack | Cutoff, U - without plastic | RER | 2015-2021 |
| Paper, Pulp | sulfate pulp production, from softwood, unbleached | sulfate pulp, unbleached | Cutoff, U | RER | 2017-2021 |
| Paper, woodfree, coated | paper production, woodfree, coated, at integrated mill | paper, woodfree, coated | Cutoff, U | RER | 2000-2021 |
| Paper, woodfree, uncoated | paper production, woodfree, uncoated, at integrated mill | paper, woodfree, uncoated | Cutoff, U | RER | 2000-2021 |
| PET, granulate (bottle) | polyethylene terephthalate production, granulate, bottle grade | polyethylene terephthalate, granulate, bottle grade | Cutoff, U | RER | 2015-2021 |
| PP, granulate | polypropylene production, granulate | polypropylene, granulate | Cutoff, U | RER | 2011-2021 |
| PS, granulate (general purpose) | polystyrene production, general purpose | polystyrene, general purpose | Cutoff, U | RER | 2001-2021 |
| PVC, bulk polymerisation | polyvinylchloride production, bulk polymerisation | polyvinylchloride, bulk polymerised | Cutoff, U | RER | 1998-2021 |
| Solid board mixed | solid bleached and unbleached board carton production | solid bleached and unbleached board carton | Cutoff, U | RER | 2018-2021 |
| Stahl, converter, low-alloyed | steel production, converter, low-alloyed | steel, low-alloyed | Cutoff, U | RER | 2013-2023 |
| Synthetic elastomer | synthetic rubber production | synthetic rubber | RER | 1995-2021 |
| Tinplated steel sheet | Modelled by Circular Analytics, based on ecoinvent 3.8 | GLO | 2021\* |
| Production | Aluminium tube production | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Blow moulding | blow moulding | blow moulding | Cutoff, U | RER | 1993-2021 |
| Can and cap production (aluminium) | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Canister and can production | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Coextrusion (tubes) | extrusion, co-extrusion of plastic sheets | extrusion, co-extrusion | Cutoff, U | RoW | 2012-2021 |
| Fibre moulding | Modelled by Circular Analytics, based on ecoinvent 3.8 | AT | 2021\* |
| Foaming (polymers) | polymer foaming | polymer foaming | Cutoff, U | RER | 1995-2021 |
| Film shrinking | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Hot rolling, steel | hot rolling, steel | hot rolling, steel | Cutoff, U | RER w/o AT | 1997-2021 |
| Injection moulding | injection moulding | injection moulding | Cutoff, U | RER | 1993-2021 |
| Laminating without solvent | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Metallisation | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Sheet rolling, aluminium | sheet rolling, aluminium | sheet rolling, aluminium | Cutoff, U | RER | 2000-2021 |
| stretch blow moulding (PET hollow bodies) | stretch blow moulding | stretch blow moulding | Cutoff, U | RER | 1993-2021 |
| Tinplated steel sheet production | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Spinning & weaving | Modelled by Circular Analytics, based on ecoinvent 3.8 | RER | 2021\* |
| Wire drawing (steel) | wire drawing, steel | wire drawing, steel | Cutoff, U | RER | 1997-2021 |
| Energy | Europe | market (group) for electricity, medium voltage | electricity, medium voltage | Cutoff, U | RER | 2015-2021 |
| Germany | market for electricity, medium voltage | electricity, medium voltage | Cutoff, U | DE | 2014-2021 |
| Renewable energy mix | market for electricity, medium voltage, renewable energy products | electricity, medium voltage, renewable energy products | Cutoff, U | CH | 2011-2021 |
| United Kingdom | market for electricity, medium voltage | electricity, medium voltage | Cutoff, U | GB | 2014-2021 |
| Transport | Container ship | transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U | GLO | 2007-2021 |
| Freight train | market for transport, freight train | transport, freight train | Cutoff, U | RER | 2016-2021 |
| Truck EURO 5 | transport, freight, lorry >32 metric ton, EURO5 | transport, freight, lorry >32 metric ton, EURO5 | Cutoff, U | RER | 2009-2021 |
| Van | transport, freight, light commercial vehicle | transport, freight, light commercial vehicle | Cutoff, U | RER w/o CH | 2005-2021 |
| Recycling | Aluminium, wrought alloy EU | Modelled by Circular Analytics, based on ecoinvent 3.8 (see paragraphs below). Recycling market for treatment aluminium scrap, (pre-post-consumer) Aluminium, at remelter, wrought alloy, RER | RER | 2021\* |
| APET, granulate | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| Corrugated board base paper: fluting medium | containerboard production, fluting medium, recycled | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| Corrugated board base paper: Kraftliner | containerboard production, linerboard, testliner | containerboard, linerboard | Cutoff, U | RER | 2009-2021 |
| Corrugated board base paper: Testliner | containerboard production, linerboard, testliner | containerboard, linerboard | Cutoff, U | RER | 2009-2021 |
| Cotton fibre | Not recycled |  |  |
| Folding Boxboard | containerboard production, fluting medium, recycled | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| Glass, brown | packaging glass production, green | packaging glass, green | Cutoff, U | DE | 2000-2021 |
| Glass, green | packaging glass production, green | packaging glass, green | Cutoff, U | DE | 2000-2021 |
| Glass, white | packaging glass production, green | packaging glass, green | Cutoff, U | DE | 2000-2021 |
| HDPE, granulate | Own Data sets (Appendix B, Table 13) | AT |  |
| Kraft paper mixed | containerboard production, fluting medium, recycled | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| LDPE, granulate | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| LLDPE, granulate | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| Paper Sack, excl. plastic | containerboard production, fluting medium, recycled | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| Paper, Pulp | treatment of waste paper to pulp, wet lap, totally chlorine free bleached | deinked pulp, wet lap | Cutoff, U | RoW | 2007-2021 |
| Paper, woodfree, coated | paper production, woodfree, uncoated, 100% recycled content, at non-integrated mill | paper, woodfree, uncoated | Cutoff, U | RER | 2000-2021 |
| Paper, woodfree, uncoated | paper production, woodfree, uncoated, 100% recycled content, at non-integrated mill | paper, woodfree, uncoated | Cutoff, U | RER | 2000-2021 |
| PET, granulate (bottle) | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| PP, granulate | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| PS, granulate (general purpose) | Modelled by Circular Analytics, based on ecoinvent 3.8 (Appendix B, Table 10) | AT | 2021\* |
| Solid board mixed | containerboard production, fluting medium, recycled | containerboard, fluting medium | Cutoff, U | RER | 2009-2021 |
| Stahl, converter, low-alloyed | steel production, electric, low-alloyed | steel, low-alloyed | Cutoff, U | RER w/o CH & AT | 2013-2021 |
| Synthetic elastomer | No recycling |  |  |
| Tinplated steel sheet | steel production, electric, low-alloyed | steel, low-alloyed | Cutoff, U | RER w/o CH & AT | 2013-2021 |
| Waste to  energy (incineration) | Aluminium, wrought alloy EU | treatment of scrap aluminium, municipal incineration | scrap aluminium | Cutoff, U | CH | 1994-2021 |
| APET, granulate | treatment of waste polyethylene terephthalate, municipal incineration | waste polyethylene terephthalate | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: fluting medium | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: Kraftliner | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: Testliner | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Cotton fibre | treatment of waste textile, soiled, municipal incineration | waste textile, soiled | Cutoff, U | CH | 1994-2021 |
| Folding Boxboard | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Glass, brown | treatment of waste glass, municipal incineration | waste glass | Cutoff, U | CH | 1994-2021 |
| Glass, green | treatment of waste glass, municipal incineration | waste glass | Cutoff, U | CH | 1994-2021 |
| Glass, white | treatment of waste glass, municipal incineration | waste glass | Cutoff, U | CH | 1994-2021 |
| HDPE, granulate | treatment of waste polyethylene, municipal incineration | waste polyethylene | Cutoff, U | CH | 1994-2021 |
| Kraft paper mixed | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| LDPE, granulate | treatment of waste polyethylene, municipal incineration | waste polyethylene | Cutoff, U | CH | 1994-2021 |
| LLDPE, granulate | treatment of waste polyethylene, municipal incineration | waste polyethylene | Cutoff, U | CH | 1994-2021 |
| Paper Sack, excl. plastic | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, Pulp | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, woodfree, coated | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, woodfree, uncoated | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| PET, granulate (bottle) | treatment of waste polyethylene terephthalate, municipal incineration | waste polyethylene terephthalate | Cutoff, U | CH | 1994-2021 |
| PP, granulate | treatment of waste polypropylene, municipal incineration | waste polypropylene | Cutoff, U | CH | 1994-2021 |
| PS, granulate (general purpose) | treatment of waste polystyrene, municipal incineration | waste polystyrene | Cutoff, U | CH | 1994-2021 |
| PVC | treatment of waste polyvinylchloride, municipal incineration | waste polyvinylchloride | Cutoff, U | CH | 1994-2021 |
| Solid board mixed | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Stahl, converter, low-alloyed | treatment of scrap steel, municipal incineration | scrap steel | Cutoff, U | Europe w/o Switzerland | 2006-2021 |
| Synthetic elastomer | treatment of waste rubber, unspecified, municipal incineration | waste rubber, unspecified | Cutoff, U | Europe w/o Switzerland | 2006-2021 |
| Tinplated steel sheet | treatment of scrap tin sheet, municipal incineration | scrap tin sheet | Cutoff, U | CH | 1994-2021 |
| Landfill | Aluminium, wrought alloy EU | treatment of waste aluminium, sanitary landfill | waste aluminium | Cutoff, U | CH | 1994-2021 |
| APET, granulate | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: fluting medium | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: Kraftliner | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Corrugated board base paper: Testliner | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Cotton fibre | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Folding Boxboard | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Glass, brown | treatment of waste glass, inert material landfill | waste glass | Cutoff, U | CH | 1995-2021 |
| Glass, green | treatment of waste glass, inert material landfill | waste glass | Cutoff, U | CH | 1995-2021 |
| Glass, white | treatment of waste glass, inert material landfill | waste glass | Cutoff, U | CH | 1995-2021 |
| HDPE, granulate | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| Kraft paper mixed | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| LDPE, granulate | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| LLDPE, granulate | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| Paper Sack, excl. plastic | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, Pulp | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, woodfree, coated | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Paper, woodfree, uncoated | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| PET, granulate (bottle) | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| PP, granulate | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| PS, granulate (general purpose) | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| PVC, bulk polymerisation | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| Solid board mixed | treatment of waste paperboard, sanitary landfill | waste paperboard | Cutoff, U | CH | 1994-2021 |
| Steel, converter, low-alloyed | treatment of scrap steel, inert material landfill | scrap steel | Cutoff, U | RER w/o CH | 2006-2021 |
| Synthetic elastomer | treatment of waste plastic, mixture, sanitary landfill | waste plastic, mixture | Cutoff, U | CH | 1994-2021 |
| Tinplated steel sheet | treatment of scrap tin sheet, sanitary landfill | scrap tin sheet | Cutoff, U | CH | 1994-2021 |

1. Transport Distances
2. Transports NR: not relevant, in Ei: in the ecoinvent data set included, NI: no information, CutO: Cut-off |Life cycle phases: MP: Raw material & production phase, TP: Transport phase, DP: Distribution phase, EOL: End of life phase | PEFCR: Product Environmental Footprint Category Rules Guidance | (European Commission 2018)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | |
| Transport | | Flow | Transport mode | PEFCR | | Modelled | | Life Cycle Phase |
| EUR [km] | GER&UK [km] | EUR [km] | GER&UK [km] |
| T1 | Raw material to pre-production | F1 | NR | NR | NR | inEi | inEi | MP |
| T2 | Pre-product to production | F2 | Truck | 230 | 230 | 230 | 230 | MP |
| Train | 280 | 280 | 280 | 280 |
| Ship | 360 | 360 | 360 | 360 |
| T3 | Production to filler | F3 | Truck | 3500 | 1200 | 1750 | 600 | TP |
| T4 | Filler to DC | F4 | 1750 | 600 | DP |
| T5 | DC to retailer | F5 | Truck | (250) | (250) | 250 | 250 | DP |
| T6 | Retailer to consumer | F6 | NR | NR | NR | CutO | CutO | NR |
| T7.1 | Waste collection (Recycling) | F7.1 | Truck | NI | NI | inEi | inEi | EOL |
| T7.2 | Waste collection (incineration) | F7.2 | Truck | NI | NI | 100 | 100 | EOL |
| T7.3 | Waste collection (landfill) | F7.3 | Truck | NI | NI | 100 | 100 | EOL |
| T8 | Sorting to recycling | F8 | Truck | NI | NI | 100 | 100 | EOL |

1. Recycling Rate and EOL
2. EOL rates European average (Eurostat 2024, 2023; European Aluminium Foil Association 2024; APEAL 2024):

|  |  |  |  |
| --- | --- | --- | --- |
| European Average | Recycling [2018/20] | Incineration (W2E) [2018] | Landfill [2018] |
| Plastic | 41.4%\* | 30.3% | 28.4% |
| Paper | 84.2%\* | 8.2% | 7.6% |
| Glass | 75.8%\* | 12.5% | 11.7% |
| Steel | 85.5%\*\* | 7.5% | 7.0% |
| Aluminium | 55.0%\*\* | 23.2% | 21.8% |

1. EOL rates Germany | source s: (Eurostat 2024; Umwelt Bundesamt 2024)

|  |  |  |  |
| --- | --- | --- | --- |
| Germany | Recycling [2020] | Incineration (W2E) [2020] | Landfill [2020] |
| Plastic | 46.2% | 53.8% | 0% |
| Paper | 84.2% | 15.8% | 0.0% |
| Glass | 79.7% | 4.5% | 15.8% |
| Steel | 87.5% | 5.4% | 7.1% |
| Aluminium | 62.1% | 36.5% | 1.4% |

1. EOL rates UK | sources: (UK Government 2024).

|  |  |  |  |
| --- | --- | --- | --- |
| United Kingdom | Recycling [2020] | Incineration (W2E) [2017] | Landfill [2017] |
| Plastic | 47.2% | 36.5% | 16.3% |
| Paper | 69.1% | 21.4% | 9.6% |
| Glass | 74.2% | 17.8% | 8.0% |
| Steel | 81.7% | 12.6% | 5.7% |
| Aluminium | 71.5% | 19.7% | 8.8% |

1. Heating Values
2. Heating Values | Ew/oS: Europe without Switzerland | XX: According to ecoinvent

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | MJ/kg | kWh/kg | Source: Ecoinvent data set | Land |
| PET | XX | XX | treatment of waste polyethylene terephthalate, municipal incineration | waste polyethylene terephthalate | Cutoff, U | CH |
| Glass | XX | XX | treatment of waste glass, municipal incineration | waste glass | Cutoff, U | CH |
| Paperboard | XX | XX | treatment of waste paperboard, municipal incineration | waste paperboard | Cutoff, U | CH |
| plastic, mixed | XX | XX | treatment of waste plastic, mixture, municipal incineration | waste plastic, mixture | Cutoff, U | CH |
| PE | XX | XX | treatment of waste polyethylene, municipal incineration | waste polyethylene | Cutoff, U | CH |
| PP | XX | XX | treatment of waste polypropylene, municipal incineration | waste polypropylene | Cutoff, U | CH |
| PS | XX | XX | treatment of waste polystyrene, municipal incineration | waste polystyrene | Cutoff, U | CH |
| PVC | XX | XX | treatment of waste polyvinylchloride, municipal incineration | waste polyvinylchloride | Cutoff, U | CH |
| Rubber | XX | XX | treatment of waste rubber, unspecified, municipal incineration | waste rubber, unspecified | Cutoff, U | CH |
| Aluminium | XX | XX | treatment of scrap aluminium, municipal incineration | scrap aluminium | Cutoff, U - CH | CH |
| Tinplated steel sheet | XX | XX | treatment of scrap tin sheet, municipal incineration | scrap tin sheet | Cutoff, U - Europe w/o Switzerland | CH |
| Steel | XX | XX | treatment of scrap steel, municipal incineration | scrap steel | Cutoff, U | Ew/oS |

1. Post-Consumer Recycled Content
2. Materials with recycled content.

|  |  |
| --- | --- |
| Material | PCR content |
| Plastics | 0% |
| Aluminium | 0% |
| Tinplated steel sheet | 20% |
| Steel | 20% |
| Chromium steel | 55% |
| Paper & Pulp | 0% |
| Folding boxboard | 5% |
| Corrugated cardboard, raw paper: corrugating medium | 10% |
| Corrugated cardboard, raw paper: kraft liner | 41% |
| Corrugated cardboard, raw paper: test liner | 100% |
| Corrugated board box production | 10%-100% (layer-dependent) |
| Solid board mixed | 0% |
| Glass, white | 63% |
| Glass, green | 85% |
| Glass, brown | 69% |
| Cotton fibre | 0% |
| Paper sacks | 0% |

1. Material Factor

The material factor determines how much raw material must be used to produce 1 unit of reference flow. It describes how much production waste occurs or how much raw material input is required. | \*Materials where offcut is included in ecoinvent data sets.

1. Material Factor

|  |  |  |
| --- | --- | --- |
| Process | Material factor | Data set |
| Aluminium tube production | 1.260 | Own data set |
| Blow moulding | Acc. to ecoinvent | blow moulding | blow moulding | Cutoff, U |
| Calendering (rigid sheets) | Acc. to ecoinvent | calendering, rigid sheets | calendering, rigid sheets | Cutoff, U |
| Can and cap production (aluminium) | 1.260 | Own data set |
| Canister and can production | 1.260 | Own data set |
| Coextrusion (tubes) | Acc. to ecoinvent | extrusion, co-extrusion of plastic sheets | extrusion, co-extrusion | Cutoff, U |
| Deep drawing (cups and trays, without extrusion) | Acc. to ecoinvent | thermoforming of plastic sheets | thermoforming of plastic sheets | Cutoff, U |
| Deep drawing, with calendering | Acc. to ecoinvent | thermoforming, with calendering | thermoforming, with calendering | Cutoff, U |
| Extrusion (Films) | Acc. to ecoinvent | extrusion, plastic film | extrusion, plastic film | Cutoff, U |
| Extrusion und deep drawing (cups & trays) | Acc. to ecoinvent | extrusion of plastic sheets and thermoforming, inline | extrusion of plastic sheets and thermoforming, inline | Cutoff, U |
| Fibre moulding | 1.000 | Own data set |
| Foaming (polymers) | Acc. to ecoinvent | polymer foaming | polymer foaming | Cutoff, U |
| Film shrinking | 1.000 | Own Data sets |
| Hot rolling, steel | Acc. to ecoinvent | hot rolling, steel | hot rolling, steel | Cutoff, U |
| Injection moulding | Acc. to ecoinvent | injection moulding | injection moulding | Cutoff, U |
| Laminating with solvent | 1.028 | Own data set |
| Laminating without solvent | 1.028 | Own data set |
| Metallisation | 1.000 | Own data set |
| Sheet rolling, aluminium | Acc. to ecoinvent | sheet rolling, aluminium | sheet rolling, aluminium | Cutoff, U |
| stretch blow moulding (PET hollow bodies) | Acc. to ecoinvent | stretch blow moulding | stretch blow moulding | Cutoff, U |
| Tinplated steel sheet production | 1.050 | Own data set |
| Spinning | 1.225 | Own data set |
| Wire drawing (steel) | Acc. to ecoinvent | wire drawing, steel | wire drawing, steel | Cutoff, U |
| Glass data sets\* | 1.000 |  |
| Paper and cardboard related data sets\* | 1.000 |  |

1. Circular Footprint Formula CFF
2. CFF, PEF Default Values

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Material | A | B | Qsin/ Qp | Qsout/Qp | XER, elec | XER, heat |
| APET, granulate | 0.5 | 0 | 1 | 1 | 11% | 32% |
| EVA\* | 1 | 0 | 0 | 0 | 11% | 32% |
| HDPE, granulate | 0.5 | 0 | 0.9 | 0.9 | 11% | 32% |
| LDPE, granulate | 0.5 | 0 | 0.75 | 0.75 | 11% | 32% |
| LLDPE, granulate | 0.5 | 0 | 0.75 | 0.75 | 11% | 32% |
| PET, granulate | 0.5 | 0 | 1 | 1 | 11% | 32% |
| PP, granulate | 0.5 | 0 | 0.9 | 0.9 | 11% | 32% |
| PS, granulate | 0.5 | 0 | 0.9 | 0.9 | 11% | 32% |
| PVC\* | 1 | 0 | 0 | 0 | 11% | 32% |
| Aluminium, wrought alloy EU | 0.2 | 0 | 1 | 1 | 11% | 32% |
| Tinplated steel sheet | 0.2 | 0 | 1 | 1 | 11% | 32% |
| Steel, electric, chromium steel 18/8 | 0.2 | 0 | 1 | 1 | 11% | 32% |
| Steel, converter, low-alloyed | 0.2 | 0 | 1 | 1 | 11% | 32% |
| Folding box board | 0.2 | 0 | 0.85 | 0.85 | 11% | 32% |
| Core board | 0.2 | 0 | 0.85 | 0.85 | 11% | 32% |
| Solid Board / Corrugated cardboard / Paper /Kraft Paper | 0.2 | 0 | 0.85 | 0.85 | 11% | 32% |
| White lined chipboard | 0.2 | 0 | 0.85 | 0.85 | 11% | 32% |
| Glass | 0.2 | 0 | 1 | 1 | 11% | 32% |
| Cotton fibre\* | 1 | 0 | 0 | 0 | 11% | 32% |
| Source | PEF: Annex C  \*exceptions: If A=1: Erecycled=0. Furthermore, A=1 sets burdens & credits from the recycling process to 0. This is to prevent burdens and credits from being generated for e.g. PVC, although there is actually no recycling stream for the material. In fact, these factors are not used since a recycling rate of 0% is provided for in all examples anyway. | | | |  | |

1. CFF, Study-specific Values

|  |  |
| --- | --- |
| Parameter | Description |
| R1 | Proportion of secondary raw material (recycled content) [0-1] (depends on product system; 0 when possible – depends on data set) |
| R2 | Proportion of material for EOL recycling [0-1] (depends on product system and scenario) |
| R3 | Proportion of material for energy recovery [0-1] (depends on product system and scenario) |
| Erecycled | Emissions from recycling data set |
| ErecyclingEOL | = Erecycled |
| Ev | Emissions of primary material data set (material data set + electrical energy consumption) |
| E\*v | = Ev |
| EER | Values from ecoinvent data set: treatment of waste municipal incineration (material (group) specific)) |
| Ese, heat | Market for heat data set is substituted (Composition according to EIA) (market for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, U; market for heat, district or industrial, other than natural gas | heat, district or industrial, other than natural gas | Cutoff, U |
| Ese, elec | Average energy mix of EUR/ GER/ UK is substituted (same data set as used in production phase) |
| ED | Values from ecoinvent data set: treatment of waste, sanitary landfill (material [group] specific) |
| LHV | Values from ecoinvent data set: treatment of waste, incineration (material [group] specific) |
| Production | No parameter. Emissions are added in the material part of the formula in the term. |

1. Flow Charts: Raw material to package manufacturing

All flow charts show the raw material and production phase of the product referred to in the title.

## Collation Shrinks

Cans 0.33 L x 6/ Cans 0.5 L x 6/ Bottles 0.5 L x 6/ Bottles 1.5L x 6

Flow Chart: Collation Shrinks – Shrink Film

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Flow Chart: Collation Shrinks – Paperboard Wrap

Ein Bild, das Text, Screenshot, Display, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Collation Shrinks – Cardboard Can Carrier & Cardboard Bottle Carrier

Ein Bild, das Text, Screenshot, Diagramm, Display enthält.

Automatisch generierte Beschreibung

## Tertiary Stretch Packaging for Pallets/ Shipping: Stretch Wraps

Flow Chart: Tertiary Stretch Packaging for Pallets/Shipping – LLDPE Stretch Film

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Flow Chart: Tertiary Stretch Packaging for Pallets/ Shipping – Paper Stretch Wrap

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Rigid Packaging Non-Food

Body Lotion 150 mL

Flow Chart: Body Lotion 150 mL – HDPE Bottle

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Flow Chart: Body Lotion 150 mL – Aluminium Can

Ein Bild, das Text, Screenshot, Diagramm, Zahl enthält.

Automatisch generierte Beschreibung

Flow Chart: Body Lotion 150 mL – Glass Jar

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Body Lotion 250 mL

Flow Chart: Body Lotion 250 mL – Paper Bottle

Ein Bild, das Text, Diagramm, Screenshot, Plan enthält.

Automatisch generierte Beschreibung

Flow Chart: Body Lotion 250 mL – HDPE Bottle

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Shampoo 500 mL

Flow Chart: Shampoo 500 mL – Glass Bottle

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Shampoo 500 mL – HDPE Bottle

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Liquid Detergent 1.5 L

Flow Chart: Liquid Detergent 1.5 L – HDPE Bottle

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Flow Chart: Liquid Detergent 1.5 L – Paper Bottle

Ein Bild, das Text, Diagramm, Screenshot, Plan enthält.

Automatisch generierte Beschreibung

Household Cleaner 1 L

Flow Chart: Household Cleaner 1 L – Glass Bottle

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Household Cleaner 1 L - HDPE Bottle

Ein Bild, das Text, Screenshot, Schrift, Diagramm enthält.

Automatisch generierte Beschreibung

Flow Chart: Household Cleaner 1 L – Paper Bottle

Ein Bild, das Text, Diagramm, Screenshot, Plan enthält.

Automatisch generierte Beschreibung

Motor Oil 1 L

Flow Chart: Motor Oil 1 L – Tinplated Steel Canister

Ein Bild, das Text, Screenshot, Diagramm, parallel enthält.

Automatisch generierte Beschreibung

Flow Chart: Motor Oil 1 L – HDPE Canister

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Dietary Supplements 140 mL

Flow Chart: Dietary Supplements 140 mL – HDPE Bottle

Ein Bild, das Text, Diagramm, Screenshot, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Dietary Supplements 140 mL – Glass Bottle

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Wall Paint 2.7 L

Flow Chart: Wall Paint 2.7 L – HDPE Bucket

Ein Bild, das Text, Screenshot, Schrift, Zahl enthält.

Automatisch generierte Beschreibung

Flow Chart: Wall Paint 2.7 L – Tinplated Steel Bucket

Ein Bild, das Text, Screenshot, Diagramm, Zahl enthält.

Automatisch generierte Beschreibung

Wall Paint 10 L

Flow Chart: Wall Paint 10 L – HDPE Bucket

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Wall Paint 10 L – Tinplated Steel Bucket

Ein Bild, das Text, Screenshot, Schrift, Zahl enthält.

Automatisch generierte Beschreibung

## Heavy Duty Sacks

Pre-Mixed Cement 10 kg

Flow Chart: Pre-Mixed Cement 10 kg – Plastic HDS

A diagram of a production process

Description automatically generated

Flow Chart: Pre-Mixed Cement 10 kg – Paper HDS with Plastic Layer

A diagram of a production process

Description automatically generated

Cement 25 kg

Flow Chart: Cement 25 kg – Plastic HDS

A diagram of a production process

Description automatically generated

Flow Chart: Cement 25 kg – Paper HDS with Plastic Layer

A diagram of a production process

Description automatically generated

Chicken Fodder 20 kg

Flow Chart: Chicken Fodder 20 kg – Plastic HDS

A diagram of a production process

Description automatically generated

Flow Chart: Chicken Fodder 20 kg – Paper HDS with Plastic Layer

A diagram of a production process

Description automatically generated

Organic Fertiliser 10.5 kg

Flow Chart: Organic Fertiliser 10.5 kg – Plastic HDS

A diagram of a process

Description automatically generated

Organic Fertiliser 10.5 kg – Paper HDS

A diagram of a paper sack production

Description automatically generatedFertiliser 20 kg

Flow Chart: Fertiliser 20 kg – Plastic HDS

A diagram of a production process

Description automatically generated

Flow Chart: Fertiliser 20 kg – Paper HDS with Plastic Layer

A diagram of a production process

Description automatically generated

Wood Pellets 15 kg

Wood Pellets 15 kg – Plastic HDS

A diagram of a process

Description automatically generated

Wood Pellets 15 kg – Paper HDS

A diagram of a paper sack production

Description automatically generated

## Flexible Packaging

Frozen Mangos 500 g

Flow Chart: Frozen Mangos 500 g – LDPE/PET Stand-Up Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Frozen Mangos 500 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Frozen Raspberries 250 g

Flow Chart: Frozen Raspberries 250 g – LDPE Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Frozen Raspberries 250 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Frozen Herbs 75 g

Flow Chart: Frozen Herbs 75 g – LDPE/PET Stand-Up Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Frozen Herbs 75 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Frozen Peas 300 g

Flow Chart: Frozen Peas 300 g – LDPE Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Frozen Peas 300 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Frozen Pizza Bread 300 g

Flow Chart: Pizza Bread 300 g – LDPE/PET Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Pizza Bread 300 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Frozen Pizza 430 g

Appendix F, Figure 48: Flow Chart: Pizza 430 g – Shrink Film | \* The process is actually arranged after the filler but is shown differently for reasons of simplification.

A diagram of a process

Description automatically generated

Flow Chart: Pizza 430 g – Laminated Paper Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Pizza 430 g – Laminated Paperboard Box

A diagram of a production process

Description automatically generated

Flow Chart: Pizza 430 g – Paperboard Box and Shrink Film | \* The process is actually arranged after the filler but is shown differently for reasons of simplification.

A diagram of a production process

Description automatically generated

Coffee 250 g

Flow Chart: Coffee 250 g – LDPE/PP Gusseted Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Coffee 250 g – PET/Alu/PE Gusseted Pouch

A diagram of a production process

Description automatically generated

Coffee 250 g – Paper/PE Gusseted Pouch

A diagram of a process flow

Description automatically generated

Coffee 250 g – Tinplate Can

A diagram of a process

Description automatically generated

Instant Coffee 250 g

Instant Coffee 250 g – PET/Alu/PE Gusseted Pouch

A diagram of a production process

Description automatically generated

Instant Coffee 250 g – Tinplate Can

A diagram of a manufacturing process

Description automatically generated

Flow Chart: Instant Coffee 250 g – Glass Container

A diagram of a production process

Description automatically generated

Hot Chocolate Powder 350 g

A diagram of a production process

Description automatically generatedFlow Chart: Hot Chocolate Powder 350 g – LDPE/PET Pouch

Flow Chart: Hot Chocolate Powder 350 g – Paperboard Box

A diagram of a solid board

Description automatically generated

Flow Chart: Hot Chocolate Powder 350 g – Paperboard Box and Coated Paper Bag

A diagram of a production process

Description automatically generated

Mayonnaise 250 g

Mayonnaise 250 g – LDPE Spouted Stand-Up Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Mayonnaise 250 g – Aluminium Tube

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Mayonnaise 250 g – Glass Jar

A diagram of a glass jar production

Description automatically generated

Apples 1 kg

Flow Chart: Apples 1 kg – LDPE Bag

A diagram of a production process

Description automatically generated

Flow Chart: Apples 1 kg – Cardboard Tray

A diagram of a process

Description automatically generated

Flow Chart: Apples 1 kg – Paperboard Tray and LDPE Film

Ein Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Produce Bags 1 kg

Flow Chart: Produce Bags 1 kg – LDPE Bag

A diagram of a production process

Description automatically generated

Flow Chart: Produce Bags 1 kg – Paper Bag

A diagram of a production process

Description automatically generated

Juice 200 mL

Flow Chart: Juice 200 mL – PET/Alu/PE Stand-Up Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Juice 200 mL – Beverage Carton

Ein Bild, das Text, Diagramm, Screenshot, Plan enthält.

Automatisch generierte Beschreibung

Flow Chart: Juice 200 mL – Non-Returnable Glass Bottle

A diagram of a production process

Description automatically generated

Sugar 1 kg

Flow Chart: Sugar 1 kg – LDPE/PET Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Sugar 1 kg – Paper Bag

Ein Bild, das Text, Screenshot, Diagramm, Design enthält.

Automatisch generierte Beschreibung

Flow Chart: Sugar 1 kg – Gable Top

Ein Bild, das Text, Diagramm, Screenshot, parallel enthält.

Automatisch generierte Beschreibung

Salt 750 g

Flow Chart: Salt 750 g – LDPE Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Salt 750 g – Paperboard Tube and Plastic Lid

Ein Bild, das Text, Screenshot, Diagramm, Rechteck enthält.

Automatisch generierte Beschreibung

Flow Chart: Salt 750 g – Paperboard Box

Ein Bild, das Text, Screenshot, Schrift, Reihe enthält.

Automatisch generierte Beschreibung

Cashew Nuts 150 g

Flow Chart: Cashew Nuts 150 g – Metallised LDPE Pillow Pouch

A diagram of a production process

Description automatically generated

Flow Chart: Cashew Nuts 150 g – Paper Stand-Up PouchEin Bild, das Text, Screenshot, Diagramm, Schrift enthält.

Automatisch generierte Beschreibung

Flow Chart: Cashew Nuts 150 g – Tinplate Can

A diagram of a process

Description automatically generated

Potatoes 1.5 kg

Potatoes 1.5 kg – LDPE Bag

A diagram of a production process

Description automatically generated

Flow Chart: Potatoes 1.5 kg – Gusseted Paper Sack

A diagram of a paper sack production

Description automatically generated

1. Recyclability assessment

The following steps were conducted for the calculation of the technical recyclability:

* Definition of the disposal unit
* Determination of the recycling streams
* Classification of the materials
* Calculation of the technical recyclability

The classification is conducted according to the following scheme:

1. Classification of Technical Recyclability

|  |  |  |
| --- | --- | --- |
| Level | Classification | Definition |
| A | Good  compatibility | The material can be recycled in the incoming material stream and the recycled material used for material-identical, high-quality applications. Here it can be assumed that the recycled material obtained is suitable for circular applications. |
| B | Limited  compatibility | The material can be recycled in the incoming material stream, but the quality of the recycled material is impaired. In addition, the recycled material quality of other materials in the disposal unit will be negatively affected. The obtained recycled material is mainly used for downcycling applications. |
| C | Poor  compatibility | The material cannot be recycled in the incoming material stream, but the recyclability and recycled material quality of other materials in the packaging unit is not affected. |
| D | No  compatibility | The material cannot be recycled in the incoming material stream and potentially negatively affects the recyclability and recycled material quality of other materials in the disposal unit. This may limit the application areas of recovered recycled material from other materials from circular applications to downcycling. |
| X | Knock-out | The material cannot be recycled in the incoming material stream and leads to contamination of the disposal unit. All materials in the disposal unit that are recycled with this material during the recycling process are considered contaminated and therefore not recyclable. In addition, this rating is also assigned if packaging main bodies are incorrectly sorted (major loss of recyclability) or if disposal units are immediately assigned to the thermal fraction due to their size. |

To calculate the technical recyclability, the mass fractions of the materials of a packaging unit that have been rated A and B are divided by the total mass of the packaging unit and multiplied by 100.

Terminology

Technical Recyclability:

The proposed method calculated the technical recyclability of a packaging system on a material level. To be considered recyclable, a material had to meet the following four requirements:

• In the chosen country, a collection infrastructure for the material in question is in place.

• The material can be sorted into one of the predefined material streams in place in the chosen country with state-of-the-art sorting infrastructure and procedures.

• Within a material recycling process, the recycled material of the material can be gathered.

• The obtained recycled material has market potential and could further be used as a replacement for material identical virgin material applications.

Technical recyclability had to be differentiated from the following other definitions of recyclability:

• The recycling rate: The recycling rate describes the rate between the amount of material put into circulation and the amount of material which are recycled within a material recycling process. Within the European Union (EU), packaging waste is considered as recycled as soon as it is put into a recycling process according to 2018/852/EC to change guideline 94/62/EC.

• The recycling potential: The recycling potential is defined similarly to technical recyclability. However, only the potential of material recycling is considered. Hence, lacking sorting and recycling infrastructure in a given country or region can be neglected as well as missing the current market potential of the recycled material.

Assessment

The recyclability of the packaging systems analysed are assessed according to the FH Campus Vienna Circular Packaging Design Guideline (Gürlich, Kladnik, & Pavlovic, 2022) that is based on the relevant European Design for Recyclability standards. The actual calculation was performed using the PACO webtool.(Gürlich Ulla et al. 2023).

1. Functional Units
2. Functional Units

|  |  |  |
| --- | --- | --- |
| Packaging Category | Product | Functional Unit |
| Collation Shrink | Six cans 0.33 L | Secondary packaging holding together six standard-sized aluminium cans with a volume of 0.33 L |
| Six cans 0.5 L | Secondary packaging holding together six standard-sized aluminium cans with a volume of 0.5 L |
| Six bottles 0.5 L | Secondary packaging holding together six standard-sized PET bottles with a volume of 0.5 L |
| Six bottles 1.5 L | Secondary packaging holding together six standard-sized PET bottles with a volume of 1.5 L |
| Stretch Wraps | Pallet | Machine wrapping of a standard pallet configuration [1.2 m x 0.8 m x 1.15 m; 1000 kg] |
| Rigid packaging (non-food) | Body lotion 150 mL | Packaging of 150 mL body lotion |
| Body lotion 250 mL | Packaging of 250 mL body lotion |
| Shampoo 500 mL | Packaging of 500 mL shampoo |
| Liquid detergent 1.5 L | Packaging of 1.5 L liquid detergent |
| Household cleaner 1 L | Packaging of 1.0 L household cleaner |
| Motor oil 1 L | Packaging of 1 L motor oil |
| Dietary supplements 140 mL | Packaging of capsules in a volume of 140 mL |
| Wall paint 2.7 L | Packaging of 2.7 L wall paint |
| Wall paint 10 L | Packaging of 10 L wall paint |
| Heavy-duty sacks (HDS) | Pre-mixed cement, 10 kg | Packaging of 10 kg pre-mixed cement |
| Cement, 25 kg | Packaging of 25 kg standard cement |
| Chicken fodder, 20 kg | Packaging of 20 kg chicken fodder |
| Organic fertiliser, 10.5 kg | Packaging of 10.5 kg organic fertiliser |
| Fertiliser, 20 kg | Packaging of 20 kg fertiliser |
| Wood pellets, 15 kg | Packaging of 15 kg wood pellets |
| Flexible food | Frozen mangos, 500 g | Deep-freeze suitable packaging of 500 g mango cubes |
| Frozen raspberries, 250 g | Deep-freeze suitable packaging of 250 g raspberries whole |
| Frozen herbs, 75 g | Deep-freeze suitable packaging of 75 g frozen herbs cut |
| Frozen peas, 300 g | Deep-freeze suitable packaging of 300 g peas whole |
| Frozen pizza bread, 300 g | Deep-freeze suitable packaging of 300 g pizza bread |
| Frozen pizza, 430 g | Deep-freeze suitable packaging of 430 g pizza |
| Coffee, 250 g | Packaging of 250 g coffee beans not grounded |
| Instant coffee, 250 g | Packaging of 250 g instant coffee powder |
| Hot chocolate, 350 g | Packaging of 350 g hot chocolate powder |
| Mayonnaise, 250 g | Packaging of 250 g mayonnaise sauce |
| Apples, 1 kg | Packaging of 1 kg apples whole |
| Produce bag, 1 kg | Ready-to-use packaging for self-filled fruits & vegetables with a carrying capacity of 1 kg |
| Juice, 200 mL | Packaging of 200 mL juice carbon dioxide-free |
| Sugar, 1 kg | Packaging of 1 kg sugar |
| Salt, 750 g | Packaging of 750 g salt |
| Cashew nuts, 150 g | Packaging of 150 g cashew nuts whole |
| Potatoes, 1.5 kg | Packaging of 1.5 kg potatoes |

Not included in the FU are the lifecycle of the packaged product itself, transports to consumer, construction site, etc. and the use phase of the packaging, which can be broken down into two components: (1) loss prevention (packaging breakage rates), and (2) cleaning packaging before disposing of it (for example flushing out cups or cans with tap water and cleaning agents).

1. Cut-Off Criteria
2. Cut-off criteria

|  |  |  |  |
| --- | --- | --- | --- |
| Cut-off | Life cycle phase | Source | Assumption and justification |
| Filling (all processes) | Production |  | It is assumed that the filling process is strongly dependent on the filling good and not necessarily on the packaging. As the filling good does not significantly differ within a comparison, the filling is not considered relevant for the comparison. |
| Distribution centre (all processes) | Distribution |  | Not relevant for comparison (no relevant differences between the systems under examination expected); Impact assumed to be negligible. |
| Retailer (all processes) | Distribution |  | Not relevant for comparison (no relevant differences between the systems under examination expected); Impact assumed to be negligible. |
| Secondary and tertiary packaging | Distribution |  | It is expected to be negligible, as also shown by a sensitivity analysis (Chapter 5.6.2.6). |
| Consumer (all processes) | Use |  | High uncertainty expected due to lack of reliable data. Would exceed scope of study. Not relevant for comparison (no relevant differences between the systems under examination expected) |
| Transport (T6): retailer to consumer | Use | According to PEF, the transport: retailer - final client (customer) (T6) is calculated as follows: 5 km; 62% passenger car (allocated via transport volume and transported goods volume), 33% no impact, 5% van (European Commission 2018) | High uncertainty or variance expected. Impact assumed to be negligible.  According to the PEF, the effects of the recommended passenger cars should be calculated using the volume of the available transport space and the volume of the goods to be transported. However, as the volume should be allocated to the product and not the packaging (as it is not the packaging but the product that is purchased) and as it is assumed that the impact would be negligible, the transport T6 is cut-off. |
| Transport: consumer to civic amenity site | EOL |  | High uncertainty or variance expected; A transport consumer to waste treatment is assumed instead. Impact assumed to be negligible. |
| Labels and Prints | In general |  | Different manufacturers can use very different printing inks (Ink less than 0.2% impact in GWP), thus not considered; Not important for comparison; Due to the low expected impact, the printing and inks are cut off. In the case of metal packaging, the coating is not cut off as it serves both to protect the product and (especially in the case of steel packaging) to protect the packaging. |
| Labels | In general |  | Labels usually have a low weight compared to the rest of the packaging. This is especially true in the areas where labels are commonly used (rigid, stretch wraps [label weight <1%]); Different manufacturers can use very different labels (shape, size, materials) - this applies to all types of packaging. Not relevant for comparison (no relevant differences between the systems under examination expected). |
| Adhesives | In general |  | It is difficult to determine the components and used weights of adhesives. They occur in only small quantities (<1%) and therefore have little effect on the impact categories under investigation. (Lamination is included.) |
| Rejects & damaged packaging during production and transport. | In general |  | There is a lack of data on this point. However, it is assumed that only minimal quantities of packaging are produced as waste or are damaged during transport, which is why this point is cut off. |

1. Life Cycle Impact Assessment Methods

The life cycle impact assessment method chosen for this study is the Environmental Footprint method, published by the European Commission. More precisely, the EF method (adapted) as published via the software portal openLCA nexus by GreenDelta is used (European Commission 2018)(Green Delta 2024). However, due to the study’s limited scope, only three relevant impact categories were assessed and interpreted: climate change, expressed in kg CO2-eq; water scarcity, expressed in m3 deprived; and fossil resource use, expressed in MJ.

The assessment was carried out using PAST version 4.0, an internally developed semi-automated software tool by Circular Analytics, which is partly based on the LCA software openLCA 2.0 and data from ecoinvent (v3.8).

1. Impact categories and characterisation methods

|  |  |  |  |
| --- | --- | --- | --- |
| EF Impact Category | Impact Category Indicator | Unit | Characterisation Model |
| Climate change,  total | Global warming  potential (GWP100) | kg CO2-eq | Bern model – Global Warming Potentials (GWP) over a 100 year time horizon (based on IPCC 2013) |
| Water scarcity | User deprivation  potential (deprivation-weighted water consumption) | m3 water-eq of  deprived water | Available Water Remaining (AWARE) model (Boulay et al. 2018) |
| Resource use,  fossils | Abiotic resource  depletion – fossil  fuels (ADP-fossil) | MJ | (van Oers et al. 2002) as in CML 2002 method, v.4.8 |

1. Life Cycle Inventory (LCI)

### Collation shrink films

1. Collation shrinks

|  |  |  |  |
| --- | --- | --- | --- |
| Product/ Process | | Assumptions and remarks | Source |
| Cans 0.33 L x 6 | shrink film | Multilayer film  composition:  53,1% LDPE  10,8% HDPE  36,1% LLDPE | Measured |
| paperboard wrap | No assumptions | Measured |
| paperboard can carrier 1 | Glue not included | Measured |
| cardboard can carrier 2 | Composition corrugated board: testliner: 33%, kraft liner: 23%, fluting board: 44% | Measured & source: Composition corrugated board ecoinvent 3.8 |
| Cans 0.5 L x 6 | shrink film 1 & shrink film 2 | Multilayer film  Composition:  53.1% LDPE  10.8% HDPE  36.1 % LLDPE | Measured |
| paperboard wrap | No assumptions | Measured |
| cardboard can carrier | Composition corrugated board: testliner: 33%, kraft liner: 23%, fluting board: 44% | Measured, scaled & source: Composition corrugated board ecoinvent 3.8 |
| Bottles 0.5 L x 6 | shrink film 1 & shrink film 2 | Multilayer film  Composition:  53.1% LDPE  10.8% HDPE  36.1% LLDPE | Measured |
| cardboard bottle carrier | Composition corrugated board: testliner: 33%, kraftliner: 23%, fluting board: 44%,  Scaled sized from the cardboard bottle carrier 1.5 L. Bottle diameters (9 cm for 1.5 L and 6.5 cm for 0.5 L) determined conversion factor. | Measured & source: Composition corrugated board ecoinvent 3.8 |
| Bottles 1.5 L x 6 | shrink film 1 & shrink film 2 | Multilayer film  Composition:  53.1% LDPE  10.8% HDPE  36.1% LLDPE | Measured |
| carboard bottle carrier | Composition corrugated board: testliner: 33%, kraftliner: 23%, fluting board: 44% | Measured & source: Composition corrugated board ecoinvent 3.8 |

1. LCI Cans 0.33 L x 6, shrink film

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Shrink film |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 3.18 | LDPE | Yes | Yes | Yes |
| Layer | 0.65 | HDPE | Yes | Yes | Yes |
| Layer | 2.17 | LLDPE | Yes | Yes | Yes |
| Total | 6.00 |  |  |  |  |

1. LCI Cans 0.33 L x 6, can carrier 1, solid board

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard can carrier 1 | | | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 22.43 | Solid board mixed | Yes | Yes | Yes |
| Total | 22.43 |  |  |  |  |

1. LCI Cans 0.33 L x 6, can carrier 2, cardboard

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard can carrier 2 | | | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 7.44 | Testliner | Yes | Yes | Yes |
| Layer | 5.24 | Kraftliner | Yes | Yes | Yes |
| Layer | 9.96 | Fluting board | Yes | Yes | Yes |
| Total | 22.64 |  |  |  |  |

1. LCI Can 0.33 L x 6, paperboard wrap

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard wrap |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 30.15 | Solid board mixed | Yes | Yes | Yes |
| Total | 30.15 |  |  |  |  |

Cans 0.5 L x 6

1. LCI Cans 0.5 L x 6, shrink film 1 and 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Shrink film | Shrink film 1 | Shrink film 2 |  | Recyclable | | |
| Component | Weight [g] | Weight [g] | Material | GER | UK | EUR |
| Layer | 4.14 | 4.67 | LDPE | Yes | Yes | Yes |
| Layer | 2.82 | 3.18 | LLDPE | Yes | Yes | Yes |
| Layer | 0.84 | 0.95 | HDPE | Yes | Yes | Yes |
| Total | 7.80 | 8.80 |  |  |  |  |

1. LCI Can 0.5 L x 6, cardboard can carrier

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard can carrier | | | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 10.55 | Testliner | Yes | Yes | Yes |
| Layer | 7.43 | Kraftliner | Yes | Yes | Yes |
| Layer | 14.12 | Fluting board | Yes | Yes | Yes |
| Total | 32.10 |  |  |  |  |

1. LCI Can 0.5 L x 6, paperboard wrap

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard wrap |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 41.7 | Solid board mixed | Yes | Yes | Yes |
| Total | 41.7 |  |  |  |  |

1. LCI Bottles 0.5 L x 6, shrink film 1 and 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Shrink film | Shrink film 1 | Shrink film 2 |  | Recyclable | | |
| Component | Weight [g] | Weight [g] | Material | GER | UK | EUR |
| Layer | 4.09 | 4.96 | LDPE | Yes | Yes | Yes |
| Layer | 2.79 | 3.38 | LLDPE | Yes | Yes | Yes |
| Layer | 0.83 | 1.01 | HDPE | Yes | Yes | Yes |
| Total | 7.71 | 9.35 |  |  |  |  |

1. LCI Bottles 0.5 L x 6, cardboard bottle carrier, corrugated board

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard bottle carrier | | | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 8.54 | Testliner | Yes | Yes | Yes |
| Layer | 6.01 | Kraftliner | Yes | Yes | Yes |
| Layer | 11.42 | Fluting board | Yes | Yes | Yes |
| Total | 25.97 |  |  |  |  |

1. LCI Bottles 1.5 L x 6, shrink film 1 and 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Shrink film | Shrink film 1 | Shrink film 2 |  | Recyclable | | |
| Component | Weight [g] | Weight [g] | Material | GER | UK | EUR |
| Layer | 10.79 | 5.66 | LDPE | Yes | Yes | Yes |
| Layer | 7.35 | 3.85 | LLDPE | Yes | Yes | Yes |
| Layer | 2.20 | 1.15 | HDPE | Yes | Yes | Yes |
| Total | 20.34 | 10.66 |  |  |  |  |

1. LCI Bottles 1.5 L x 6, cardboard bottle carrier, corrugated board

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard bottle carrier | | | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 11.82 | Testliner | Yes | Yes | Yes |
| Layer | 8.32 | Kraftliner | Yes | Yes | Yes |
| Layer | 15.81 | Fluting board | Yes | Yes | Yes |
| Total | 35.95 |  |  |  |  |

### Stretch films for pallet wrap

1. Stretch wraps - different weights. Details: Stretchability in % | LLDPE stretch films and paper wraps are recyclable | \*Corresponding to FU (Film 25/400, Film 23/150, PaperWrap10, PaperWrap30, PaperWrap40) | FU: standard pallet configuration (0.8 x 1.2 x 1.15m, 1t)| Approach: Calculation: weights are calculated using pallet configuration and manufacturer information (on stretch wraps and wrapping techniques). Retailer information: Retailers were contacted (average values). Literature: Weights from the literature were examined.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Material | Approach | Sample | Details | Weight | Source |
| LLDPE | Calculation | Film25/400\* | 25μm/400% | 177 g | (Personal communica-tion with specialist at Interpack, 2023) |
| Film17/200 | 17μm/200% | 200 g |  |
| Film23/150\* | 23μm/150% | 325 g |
| Retailer Information | RetailerFilm1 |  | 255 g | (Personal communication with retailer [1]: Information about pallet configurations, 2023) |
| RetailerFilm2 |  | 300 g | (Personal communication with retailer [2]: Information about pallet configurations 2023) |
| Literature | Lantech2022:Film |  | 132 g | (Lantech 2017) |
| SWAP2022 | other pallet size: 48" x 40" x 50" | 160 g | (Microsoft 2022) |
| Mondi2021:Film1 |  | 300 g |  |
| Mondi2021:Film2 |  | 400 g |  |
| Paper | Calculation | PaperWrap40\* | 40% | 600 g |  |
| PaperWrap30\* | 30% | 646 g |  |
| PaperWrap10\* | 10% |  |  |
| Literature | Mondi2021:Paper | 30%; Optimized | 680 g | (Mondi 2021) |
| Mondi2021:Paper | 30%; Standard | 840 g |
| Lantech2022:Paper | 30% | 964 g | (Lantech 2017) |

### Rigid non-food

1. Rigid non-food packaging: Assumptions and remarks. If nothing is specified at “Source”, or only one component is affected by the assumption, the rest is read off the product label, or it was measured. | All investigated glass bottles have aluminium lids. In practice lids from e.g. PP, are also common.

|  |  |  |  |
| --- | --- | --- | --- |
| Product/Process | | Assumptions and remarks | Source |
| Body lotion 150 mL | HDPE bottle | 0% PCR | Measured |
| Glass jar | Aluminium foil coating: PE layer (3 μm inside, 10 μm outside); Lid inlay: LDPE (Burning test); Green glass 90% PCR, other materials 0% PCR | Measured; |
| Aluminium can | Coating lid and can: epoxy/ polyester/ acrylic; 0% PCR | Measured, Coating: (Niero und Olsen 2016; Li und Qiu 2013; Lestido-Cardama et al. 2022) |
| Body lotion 250 mL | HDPE bottle | 0% PCR | Measured |
| Paper (+PET) bottle | Scaled from 455 mL to 250 mL (Cap and bottleneck remain the same); 0% PCR | 455 mL bottle measured |
| Shampoo 500 mL | HDPE bottle | Cap: PP; 0% PCR | Measured |
| Glass bottle | Inlay: Rubber; Brown glass 70% PCR, other materials 0% PCR | Measured |
| Liquid detergent 1.5 L | HDPE bottle | 0% PCR | Measured |
| Paper (+PET) bottle | Scaled from 0.455 L to 1.5 L (Cap and bottleneck remain the same); 0% PCR | 455 mL bottle measured |
| Household cleaner 1 L | HDPE bottle | Nozzle: PP; 0% PCR | Measured |
| Paper (+PET) bottle | Scaled from 0.455 L to 1.5 L (Cap and bottleneck remain the same); 0% PCR | 455 mL bottle measured |
| Glass bottle | Cap and inlay from the shampoo bottle; bottle weight from datasheet: The weight of the cap (which is estimated to be very low compared to the bottle) is not subtracted from the bottle weight, as it is not known what it weighs and whether it is included in the stated weight at all.; Brown glass 70% PCR, other materials 0% PCR | Datasheet: (Flaschenland 2023) |
| Motor oil 1 L | HDPE canister | Scaled from 956 mL to 1000 mL; 0% PCR | 956 mL canister measured, Datasheet: **(Bukowsky Todd und Richmond Michale 2018)** |
| Tin canister | Nozzle: LDPE; coating body: epoxy/ polyester/ acrylic; 55% PCR, other materials 0% PCR | Measured, Nozzle: (Niero und Olsen 2016; Li und Qiu 2013; Lestido-Cardama et al. 2022) |
| Dietary supplements 140 mL | HDPE bottle | Seal: Data set with coated paper is chosen to represent the lacquer portion of the seal; 0% PCR  Inlay for cap: Solid board mixed; Scaled from 135 mL to 140 mL | 135 mL bottle measured |
| Glass bottle | Inlay for cap: HDPE (burning test); Scaled from 139 mL to 140 mL; Brown glass 70% PCR, other materials 0% PCR; | 139 mL bottle measured |
| Wall paint 2.7 L | HDPE bucket | Scaled from 2.6 L to 2.7 L and PP to PE (density); Datasheet; Steel 55% PCR, other materials 0% PCR | Datasheet |
| Tin bucket | Datasheets; Tin 19% PCR, steel 55% PCR | Datasheets: (Menke Industrieverpackungen 2023) |
| Wall paint 10 L | HDPE bucket | Datasheet; 0% PCR | (Fries Kunststofftechnik) |
| Tin bucket | Handle: length estimated with the help of a technical drawing; seal bottom: cut off; Tension ring & seal: cut off; seal & tension ring: The weight is considered as a sheet metal part of the bucket, as the weight of the individual components is not known; 19% PCR | Datasheet and technical drawing: (Hildering Packaging 2023) |

The weights of the wrapping materials were calculated based on a standard pallet configuration and a manufacturer's hand-wrapping data for the specific scenario (standard pallet configuration). The loaded standard pallet measures 80 cm x 120 cm x 115 cm composed of an Europallet (80 cm x 120 cm x 115 cm) that is loaded with 40 boxes (one box: 40 cm x 30 cm x 20 cm). Those dimensions were chosen to stay below a total height of 120 cm and thus correspond to the pallet configuration EUL1 (ECR Austria, n.d.). The weight of the standard pallet configuration is set at 1 t (= 1000 kg).

1. LCI Body lotion 150 mL, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 18.04 | HDPE | Yes | Yes | Yes |
| Cap | 4.40 | PP | No | No | No |
| Total | 22.44 |  |  |  |  |

1. LCI Body lotion 150 mL, glass jar

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass Jar |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Jar | 129.76 | Glass | Yes | Yes | Yes |
| Cap | 7.20 | PP | No | No | No |
| Foil | 0.36 | Aluminium | Yes | Yes | Yes |
| Foil Coating | 0.05 | PE | No | No | No |
| Lid inlay | 1.56 | LDPE | No | No | No |
| Total | 138.88 |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Aluminium Can |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Can (incl. Coating) | 9.50 | Aluminium | Yes | Yes | Yes |
| Cap (incl. Coating) | 6.39 | Aluminium | Yes | Yes | Yes |
| Foil | 0.33 | Aluminium | Yes | Yes | Yes |
| Paper layer | 0.23 | Paper | No | No | No |
| Total | 16.45 |  |  |  |  |

1. LCI Body lotion 250 mL, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 28.09 | HDPE | Yes | Yes | Yes |
| Cap | 7.18 | PP | No | No | No |
| Total | 35.27 |  |  |  |  |

1. LCI Body lotion 250 mL, paper (+PET) bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper (+PET) bottle 250 mL |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 8.97 | PET | No | No | No |
| Sleeve | 16.86 | Fibres | No | No | No |
| Cap | 2.97 | PP | No | No | No |
| Tape | 0.42 | Paper | No | No | No |
| Total | 29.22 |  |  |  |  |

1. LCI Shampoo 500 mL, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 33.83 | HDPE | Yes | Yes | Yes |
| Cap | 10.09 | PP | No | No | No |
| Total | 43.92 |  |  |  |  |

1. LCI Shampoo 500 mL, glass bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Bottle | 263.83 | Brown Glass | Yes | Yes | Yes |
| Cap (incl. coating) | 1.26 | Aluminium | Yes | Yes | Yes |
| Inlay | 0.91 | Rubber | No | No | No |
| Total | 266.00 |  |  |  |  |

1. LCI Liquid detergent 1.5 L, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 62.2 | HDPE | Yes | Yes | Yes |
| Cap | 7.02 | PP | No | No | No |
| Total | 69.22 |  |  |  |  |

1. LCI Liquid detergent 1.5 L, paper (+PET) bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper (+PET) bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 26.46 | PET | No | No | No |
| Sleeve | 94.40 | Fibres | No | No | No |
| Cap | 2.97 | PP | No | No | No |
| Tape | 0.42 | Paper | No | No | No |
| Total | 124.24 |  |  |  |  |

1. LCI Household cleaner 1 L, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 55.45 | HDPE | Yes | Yes | Yes |
| Cap | 3.57 | PP | No | No | No |
| Nozzle | 1.45 | PP | No | No | No |
| Total | 60.47 |  |  |  |  |

1. LCI Household cleaner 1 L, paper (+PET) bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper (+PET) bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 19.46 | PET | No | No | No |
| Sleeve | 63.38 | Fibres | No | No | No |
| Cap | 2.97 | PP | No | No | No |
| Tape | 0.42 | Kraft paper | No | No | No |
| Total | 86.23 |  |  |  |  |

1. LCI Household cleaner 1 L, glass bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Bottle | 490 | Brown Glass | Yes | Yes | Yes |
| Cap | 1.26 | Aluminium | Yes | Yes | Yes |
| Inlay | 0.91 | Rubber | No | No | No |
| Total | 492.17 |  |  |  |  |

1. LCI Motor oil 1 L, HDPE canister

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Canister |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 56.6 | HDPE | No | No | No |
| Lid | 3.0 | PP | No | No | No |
| Total | 59.6 |  |  |  |  |

1. LCI Motor oil 1 L, tinplated steel canister

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplated steel canister |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body (incl. coating) | 138.73 | Steel (coated) | Yes | Yes | Yes |
| Lid1 | 2.26 | HDPE | No | No | No |
| Lid2 (nozzle) | 3.98 | LDPE | No | No | No |
| Total | 144.97 |  |  |  |  |

1. LCI Dietary supplements 140 mL, HDPE bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Bottle | 15.87 | HDPE | Yes | Yes | Yes |
| Film | 0.19 | PVC | No | No | No |
| Inlay Cap | 0.43 | Solid board mixed | No | No | No |
| Cap | 2.9 | PP | No | No | No |
| Seal (multilayer) | 0.04 | Aluminium | Yes | Yes | Yes |
| Seal (multilayer) | 0.02 | Paper +Lacquer | No | No | No |
| Seal (multilayer) | 0.05 | LDPE | No | No | No |
| Total | 19.5 |  |  |  |  |

1. LCI Dietary supplements 140 mL, glass bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass Bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Bottle | 121.02 | Brown glass | Yes | Yes | Yes |
| Cap (incl. coating) | 2.03 | Aluminium | Yes | Yes | Yes |
| Inlay | 0.41 | HDPE | No | No | No |
| Film | 1.22 | PS | No | No | No |
| Total | 124.68 |  |  |  |  |

1. LCI Wall paint 2.7 L, HDPE bucket

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bucket |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body, Lid & Handle | 101.59 | HDPE granulate | Yes | Yes | Yes |
| Total | 101.59 |  |  |  |  |

1. LCI Wall paint 2.7 L, tinplated steel bucket; (incl. coating)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplated steel Bucket |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 191 | Tinplated steel | Yes | Yes | Yes |
| Lid | 52 | Tinplated steel | Yes | Yes | Yes |
| Total | 243 |  |  |  |  |

1. LCI Wall paint 10 L, HDPE bucket

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDPE Bucket |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 372 | HDPE | No | No | No |
| Lid | 114 | HDPE | No | No | No |
| Handle | 41 | Steel wire | Yes | Yes | Yes |
| Total | 527 |  |  |  |  |

1. LCI Wall paint 10 L, tinplated steel bucket

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplated steel Bucket |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body & Lid (incl. coating) | 871.53 | Steel tin | Yes | Yes | Yes |
| Handle | 9.47 | Steel wire | Yes | Yes | Yes |
| Seal Bottom | Cut off | Rubber |  |  |  |
| Tension Ring & Seal | Cut off |  |  |  |  |
| Total | 881 |  |  |  |  |

### Heavy Duty Sacks

1. Heavy duty sacks: Assumptions and remarks

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Product/ Process | | | Assumptions and remarks | | Source |
| Pre-mixed cement 10 kg | plastic sack | | 5-layer 125 µm LLDPE, LDPE and HDPE film, gusseted sack. Calculated as cuboid with a correction factor of 0.807 to adjust surface for a gusseted bag and actual size. Size: 29 x 18 x 12 cm. 0% PCR. Grammage: 116.4 g/m2 | | (Personal communication with Eurosac, 2023 |
| paper sack | | 3-layer paper sack: white kraft paper 70 g/m2, HDPE film 10 µm, brown kraft paper 70 g/m2. Calculated as cuboid with no correction factor, since paper sack is similar to a cuboid. Size: 29 x 18 x 12 cm. 0% PCR. Grammage: 149.6 g/m2 | | (Personal communication with Eurosac, 2023) |
| Cement 25 kg | plastic sack | | 5-layer 125 µm LLDPE, LDPE and HDPE film, gusseted sack. Calculated as cuboid with a correction factor of 0.807 to adjust surface for a gusseted bag and actual size. Size: 40 x 30 x 28 cm. 0% PCR. Grammage: 116.4 g/m2 | | (Personal communication with Eurosac, 2023) |
| paper sack | | 3-layer paper sack: white kraft paper 70 g/m2, HDPE film 10 µm, brown kraft paper 70 g/m2. Calculated as cuboid with no correction factor, since paper sack is similar to a cuboid. Size: 40 x 30 x 28 cm. 0% PCR. Grammage: 149.6 g/m2 | | (T.J.Cottis Transport LTD, 2023; Personal communication with Eurosac, 2023) |
| Chicken fodder 20 kg | plastic sack | | 5-layer 100 µm LLDPE HDPE film, gusseted sack. Calculated as cuboid with a correction factor of 0.807 to adjust surface for a gusseted bag and actual size. Size: 72 x 36 x 14 cm. 0% PCR. Grammage: 93.5 g/m2 | | (Windmöller & Hölscher, 2023) |
| paper sack | | 4-layer sewn open mouth paper sack: white kraft paper 70 g/m2, brown kraft paper 80 g/m2, HDPE film 15 µm, brown kraft paper 70 g/m2. Calculated as cuboid with a correction factor of 0.886 to adjust surface for an open mouth paper sack. Size: 72 x 36 x 14 cm. 0% PCR. Grammage: 234.3 g/m2 | | (Personal communication with Eurosac, 2023; “Gallugold Hühnerfutter”, n.d.) |
| Organic fertiliser 10.5 kg | plastic sack | | 110 µm LDPE film. Surface area 5168 cm2. 0% PCR. Grammage: 101.6 g/m2 | | Measured |
| paper sack | | 2-layer sewn open mouth paper sack: brown kraft paper 90 g/m2, brown kraft paper 70 g/m2. Surface area: 6916 cm2. 0% PCR. Grammage: 164.5 g/m2 | | Measured |
| Fertiliser 20 kg | plastic sack | | 3-layer 140 µm LLDPE (112 µm), LDPE (7 µm) and HDPE film (21 µm), gusseted sack. Calculated as cuboid with a correction factor of 0.807 to adjust surface for a gusseted bag and actual size. Size: 69 x 50 x 13 cm. 0% PCR. Grammage: 129.6 g/m2 | | (Personal communication with ExxonMobil, 2023) |
| paper sack | | 3-layer sewn open mouth paper sack: white kraft paper 90g/m2, brown kraft paper 90 g/m2, HDPE film 20 µm. Size: 69 x 50 x 13 cm. 0% PCR. Grammage: 199.1 g/m2 | | (Personal communication with Eurosac, 2023) |
| Wood pellets 15 kg | plastic sack | | 74 µm LDPE film. Surface area 6200 cm2. 0% PCR. Grammage: 68.5 g/m2 | | Measured |
|  | | paper sack | | 2-layer paper sack: white kraft paper 70 g/m2, brown kraft paper 70 g/m2. Surface area 9243 cm2. 0% PCR. Grammage: 140 g/m2 | (Personal communication with Eurosac, 2023; Personal communi-cation with specialist on paper HDS, 2023) |

1. LCI Pre-mixed cement 10 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 20.52 | LLDPE | Yes | Yes | Yes |
| Layer | 0.32 | LDPE | Yes | Yes | Yes |
| Layer | 10.55 | HDPE | Yes | Yes | Yes |
| Masterbatch (cut-off) | 0.76 | Ink, Additives | No | No | No |
| Total | 31.39 |  |  |  |  |

1. LCI Pre-mixed cement 10 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 47.88 | Mixed Kraft Paper | Yes | Yes | Yes |
| Layer | 3.27 | HDPE | No | No | No |
| Glue | 1.06 | Starch and PVA glue | No | No | No |
| Ink (cut-off) | 1.95 | Ink | No | No | No |
| Total | 52.79 |  |  |  |  |

1. LCI Cement 25 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 37.90 | LLDPE | Yes | Yes | Yes |
| Layer | 0.58 | LDPE | Yes | Yes | Yes |
| Layer | 19.50 | HDPE | Yes | Yes | Yes |
| Masterbatch (cut-off) | 1.44 | Ink, Additives | No | No | No |
| Total | 59.42 |  |  |  |  |

1. LCI Cement 25 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 88.48 | Mixed Kraft Paper | Yes | Yes | Yes |
| Layer | 6.04 | HDPE | No | No | No |
| Glue | 1.95 | Starch and PVA glue | No | No | No |
| Ink (cut-off) | 1.08 | Ink | No | No | No |
| Total | 97.55 |  |  |  |  |

1. LCI chicken fodder 20 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 37.71 | LLDPE | Yes | Yes | Yes |
| Layer | 27.38 | HDPE | Yes | Yes | Yes |
| Masterbatch (cut-off) | 1.95 | Ink, Additives | No | No | No |
| Total | 66.99 |  |  |  |  |

1. LCI chicken fodder 20 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 172.83 | Mixed Kraft Paper | Yes | Yes | Yes |
| Layer | 11.25 | HDPE | No | No | No |
| String (cut-off) | 0.42 | Cotton | No | No | No |
| Total | 184.5 |  |  |  |  |

1. LCI Organic fertiliser 10.5 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 49.95 | LDPE | Yes | Yes | Yes |
| Total | 49.95 |  |  |  |  |

1. LCI Organic fertiliser 10.5 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 113.51 | Mixed Kraft Paper | Yes | Yes | Yes |
| String (cut-off) | 0.42 | Cotton | No | No | No |
| Total | 113.93 |  |  |  |  |

1. LCI Fertiliser 20 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 86.30 | LLDPE | Yes | Yes | Yes |
| Layer | 5.42 | LDPE | Yes | Yes | Yes |
| Layer | 16.80 | HDPE | Yes | Yes | Yes |
| Total | 108.51 |  |  |  |  |

1. LCI Fertiliser 20 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 186.74 | Mixed Kraft Paper | Yes | Yes | Yes |
| Layer | 19.81 | HDPE | No | No | No |
| Total | 206.55 |  |  |  |  |

1. LCI Wood pellets 15 kg, plastic sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS plastic |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 42.44 | LDPE | Yes | Yes | Yes |
| Total | 42.44 |  |  |  |  |

1. LCI Wood pellets 15 kg, paper sack

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HDS paper |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Layer | 114.48 | Mixed Kraft Paper | Yes | Yes | Yes |
| Total | 114.48 |  |  |  |  |

### Flexible food category

1. Flexible packaging: Assumptions and remarks

|  |  |  |  |
| --- | --- | --- | --- |
| Product/ Process | | Assumptions and remarks | Source |
| Frozen mangos 500 g | LDPE/PET stand-up pouch | LDPE stand-up pouch labelled as LDPE/PET. 12 µm PET layer on the outside assumed. Closing mechanism assumed to be LDPE. 0% PCR | Measured |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. Scaled from 300 g. 0% PCR | Measured + scaled |
| Frozen raspberries 250 g | LDPE pillow pouch | Scaled from 500g. 0% PCR | Measured + scaled |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. 0% PCR | Measured |
| Frozen herbs 75 g | LDPE stand-up pouch | Closing mechanism assumed to be LDPE. 0% PCR | Measured |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. Scaled from 40 g. 0% PCR | Measured + scaled |
| Frozen peas 300 g | LDPE pillow pouch | 0% PCR | Measured |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. Scaled from 330 g. 0% PCR | Measured + scaled |
| Pizza bread 300 g | LDPE/PET pillow pouch | LDPE pillow pouch labelled as LDPE/PET. 12 µm PET layer on the outside assumed. 0% PCR | Measured |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. Scaled from 420 g. 0% PCR | Measured + scaled |
| Frozen pizza 430 g | LDPE shrink film | Assumed to be the same film as in combination with paperboard. 0% PCR | Measured |
| paperboard box + LDPE shrink film | 0% PCR | Measured |
| Laminated paperboard box | 8 µm LDPE layer assumed on the inside. 0% PCR | Measured |
| Laminated paper pouch | 5 µm LDPE layer assumed on the inside. Scaled from 400 g. 0% PCR | Measured + scaled |
| Coffee 250 g | PET/Alu/PE gusseted pouch | Gusseted pouch labelled as PET/Alu/PE. 12 µm PET layer on the outside assumed. 5 µm aluminium foil assumed. 0% PCR | Measured |
| Tinplate can | Tin 19% PCR, PP 0% PCR | Measured |
| Paper-PE gusseted pouch | 8 µm LDPE layer assumed on the inside. Steel wire 55% PCR, other materials 0% PCR | Measured |
| LDPE/PP gusseted pouch | 0.1 µm aluminium metallization assumed. Valve assumed to be PP. Scaled from 180 g. 0% PCR | Measured + scaled |
| Instant coffee 250 g | PET/Alu/PE pouch | 0% PCR | Measured |
| Glass container | Lid assumed to be PP, insert into lid assumed to be HDPE. Scaled from 100 g. White glass 60% PCR, other materials 0% PCR | Measured + scaled |
| Tinplate can | Insert tinplate lid labelled as LDPE. Tin 19% PCR, other materials 0% PCR | Measured |
| Hot chocolate powder 350 g | LDPE/PET gusseted pouch | LDPE gusseted pouch labelled as LDPE/PET. 12 µm PET layer on the outside assumed. 0% PCR | Measured |
| Paperboard box | Glue not included. Scaled from 350 g packaging. 0% PCR | Measured + scaled |
| Paperboard + coated paper bag | Coating assumed as 8 µm LDPE layer. Scaled from 250 g packaging. 0% PCR | Measured + scaled |
| Mayonnaise 250 g | LDPE spouted stand-up pouch | Lid assumed to be PP. Scaled from 268 g packaging. 0% PCR | Measured |
| Aluminium tube | Coating on the inside of tube not included. Sealant (latex) not included. Scaled from 258 g packaging (lid not scaled). 0% PCR | Measured + scaled |
| Glass jar | Sealant in lid is PVC. Flame test. White glass 60% PCR, tin 19% PCR, other 0% PCR. | Measured |
| Apples 1 kg | LDPE bag | 0% PCR | Measured |
| Paperboard tray + LDPE film | Glue not included. Scaled from 0.585 kg packaging. 0% PCR | Measured + scaled |
| Cardboard tray | 33% testliner with 95% PCR, 23% kraftliner with 24% PCR and 44% fluting with 5% PCR assumed. Glue not included. Scaled from 0.858 kg packaging. | Composition corrugated board from ecoinvent 3.8  Measured + scaled |
| Produce bag 1 kg | Paper single use bag | Glue not included. 0% PCR | Measured |
| PE single use bag | 0% PCR | Measured |
| Juice 200 mL | PET/Alu/PE stand-up pouch | Glue not included. 0% PCR, secondary material 33% testliner with 95% PCR, 23% kraftliner with 24% PCR and 44% fluting with 5% PCR. | Measured |
| Beverage carton | 19% LDPE, 77% solid board mixed, 5% aluminium foil. Production assumed as film extrusion. 0% PCR, secondary material 33% testliner with 95% PCR, 23% kraftliner with 24% PCR and 44% fluting with 5% PCR. | Measured and composition is average of internal data. |
| Glass bottle | Lid sealant same as mayonnaise glass. Green glass 90% PCR, tin 19% PCR, secondary material 33% testliner with 95% PCR, 23% kraftliner with 24% PCR and 44% fluting with 5% PCR. | Measured |
| Sugar 1 kg | LDPE/PET pillow pouch | Bag labelled as PE/PET. 12 µm PET layer on the outside assumed. 0% PCR | Measured |
| Paper bag | Glue not included. 0% PCR | Measured |
| Gable top | 4% LDPE outside, 88% solid board mixed, 8% LDPE inside. 0% PCR | Measured + scaled and composition is average of internal data. |
| Salt 750 g | LDPE pillow pouch | 0% PCR | Measured |
| Paperboard box | Scaled from 1 kg packaging. 0% PCR | Measured + scaled |
| Paperboard tube + plastic lid | Lid assumed to be PP. Scaled from 500 g packaging. 0% PCR | Measured |
| Cashew nuts 150 g | Metallised LDPE pillow pouch | Metallised LDPE with 0.1 µm aluminium layer. 0% PCR | Measured |
| Tinplate can | Can lid and pull tab assumed to be tinplate. Tin 19% PCR | Measured |
| Paper stand-up pouch | 10 µm LDPE film assumed as proxy for coating. Scaled from 175 g packaging. 0% PCR | Measured + scaled |
| Potatoes 1.5 kg | LDPE bag | Scaled from 5 kg packaging. 0% PCR | Measured + scaled |
| Paper bag | Modelled as paper sack.  0% PCR | Measured |

1. LCI Frozen mango 500 g, LDPE/PET stand-up pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE/PET stand-up pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 9.28 | LDPE | No | No | No |
| Body | 1.73 | PET | No | No | No |
| Closure | 1.60 | LDPE | No | No | No |
| Total | 12.61 |  |  |  |  |

1. LCI Frozen mango 500 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Laminated paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 31.67 | Solid mixed board | Yes | Yes | Yes |
| Body | 0.90 | LDPE | No | No | No |
| Total | 32.57 |  |  |  |  |

1. LCI Frozen raspberries 250 g, LDPE pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 3.11 | LDPE | Yes | Yes | Yes |
| Total | 3.11 |  |  |  |  |

1. LCI Frozen raspberries 250 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Laminated Paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 18.14 | Solid mixed board | Yes | Yes | Yes |
| Body | 0.53 | LDPE | No | No | No |
| Total | 18.67 |  |  |  |  |

1. LCI Frozen herbs 75 g, LDPE stand-up pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE stand-up pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 3.52 | LDPE | Yes | Yes | Yes |
| Closure | 2.16 | LDPE | Yes | Yes | Yes |
| Total | 5.68 |  |  |  |  |

1. LCI Frozen herbs 75 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Laminated paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 23.66 | Solid mixed board | Yes | Yes | Yes |
| Body | 0.59 | LDPE | No | No | No |
| Total | 24.24 |  |  |  |  |

1. LCI Frozen peas 300 g, LDPE pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 6.97 | LDPE | Yes | Yes | Yes |
| Total | 6.97 |  |  |  |  |

1. LCI Frozen peas 300 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Laminated paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 18.52 | Solid mixed board | Yes | Yes | Yes |
| Body | 0.54 | LDPE | No | No | No |
| Total | 19.06 |  |  |  |  |

1. LCI Pizza bread 300 g, LDPE/PET pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE/PET pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 12.43 | LDPE | No | No | No |
| Body | 1.18 | PET | No | No | No |
| Total | 13.61 |  |  |  |  |

1. LCI Pizza bread 300 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Laminated paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 49.77 | Solid board mixed | Yes | Yes | Yes |
| Body | 1.70 | LDPE | No | No | No |
| Total | 51.47 |  |  |  |  |

1. LCI Pizza 430 g, shrink film

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE shrink film |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Shrink | 3.51 | LDPE | Yes | Yes | Yes |
| Total | 3.51 |  |  |  |  |

1. LCI Pizza 430 g, laminated paper pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 17.70 | Kraft paper | Yes | Yes | Yes |
| Body | 1.15 | LDPE | No | No | No |
| Total | 18.85 |  |  |  |  |

1. LCI Pizza 430 g, laminated paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| laminated paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 72.08 | Solid board mixed | Yes | Yes | Yes |
| Body | 1.70 | LDPE | No | No | No |
| Total | 73.78 |  |  |  |  |

Paperboard Box and Shrink Film

1. LCI Pizza 430 g, cardboard box and shrink film

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard box + LDPE shrink |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 96.20 | Solid board mixed | Yes | Yes | Yes |
| Film | 3.51 | LDPE | Yes | Yes | Yes |
| Total | 99.71 |  |  |  |  |

1. LCI Coffee 250 g, LDPE/PP gusseted pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE/PP Gusseted Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 0.03 | Aluminium (cut off) | No | No | No |
| Body | 1.15 | PP | Yes | No | No |
| Body | 10.72 | LDPE | Yes | No | No |
| Total | 11.90 |  |  |  |  |

1. LCI Coffee 250 g, PET/Alu/PE gusseted pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PET/Alu/PE Gusseted Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 0.93 | PET | No | No | No |
| Body | 0.77 | Aluminium | No | No | No |
| Body | 5.90 | LDPE | No | No | No |
| Total | 7.60 |  |  |  |  |

1. LCI Coffee 250 g, paper/PE gusseted pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper/PE Gusseted Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 6.96 | Paper | Yes | Yes | Yes |
| Body | 0.58 | LDPE | No | No | No |
| Body | 5.34 | Paper | Yes | Yes | Yes |
| Lid | 0.58 | Steel wire for lid | Yes | Yes | Yes |
| Lid | 0.13 | Paper | No | No | No |
| Total | 13.59 |  |  |  |  |

1. LCI Coffee 250 g, tinplate can; (incl. coating)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplate Can |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body can | 88.80 | Tinplate | Yes | Yes | Yes |
| Can lid | 8.37 | Tinplate | Yes | Yes | Yes |
| Pull tap | 1.57 | Tinplate | Yes | Yes | Yes |
| Insert Lid | 11.88 | PP | No | No | No |
| Lid | 25.32 | Tinplate | Yes | Yes | Yes |
| Total | 135.94 |  |  |  |  |

1. : LCI Instant coffee 250 g, PET/Alu/PE gusseted pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 1.37 | PET | No | No | No |
| Body | 1.14 | Aluminium | Yes | Yes | Yes |
| Body | 7.13 | LDPE | No | No | No |
| Total | 9.64 |  |  |  |  |

1. LCI Instant coffee 250 g, tinplate can; (incl. coating)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplate can |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 94.40 | Tinplate | Yes | Yes | Yes |
| Can lid | 12.11 | Tinplate | Yes | Yes | Yes |
| Pull tap | 1.50 | Tinplate | Yes | Yes | Yes |
| Lid | 8.70 | LDPE | Yes | Yes | Yes |
| Total | 116.71 |  |  |  |  |

1. LCI Instant coffee 250 g, glass container

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass container |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 482.58 | Glass | Yes | Yes | Yes |
| Lid | 17.92 | PP | No | No | No |
| Lid | 9.14 | PP | No | No | No |
| Insert Lid | 2.87 | HDPE | No | No | No |
| Platine | 0.26 | Aluminium | Yes | Yes | Yes |
| Total | 512.77 |  |  |  |  |

1. LCI Hot chocolate powder 350 g, LDPE/PET pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE/PET Gusseted Pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 4.43 | LDPE | No | No | No |
| Body | 0.46 | PET | No | No | No |
| Total | 4.89 |  |  |  |  |

1. LCI Hot chocolate powder 350 g, paperboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 31.29 | Solid mixed board | Yes | Yes | Yes |
| Total | 31.29 |  |  |  |  |

1. LCI Hot chocolate powder 350 g, paperboard box, and coated paper bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard box + paper bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 41.96 | Solid mixed board | Yes | Yes | Yes |
| Bag | 9.70 | Paper | Yes | Yes | Yes |
| Coating | 0.76 | LDPE | No | No | No |
| Total | 52.42 |  |  |  |  |

1. LCI Mayonnaise 250 g, LDPE spouted stand-up pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE spouted stand-up pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 6.28 | LDPE | Yes | Yes | Yes |
| Lid/Spout | 2.53 | PP | Yes | No | No |
| Total | 8.81 |  |  |  |  |

1. LCI Mayonnaise 250 g, aluminium tube; (incl. coating)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Alu tube |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 20.12 | Aluminium | Yes | Yes | Yes |
| Lid | 1.92 | PP | No | No | No |
| Sealant, Latex (cut-off) | 0.50 | Latex | No | No | No |
| Total | 22.54 |  |  |  |  |

1. LCI Mayonnaise 250 g, c

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass jar |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 199.49 | Glass, white | Yes | Yes | Yes |
| Lid (incl. coating) | 9.85 | Tinplate | Yes | Yes | Yes |
| Lid | 1.72 | PVC (sealant lid) | No | No | No |
| Label (cut off) | 1.46 | Paper | No | No | No |
| Total | 212.52 |  |  |  |  |

1. LCI Apples 1 kg, LDPE bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE Bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 6.39 | LDPE | Yes | Yes | Yes |
| Total | 6.39 |  |  |  |  |

1. LCI Apples 1 kg, cardboard tray

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard tray |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 26.82 | Corrugated Cardboard (1,2,3) | Yes | Yes | Yes |
| Body | 8.85 | 1 Testliner | Yes | Yes | Yes |
| Body | 6.17 | 2 Kraftliner | Yes | Yes | Yes |
| Body | 11.80 | 3 Fluting | Yes | Yes | Yes |
| Label (cut-off) | 0.31 | Paper label | No | No | No |
| Glue (cut-off) | 0.35 | Glue | No | No | No |
| Total | 27.48 |  |  |  |  |

1. LCI Apples 1 kg, paperboard tray, and LDPE film

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paperboard tray + LDPE film |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 27.88 | Solid Board mixed | Yes | Yes | Yes |
| Closure/Film | 4.05 | LDPE | Yes | Yes | Yes |
| Label (cut-off) | 0.54 | Paper label | No | No | No |
| Total | 32.48 |  |  |  |  |

1. LCI Produce bag 1 kg, LDPE bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PE single use bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 3.27 | LDPE | Yes | Yes | Yes |
| Total | 3.27 |  |  |  |  |

Paper Bag

1. LCI Produce bag 1 kg, paper bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper single use bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 10.12 | Kraft paper, mixed | Yes | Yes | Yes |
| Total | 10.12 |  |  |  |  |

1. LCI Juice 200 mL, PET/Alu/PE stand-up pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PET/Alu/PE stand-up pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 0.59 | PET (outside layer) | No | No | No |
| Body | 1.02 | Aluminium (middle layer) | Yes | Yes | Yes |
| Body | 2.39 | LDPE (inside layer) | No | No | No |
| Body | 0.03 | LDPE (straw opening) | No | No | No |
| Straw | 0.49 | Solid board mixed (straw) | Yes | Yes | Yes |
| Straw | 0.09 | PP (straw packaging) | No | No | No |
| Total | 4.61 |  |  |  |  |
| Secondary packaging per unit |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Secondary packaging | 8.52 | Corrugated Board (1, 2, 3) | Yes | Yes | Yes |
| Secondary packaging | 2.81 | 1 Testliner | Yes | Yes | Yes |
| Secondary packaging | 1.96 | 2 Kraftliner | Yes | Yes | Yes |
| Secondary packaging | 3.75 | 3 Fluting | Yes | Yes | Yes |
| Total | 8.52 |  |  |  |  |

1. LCI Juice 200 mL, beverage carton

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Beverage carton |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 1.60 | LDPE | No | No | No |
| Body | 6.55 | Solid Board mixed | Yes | Yes | Yes |
| Body | 0.40 | Aluminium | No | No | No |
| Straw | 0.63 | Solid Board mixed (Straw) | Yes | Yes | Yes |
| Body | 0.10 | LDPE | No | No | No |
| Straw | 0.10 | PP (Packaging straw) | No | No | No |
| Total | 9.38 |  |  |  |  |
| Secondary packaging per unit |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Secondary packaging | 0.67 | Collation shrink (a, b, c) | Yes | Yes | Yes |
| Secondary packaging | 0.24 | a LLDPE | Yes | Yes | Yes |
| Secondary packaging | 0.36 | b LDPE | Yes | Yes | Yes |
| Secondary packaging | 0.07 | c HDPE | Yes | Yes | Yes |
| Secondary packaging | 1.83 | Corrugated Board (1, 2, 3) | Yes | Yes | Yes |
| Secondary packaging | 0.60 | 1 Testliner | Yes | Yes | Yes |
| Secondary packaging | 0.42 | 2 Kraftliner | Yes | Yes | Yes |
| Secondary packaging | 0.81 | 3 Fluting | Yes | Yes | Yes |
| Total | 2.50 |  |  |  |  |

1. LCI Juice 200 mL, glass bottle

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Glass bottle |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 121.89 | Glass green | Yes | Yes | Yes |
| Lid | 3.65 | Tinplate | Yes | Yes | Yes |
| Lid | 0.64 | PVC (sealant lid) | No | No | No |
| Label (cut-off) | 0.71 | Paper, label |  |  |  |
| Total | 126.89 |  |  |  |  |
| Secondary packaging per unit |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Secondary packaging | 0.96 | Collation shrink (a, b, c) | Yes | Yes | Yes |
| Secondary packaging | 0.35 | a LLDPE | Yes | Yes | Yes |
| Secondary packaging | 0.51 | b LDPE | Yes | Yes | Yes |
| Secondary packaging | 0.10 | c HDPE | Yes | Yes | Yes |
| Secondary packaging | 2.75 | Corrugated Board (1, 2, 3) | Yes | Yes | Yes |
| Secondary packaging | 0.91 | 1 Testliner | Yes | Yes | Yes |
| Secondary packaging | 0.63 | 2 Kraftliner | Yes | Yes | Yes |
| Secondary packaging | 1.21 | 3 Fluting | Yes | Yes | Yes |
| Total | 3.71 |  |  |  |  |

1. LCI Sugar 1 kg, LDPE/PET pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE PET pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 10.30 | LDPE | No | No | No |
| Body | 1.67 | PET | No | No | No |
| Total | 11.97 |  |  |  |  |

1. LCI Sugar 1 kg, paper bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 8.83 | Kraft paper, mixed | Yes | Yes | Yes |
| Glue (cut-off) |  |  |  |  |  |
| Total | 8.83 |  |  |  |  |

1. LCI Sugar 1 kg, gable top

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Gable top |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 1.89 | LDPE inside | No | No | No |
| Body | 38.36 | Solid board mixed | Yes | Yes | Yes |
| Body | 3.49 | LDPE outside | No | No | No |
| Spout | 1.34 | LDPE | No | No | No |
| Screw cap | 1.24 | HDPE | No | No | No |
| Total | 46.32 | Total |  |  |  |

1. LCI Salt 750 g, LDPE pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 4.85 | LDPE | Yes | Yes | Yes |
| Total | 4.85 |  |  |  |  |

1. LCI Salt 750 g, cardboard box

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard box |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 25.67 | Solid Board Mixed | Yes | Yes | Yes |
| Glue (cut-off) |  |  |  |  |  |
| Total | 25.67 |  |  |  |  |

1. LCI Salt 750 g, cardboard tube, and plastic lid

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cardboard tube + plastic lid |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 49.70 | Solid Board Mixed | Yes | Yes | Yes |
| Lid | 15.39 | PP | No | No | No |
| Total | 65.09 |  |  |  |  |

1. LCI Cashew nuts 150 g, metallised LDPE pillow pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Metallised LDPE pillow pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 3.55 | LDPE | Yes | Yes | Yes |
| Body | 0.01 | Aluminium (cut off) | No | No | No |
| Total | 3.56 |  |  |  |  |

1. LCI Cashew nuts 150 g, tinplate can; (incl. coating)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tinplate can |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 41.04 | Tinplate | Yes | Yes | Yes |
| Can lid | 5.97 | Tinplate | Yes | Yes | Yes |
| Pull tab | 1.35 | Tinplate | Yes | Yes | Yes |
| Total | 48.36 |  |  |  |  |

1. LCI Cashew nuts 150 g, paper stand-up pouch

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper stand-up pouch |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 5.86 | Kraft paper | Yes | Yes | Yes |
| Body | 0.62 | LDPE | No | No | No |
| Total | 6.48 |  |  |  |  |

1. LCI Potatoes 1.5 kg, LDPE bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| LDPE bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body | 5.21 | LDPE | Yes | Yes | Yes |
| Total | 5.21 |  |  |  |  |

1. LCI Potatoes 1.5 kg, paper bag

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Paper bag |  |  | Recyclable | | |
| Component | Weight [g] | Material | GER | UK | EUR |
| Body (incl. handle) | 28.77 | Paper sack | Yes | Yes | Yes |
| Closure | 0.48 | Cotton string | No | No | No |
| Total | 29.25 |  |  |  |  |

1. Potential life cycle GWP impacts of substituting PE-based packaging in Europe
2. Estimated PE packaging sales volumes (million metric tons per annum, MTA) in the Europe, material requirements to substitute PE-based materials (material weight substitution ratios) and estimates of potential annual life cycle GWP impacts (in MTA of CO2e) of substituting PE-based packaging.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Product** | **Packaging material and format** | **Weight ratio** | **Life cycle GWP** | **Packaging CI** | **Estimated Sales Volume** | **PE Packaging GWP** | **Alternative Packaging GWP  (Lowest GWP Alternative)** | | **Alternative Packaging GWP (Highest GWP Alternative)** | |
| **wt./ wt. PE** | **kgCO2e /FU** | **kgCO2e /kg** | **MTA** | **MTA CO2-eq** | **MTA CO2-e** | **% Reduction** | **MTA CO2e** | **% Reduction** |
| ***Collation Shrink*** | | | | | | ***1.207*** | ***0.748*** | ***38%*** | ***0.893*** | ***26%*** |
| 1.5 L bottles | PE Shrink film 1 | 1.00 | 0.11 | 5.17 | 0.127 | 0.658 |  |  |  |  |
| Corrugated carrier [P1] | 1.77 | 0.04 | 1.23 | 0.225 |  | 0.277 | 58% | 0.277 | 58% |
| 0.5 L bottles | *PE Shrink film 2* | 1 | 0.048 | 5.17 | 0.021 | 0.110 |  |  |  |  |
| *Corrugated carrier [P2]* | 2.78 | 0.032 | 1.23 | 0.059 |  | 0.073 | 34% | 0.073 | 34% |
| 0.5 L cans | *PE Shrink film 2* | 1 | 0.046 | 5.17 | 0.042 | 0.219 |  |  |  |  |
| *Corrugated carrier [P3]* | 3.65 | 0.04 | 1.23 | 0.155 |  | 0.191 | 13% |  |  |
| *Paperboad box [P4]* | 4.74 | 0.055 | 1.31 | 0.201 |  |  |  | 0.264 | 17% |
| 0.33 L cans | *PE Shrink film 1* | 1 | 0.031 | 5.17 | 0.042 | 0.219 |  |  |  |  |
| *Paperboard carrier 1 [P5]* | 3.74 | 0.029 | 1.31 | 0.159 |  | 0.208 | 5% |  |  |
| *Paperboard box [P7]* | 5.03 | 0.04 | 1.31 | 0.213 |  |  |  | 0.280 | -28% |
| ***Shrink wrap for pallet*** | | | | | | ***7.144*** | ***9.310*** | ***-30%*** | ***9.310*** | ***-30%*** |
| Pallet | *PE Stretch Film* | 1 | 0.591 | 3.34 | 2.140 | 7.144 |  |  |  |  |
| *Paper wrap [P8]* | 3.65 | 0.77 | 1.19 | 7.810 |  | 9.310 | -30% | 9.310 | -30% |
| ***Heavy duty sacks*** | | | | | | ***1.067*** | ***1.065*** | ***0.1%*** | ***1.065*** | ***0.1%*** |
| Wood pellets | *PE bag* | 1 | 0.144 | 3.38 | 0.098 | 0.330 |  |  |  |  |
| *Paper bag [P9]* | 2.7 | 0.145 | 1.27 | 0.263 |  | 0.334 | -1% | 0.334 | -1% |
| Fertilizer | *PE bag* | 1 | 0.36 | 3.32 | 0.062 | 0.206 |  |  |  |  |
| *Paper bag\* [M1]* | 1.9 | 0.315 | 1.53 | 0.118 |  | 0.180 | 13% | 0.180 | 13% |
| Organic fertilizer | *PE bag* | 1 | 0.167 | 3.38 | 0.062 | 0.210 |  |  |  |  |
| *Paper bag [P10]* | 2.3 | 0.144 | 1.27 | 0.142 |  | 0.180 | 14% | 0.180 | 14% |
| Chicken fodder | *PE bag* | 1 | 0.214 | 3.29 | 0.083 | 0.272 |  |  |  |  |
| *Paper bag\* [M2]* | 2.83 | 0.264 | 1.43 | 0.234 |  | 0.335 | -23% | 0.335 | -23% |
| Cement | *PE bag* | 1 | 0.191 | 3.3 | 0.008 | 0.025 |  |  |  |  |
| *Paper bag\* [M3]* | 1.66 | 0.139 | 1.44 | 0.012 |  | 0.018 | 28% | 0.018 | 28% |
| Pre-mixed cement | *PE bag* | 1 | 0.104 | 3.3 | 0.008 | 0.025 |  |  |  |  |
| *Paper bag\* [M4]* | 1.66 | 0.075 | 1.44 | 0.012 |  | 0.018 | 28% | 0.018 | 28% |
| ***Rigid nonfood bottles*** | | | | | | ***5.915*** | ***9.984*** | ***-68.8%*** | ***10.497*** | ***-77.5%*** |
| Paint 10L | *PE bucket* | 1 | 2.221 | 4.21 | 0.086 | 0.361 |  |  |  |  |
| *Tinplated steel bucket [S1]* | 1.67 | 2.9 | 3.29 | 0.143 |  | 0.472 | -31% | 0.472 | -31% |
| Paint 2.7L | *PE bucket* | 1 | 0.377 | 3.71 | 0.086 | 0.318 |  |  |  |  |
| *Tinplated steel bucket [S2]* | 2.39 | 0.805 | 3.31 | 0.205 |  | 0.679 | -113% | 0.679 | -113% |
| Supplements | *PE bottle* | 1 | 0.074 | 3.77 | 0.044 | 0.164 |  |  |  |  |
| *Glass bottle [G1]* | 6.39 | 0.134 | 1.07 | 0.279 |  | 0.299 | -82% | 0.299 | -82% |
| Motor oil | *PE bottle* | 1 | 0.257 | 4.32 | 0.046 | 0.198 |  |  |  |  |
| *Tinplated steel can [S3]* | 2.43 | 0.487 | 3.36 | 0.111 |  | 0.374 | -89% | 0.374 | -89% |
| House cleaner | *PE bottle* | 1 | 0.221 | 3.65 | 0.372 | 1.358 |  |  |  |  |
| *Paper bottle\* [M5]* | 1.43 | 0.364 | 4.22 | 0.531 |  | 2.238 | -65% |  |  |
| *Glass bottle [G2]* | 8.14 | 0.437 | 0.89 | 3.028 |  |  |  | 2.688 | -98% |
| Detergent | *PE bottle* | 1 | 0.254 | 3.66 | 0.372 | 1.363 |  |  |  |  |
| *Paper bottle\* [M6]* | 1.8 | 0.522 | 4.2 | 0.668 |  | 2.807 | -106% | 2.807 | -106% |
| Shampoo | *PE bottle* | 1 | 0.165 | 3.75 | 0.437 | 1.639 |  |  |  |  |
| *Glass bottle [G3]* | 6.06 | 0.243 | 0.91 | 2.644 |  | 2.417 | -47% | 2.417 | -47% |
| Lotion 250mL | *PE bottle* | 1 | 0.132 | 3.74 | 0.069 | 0.257 |  |  |  |  |
| *Paper bottle\* [M7]* | 0.83 | 0.126 | 4.32 | 0.057 |  | 0.247 | 4% | 0.247 | 4% |
| Lotion 150mL | *PE bottle* | 1 | 0.084 | 3.73 | 0.069 | 0.257 |  |  |  |  |
| *Glass jar [G4]* | 6.19 | 0.147 | 1.06 | 0.426 |  | 0.452 | -76% |  |  |
| *Aluminum foil [A1]* | 0.72 | 0.168 | 10.41 | 0.049 |  |  |  | 0.515 | -101% |
| ***Flexible food pouches*** | | | | | | ***2.207*** | ***3.391*** | ***-53.6%*** | ***6.888*** | ***-212.1%*** |
| Potatoes | *PE bag* | 1 | 0.018 | 3.38 | 0.074 | 0.251 |  |  |  |  |
| *Paper bag [P11]* | 5.61 | 0.045 | 1.53 | 0.417 |  | 0.637 | -154% | 0.637 | -154% |
| Cashew nuts | *PE pillow pouch* | 1 | 0.012 | 3.51 | 0.054 | 0.190 |  |  |  |  |
| *Tinplated steel can [S4]* | 13.62 | 0.16 | 3.31 | 0.738 |  | 0.144 | 24% |  |  |
| *Paper stand-up pouch\* [M20]* | 1.83 | 0.009 | 1.46 | 0.099 |  |  |  | 2.442 | -1186% |
| Salt | *PE pillow pouch* | 1 | 0.016 | 3.38 | 0.000 | 0.002 |  |  |  |  |
| *Paperboard box [P12]* | 5.29 | 0.034 | 1.31 | 0.003 |  | 0.003 | -106% |  |  |
| *Paperboard tube\* [M8]* | 13.41 | 0.131 | 2.02 | 0.007 |  |  |  | 0.013 | -701% |
| Sugar | *PE pouch* | 1 | 0.049 | 4.1 | 0.090 | 0.369 |  |  |  |  |
| *Paper gable top\* [M9]* | 3.87 | 0.083 | 1.8 | 0.348 |  | 0.079 | 79% |  |  |
| *Paper pouch [P13]* | 0.74 | 0.011 | 1.19 | 0.066 |  |  |  | 0.627 | -70% |
| Juice | *PE stand-up pouch* | 1 | 0.034 | 2.55 | 0.000 | 0.000 |  |  |  |  |
| *Carton\* [M10]* | 0.9 | 0.028 | 2.35 | 0.000 | 0.000 |  |  |  |  |
| *Glass bottle [G5]* | 9.89 | 0.127 | 0.97 | 0.000 | 0.000 |  |  |  |  |
| Produce bag | *PE bag* | 1 | 0.011 | 3.38 | 0.074 | 0.251 |  |  |  |  |
| *Paper bag [P14]* | 3.09 | 0.012 | 1.19 | 0.230 |  | 0.274 | -9% | 0.274 | -9% |
| Apples | *PE bag* | 1 | 0.022 | 3.38 | 0.074 | 0.251 |  |  |  |  |
| *Corrugated tray [P15]* | 4.2 | 0.033 | 1.23 | 0.312 |  | 0.384 | -53% |  |  |
| *Paperboard tray\* [M11]* | 5 | 0.05 | 1.58 | 0.371 |  |  |  | 0.585 | -133% |
| Mayonnaise | *PE stand-up pouch* | 1 | 0.032 | 3.65 | 0.016 | 0.059 |  |  |  |  |
| *Aluminum tube [A2]* | 2.5 | 0.226 | 10.26 | 0.041 |  | 0.405 | -584% |  |  |
| *Glass jar [G6]* | 23.96 | 0.22 | 1.04 | 0.389 |  |  |  | 0.417 | -604% |
| Hot chocolate | *PE pouch* | 1 | 0.02 | 4 | 0.007 | 0.029 |  |  |  |  |
| *Paperboard + bag [P16]* | 6.4 | 0.041 | 1.31 | 0.046 |  | 0.061 | -110% |  |  |
| *Paperboard box\* [M12]* | 10.72 | 0.07 | 1.33 | 0.077 |  |  |  | 0.103 | -256% |
| Instant coffee | *PE gusseted pouch* | 1 | 0.045 | 4.63 | 0.007 | 0.033 |  |  |  |  |
| *Tinplated steel can [S5]* | 12.11 | 0.391 | 3.35 | 0.087 |  | 0.293 | -776% |  |  |
| *Glass container [G7]* | 53.19 | 0.547 | 1.07 | 0.384 |  |  |  | 0.409 | -1125% |
| Coffee | *PE pouch* | 1 | 0.049 | 4.14 | 0.007 | 0.030 |  |  |  |  |
| *Paper gusseted pouch\* [13]* | 1.14 | 0.017 | 1.27 | 0.008 |  | 0.011 | 65% |  |  |
| *Tinplated steel can* | 11.45 | 0.462 | 3.4 | 0.083 |  |  |  | 0.281 | -840% |
| Frozen pizza | *PE shrink film* | 1 | 0.018 | 5.21 | 0.084 | 0.438 |  |  |  |  |
| *Paper pouch\* [M14]* | 5.37 | 0.026 | 1.36 | 0.452 |  | 0.616 | -41% | 0.616 | -41% |
| Frozen pizza bread | *PE pillow pouch* | 1 | 0.055 | 4.06 | 0.027 | 0.108 |  |  |  |  |
| *Paperboard box\* [M15]* | 3.78 | 0.072 | 1.4 | 0.101 |  | 0.141 | -31% | 0.141 | -31% |
| Frozen peas | *PE pillow pouch* | 1 | 0.024 | 3.38 | 0.027 | 0.090 |  |  |  |  |
| *Paperboard box\* [M16]* | 2.73 | 0.026 | 1.39 | 0.073 |  | 0.101 | -12% | 0.101 | -12% |
| Frozen herbs | *PE stand-up pouch* | 1 | 0.019 | 3.38 | 0.002 | 0.006 |  |  |  |  |
| *Paperboard box\* [M17]* | 4.27 | 0.033 | 1.38 | 0.008 |  | 0.011 | -74% | 0.011 | -74% |
| Frozen raspberries | *PE pillow pouch* | 1 | 0.011 | 3.38 | 0.027 | 0.090 |  |  |  |  |
| *Paperboard box\* [M18]* | 6 | 0.026 | 1.39 | 0.160 |  | 0.223 | -146% | 0.223 | -146% |
| Frozen mangos | *PE stand-up pouch* | 1 | 0.052 | 4.13 | 0.002 | 0.008 |  |  |  |  |
| *Paperboard box\* [M19]* | 2.58 | 0.045 | 1.39 | 0.005 |  | 0.007 | 13% | 0.007 | 13% |
| **Total** | |  |  |  | **4.85** | **17.54** | **24.50** |  | **28.65** |  |

Asterisk (\*) indicates a multi-material paper format, with the primary material and format listed before the asterisk. MTA = million metric tons per annum; PE: polyethylene-based; FU: functional unit

1. Sensitivity Analyses

Different sensitivity analyses were performed on the shrink film, paperboard wrap, and cardboard can carrier 2 for cans 0.33 L x 6 in EUR and geographical ones for all four products.

Alternative polymer composition of the shrink film (70% LDPE + 30% LLDPE instead of 54% LDPE + 37% LLDPE + 9% HDPE)

Higher amount of PCR content of the shrink film (30% instead of 0%)

Higher plastic recycling rates (RR) of 50% and 70% instead of 41.4%.

Lower paper recycling rates of 50% and 71.4% in addition to the baseline paper recycling rate of 84.2% on the examples of the cardboard can carrier 2 and the paperboard wrap (cans 0.33 L x 6).

The A-factor for fibre-based materials is changed (default: 0.2) to A = 0, 0.5, 0.8 and 1. The A-factor for plastic (default 0.5) is changed to A = 0, 0.5, 0.8, 1.

Geographical scenarios for Germany and the United Kingdom with changed rates for recycling, incineration and landfilling at EOL.

### Collation shrinks

1. Sensitivity analysis for plastic collation shrink (cans 0.33 L x 6) EUR. |positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on collation shrink film  (cans 0.33 L x 6) | Climate change | Water  scarcity | Resources,  fossil |
| 1. | Other composition (70% LDPE, 30% LLDPE) | 0% | 0% | +1% |
| 2. | 30% PCR | -8% | -11% | -12% |
| 3. | RR 50% | -3% | -1% | -1% |
| 3. | RR 70% | -8% | -4% | -3% |
| 5. | A-factor = 0 | -3% | -7% | -8% |
| 5. | A-factor = 0.2 | -2% | -4% | -5% |
| 5. | A-factor = 0.8 | +2% | +4% | +5% |
| 5. | A-factor = 1 | +3% | +7% | +8% |
| 6. | Geographical scenarios | GER: +22%, UK: -10% | GER: -18%, UK: -19% | GER: -9.9%, UK: -5% |
|  | 54% LDPE, 37% LLDPE, 9% HDPE; PCR 0% RR 41.4%, A = 0.5, EUR | Baseline | Baseline | Baseline |

1. Results sensitivity analysis for paperboard wrap (cans 0.33 L x 6) EUR. |positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on paperboard wrap  (cans 0.33 L x 6) | Climate change | Water  scarcity | Resources,  fossil |
| 4. | RR 50% | +18% | +1% | +1% |
| 4. | RR 71.4% | +7% | +1% | 0% |
| 5. | A-factor = 0 | +1% | -3% | -4% |
| 5. | A-factor = 0.5 | -1% | +4% | +6% |
| 5. | A-factor = 0.8 | -2% | +9% | +12% |
| 5. | A-factor = 1 | -2% | +12% | +17% |
| 6. | Geographical scenarios | GER: -23%, UK: -20% | GER: -14%, UK: -16% | GER: -22%, UK: -20% |
|  | RR 84.2%, A=0.2, EUR | Baseline | Baseline | Baseline |

1. Results sensitivity analysis for cardboard can carrier 2 (cans 0.33 L x 6) EUR. |positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on cardboard can carrier 2 (cans 0.33 L x 6) | Climate change | Water  scarcity | Resources,  fossil |
| 4. | RR 50% | +16.3% | -6.8% | -11.0% |
| 4. | RR 71.4% | +6.2% | -2.5% | -4.1% |
| 6. | Geographical scenarios | GER: -30%, UK: -19% | GER: -8%,  UK: -10% | GER: -26%, UK: -30% |
|  | RR 84.2%, EUR | Baseline | Baseline | Baseline |

1. Results sensitivity analysis for paperboard can carrier 1 (cans 0.33 L x 6) EUR. |positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on cans 0.33 L x 6 | Climate change | Water  scarcity | Resources, fossil |
| 6. | Geographical scenarios | GER: -23%, UK: -20% | GER: -14%,  UK: -16% | GER: -22%, UK: -20% |
|  | EUR | Baseline | Baseline | Baseline |

### Stretch films for pallet wraps

The sensitivity analysis included:

1. Additional packaging formats. Different weights of eight stretch films and six paper wraps.
2. Different recycling rates
   * Lower paper recycling rate of 71.4% instead of 84.2% for stretch wraps.
   * Lower paper recycling rate of 50% instead of 84.2% for stretch wraps.
   * Higher plastics recycling rate of 50% instead of 41.4% for stretch films.
   * Higher plastics recycling rate of 70% instead of 41.4% for stretch films.
3. Higher amount of secondary raw material of 30% instead of 0% for stretch wraps
4. Different transport modes for paper wrap: van instead of a truck for T5 (250 km).
5. The renewable energy mix instead of the European for stretch wraps. The raw material & production phase is investigated.)
6. The impact of stretch films (tertiary packaging) compared to primary/secondary packaging on a pallet loaded with cardboard boxes on the three considered categories.
7. Manipulating the A-factor (0, 0.2, 0.5, 0.8, 1) of a stretch film and a paper wrap.
8. The stretch wraps are calculated with the cut-off approach to determine the influence of the EOL allocation method (burden sharing) of the CFF.
9. Geographical scenarios for Germany and the United Kingdom with changed rates for recycling, incineration and landfilling at EOL.
10. Results Sensitivity analysis for stretch films (LLDPE, 177 g) EUR | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis  on stretch films | Climate change | Water  scarcity | Resources,  fossil |
| 1. | Other weights (132 g – 400 g) | -25% to +126% | -25% to 126% | -25% to 126% |
| 2. | RR 50% | -4% | -2% | -1% |
| 2. | RR 70% | -13% | -5% | -4% |
| 3. | PCR 30% | -8% | -13% | -16% |
| 5. | Renewable energy mix (raw material & production phase) | -16% | -3% | -11% |
| 6. | Tertiary and secondary packaging (cardboard boxes compared to 177 g stretch film) | +2737% | +1264% | +1656% |
| 7. | A = 0 | -4% | -9% | -11% |
| 7. | A = 0.2 | -3% | -6% | -7% |
| 7. | A = 0.8 | +3% | +6% | +7% |
| 7. | A = 1 | +4% | +9% | +11% |
| 8. | Cut-off instead of CFF | +13% | +12% | +18% |
| 9. | Geographical scenarios | GER: +8%,  UK: -4% | GER: -4%,  UK: -4% | GER: -11%,  UK: -8% |
|  | 177 g, EUR, RR 41.4%, A = 0.5 | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis for paper wraps (Paper, 646g) EUR | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on paper wraps | Climate change | Water  scarcity | Resources, fossil |
| 1. | Other weights (600 g – 964 g) | -7% to +49% | -7% to +49% | -7% to +49% |
| 2. | RR 71.5% | +5% | +2% | -4% |
| 2. | RR 50% | +14% | +5% | -11% |
| 4. | Van (instead of truck for T5) | +37% | +10% | +46% |
| 5. | Renewable energy mix (raw material & production phase) | -27% | -7% | -41% |
| 7. | A = 0 | +4% | -5% | 3% |
| 7. | A = 0.5 | -6% | +7% | -4% |
| 7. | A = 0.8 | -12% | +14% | -8% |
| 7. | A = 1 | -16% | +19% | -11% |
| 8. | Cut-off instead of CFF | -14% | +21% | -8% |
| 9. | Geographical scenarios | GER: -30, UK: -21 | GER: -4%, UK: -12% | GER: -22%, UK: -28% |
|  | 646 g, EUR, RR 84.2%, A = 0.2 | Baseline | Baseline | Baseline |

### Rigid Packaging Non-Food

For rigid non-food packaging the following sensitivity analysis were performed:

Modified PCR content on the example of the HDPE bottle (30% PCR) and the aluminium can (50% and 75% PCR) of the body lotion 150 mL is examined

Furthermore, different geographical scenarios were calculated using the example of shampoo 500 mL (see Table 118) and liquid detergents 1.5 L

1. Results Sensitivity analysis for HDPE bottle (body lotion 150 mL) EUR. | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on HDPE bottle (body lotion 150 mL) | Climate change | Water  scarcity | Resources,  fossil |
| 1. | 30% PCR | -6% | -11% | -10% |
|  | 0% PCR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis for aluminium can (body lotion 150 mL) EUR. | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on aluminium can (body lotion 150 mL) | Climate change | Water  scarcity | Resources,  fossil |
| 1. | 50% PCR | -21% | -15% | -21% |
| 1. | 75% PCR | -32% | -22% | -31% |
|  | 0% PCR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios – shampoo 500 mL | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on shampoo 500 mL | Climate change | Water  scarcity | Resources,  fossil |
| 2. | Geographical scenarios: HDPE bottle | GER: +8%,  UK: -5% | GER: -17%,  UK: -15% | GER: -13%,  UK: -7% |
| 2. | Geographical scenarios: glass bottle | GER: -22%,  UK: -23% | GER: -11%,  UK: -11% | GER: -24%,  UK: -24% |
|  | EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios – liquid detergent 1.5 L | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on liquid detergent 1.5 L | Climate change | Water  scarcity | Resources,  fossil |
| 2. | Geographical scenarios: HDPE bottle | GER: +13%,  UK: -6% | GER: -16%,  UK: -16% | GER: -12%,  UK: -7% |
| 2. | Geographical scenarios: paper bottle | GER: +3%,  UK: -21% | GER: -23%,  UK: -25% | GER: -14%,  UK: -6% |
|  | EUR | Baseline | Baseline | Baseline |

### Heavy Duty Sacks

The following parameters were checked by sensitivity analyses:

1. Different recycling rates are examined using the examples of HDS cement 25 kg paper and plastic.
2. Incorporation of secondary material: A PCR content of 30% is examined on the wood pellet plastic sack of 15 kg.
3. Different film strength: Other film thicknesses (100 µm, 140 µm) are examined using the example of HDS plastic cement 25 kg.
4. Geographical sensitivities (GER and UK) on the example of HDS cement 25 kg, chicken fodder 20 kg, and wood pellets 15 kg.

1. Results Sensitivity analysis RR and thickness plastic HDS cement 25 kg | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on plastic HDS cement 25 kg | Climate change | Water  scarcity | Resources, fossil |
| 1. | RR 0% | +20% | +8% | +8% |
| 1. | RR 50% | -4% | -2% | -2% |
| 1. | RR 70% | -14% | -5% | -6% |
| 3. | 100 µm | -20% | -23% | -20% |
| 3. | 140 µm | +15% | +21% | +15% |
| 4. | Geographical scenarios | GER: -22%, UK: -15% | GER: -5%, UK: -0% | GER: -22%, UK: -22% |
|  | RR 41.4%, EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis RR paper HDS cement 25 kg | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on paper HDS cement 25 kg | Climate change | Water  scarcity | Resources, fossil |
| 1. | RR 0% | +34% | +19% | -13% |
| 1. | RR 35% | +20% | +11% | -7% |
| 1. | RR 50% | +14% | +8% | -5% |
| 1. | RR 71.4% | +5% | +3% | -2% |
| 4. | Geographical scenarios | GER: +8%, UK: -5% | GER: -5%, UK: -4% | GER: -12%, UK: -8% |
|  | RR 84.2%, EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis PCR and geographies plastic HDS wood pellets 15 kg| positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on wood pellets 15 kg plastic sack | Climate change | Water  scarcity | Resources, fossil |
| 2. | PCR 30% | -8% | -10% | -16% |
| 4. | Geographical scenarios | GER: +11%, UK: -6% | GER: -7%, UK: -6% | GER: -11%, UK: -7% |
|  | PCR 0%, EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographies paper HDS wood pellets 15 kg. | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nr. | Sensitivity analysis on wood pellets 15 kg paper sack | Climate change | Water  scarcity | Resources, fossil |
| 4. | Geographical scenarios | GER: -30%, UK: -18% | GER: -5%, UK: +1% | GER: -24%, UK: -26% |
|  | EUR | Baseline | Baseline | Baseline |

### Flexible Packaging

A sensitivity analysis on the recycling rate of aluminium was performed on the Coffee PET/Alu/PE pouch

1. Results Sensitivity analysis recycling rate - Coffee PET/Alu/PE pouch EUR | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on Coffee PET/Alu/PE Pouch | Climate change | Water  scarcity | Resources, fossil |
| RR 55% Aluminium | -8% | -4% | -6% |
| RR 0% Aluminium | Baseline | Baseline | Baseline |

Moreover, the impacts of packaging for frozen mango, frozen peas, frozen pizza, produce bags and juice were examined for other regional scenarios

1. Results Sensitivity analysis geographical scenarios - frozen mangos 500 g | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on frozen mangos 500 g | Climate change | Water  scarcity | Resources, fossil |
| LDPE/PET stand-up pouch (GER, UK) | GER: +19%, UK: +1% | GER: -7%,  UK: -6% | GER: -13%, UK: -7% |
| Laminated paperboard box (GER, UK) | GER: -20%, UK: -18% | GER: -13%, UK: -15% | GER: -21%, UK: -18% |
| EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios - frozen peas 300 g | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on frozen peas 300 g | Climate change | Water  scarcity | Resources, fossil |
| LDPE pillow pouch (GER, UK) | GER: +11%, UK: -6% | GER: -7%,  UK: -6% | GER: -11%, UK: -7% |
| paperboard box (GER, UK) | GER: -20%, UK: -18% | GER: -13%, UK: -15% | GER: -21%, UK: -18% |
| EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios - frozen pizza 430 g | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on frozen pizza 430 g | Climate change | Water  scarcity | Resources, fossil |
| LDPE shrink film | GER: +23%, UK: -11% | GER: -19%, UK: -21% | GER: -10%, UK: -5% |
| Laminated paper pouch | GER: -21%, UK: -15% | GER: -7%,  UK: -6% | GER: -23%, UK: -19% |
| Laminated paperboard box | GER: -20%, UK: -18% | GER: -13%, UK: -15% | GER: -22%, UK: -19% |
| Paperboard box + shrink film | GER: -17%, UK: -18% | GER: -15%, UK: -13% | GER: -20%, UK: -17% |
| EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios – produce bags 1 kg | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on produce bags 1 kg | Climate change | Water  scarcity | Resources, fossil |
| LDPE bag (GER, UK) | GER: +11%, UK: -6%% | GER: -7%,  UK: -6% | GER: -11%, UK: -7% |
| Paper bag (GER, UK) | GER: -30%, UK: -22% | GER: -7%,  UK: -5% | GER: -26%, UK: -30% |
| EUR | Baseline | Baseline | Baseline |

1. Results Sensitivity analysis geographical scenarios - juice 200 mL | positive values indicate higher impacts than the baseline scenario, negative values indicate lower impacts than the baseline scenario; only significant if difference is greater than 10%

|  |  |  |  |
| --- | --- | --- | --- |
| Sensitivity analysis on juice 200 mL | Climate change | Water  scarcity | Resources, fossil |
| PET/Alu/PE stand-up pouch (GER, UK) | GER: -4%,  UK: -11% | GER: -7%,  UK: -8% | GER: -15%,  UK: -14% |
| Beverage carton (GER, UK) | GER: -2%,  UK: -10% | GER: -9%,  UK: -10% | GER: -14%, UK: -11% |
| Glass bottle (GER, UK) | GER: -19%, UK: -22% | GER: -11%, UK: -11% | GER: -23%, UK: -22% |
| EUR | Baseline | Baseline | Baseline |

List of references:

APEAL (2024): Statistics. Association of European Producers of steel for packaging. Online verfügbar unter https://www.apeal.org/statistics/?\_gl=1\*1p9kec0\*\_up\*MQ.\*\_ga\*NDE4MzkwNzQ0LjE3MTgwMDQ5NzY.\*\_ga\_Y7QMD6NMVV\*MTcxODAwNDk3Ni4xLjAuMTcxODAwNDk3Ni4wLjAuMA., zuletzt geprüft am 10.06.2024.

Boulay, Anne-Marie; Bare, Jane; Benini, Lorenzo; Berger, Markus; Lathuillière, Michael J.; Manzardo, Alessandro et al. (2018): The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). In: *Int J Life Cycle Assess* 23 (2), S. 368–378. DOI: 10.1007/s11367-017-1333-8.

Bukowsky Todd; Richmond Michale (2018): A Holistic View of the Role of Flexible Packaging in a Sustainable World. Flexible Packaging Association. Online verfügbar unter www.flexpack.org/publication, zuletzt geprüft am 10.06.2024.

European Aluminium Foil Association (2024): Recycling & Recovery of Aluminium Foil Packaging. European Aluminium Foil Association. Online verfügbar unter https://www.alufoil.org/recycling-recovery, zuletzt geprüft am 10.06.2024.

European Commission (2018): Product Environmental Footprint Category Rules Guidance. Version 6.3. European Commission. Online verfügbar unter https://eplca.jrc.ec.europa.eu/permalink/PEFCR\_guidance\_v6.3-2.pdf, zuletzt geprüft am 23.05.2024.

Eurostat (2023): Food waste per capita in the EU remained stable in 2021. Online verfügbar unter https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20230929-2, zuletzt geprüft am 31.05.2024.

Eurostat (2024): Packaging waste statistics. Eurostat. Online verfügbar unter https://ec.europa.eu/eurostat/databrowser/view/env\_waspac\_\_custom\_11505561/default/table?lang=en, zuletzt geprüft am 23.05.2024.

Flaschenland (2023): 1000 ml Medizinflasche. Flaschenland. Online verfügbar unter https://www.flaschenland.de/1-000-ml-medizinflasche-braun-glas-muendung-pp-28-100013690, zuletzt geprüft am 10.11.2023.

Fries Kunststofftechnik: Rundeimer 10 Liter. Fries Kunststofftechnik. Online verfügbar unter https://www.fries-kt.com/wp-content/uploads/Rundeimer-10l-PE.pdf, zuletzt geprüft am 10.10.2023.

Green Delta (2024): openLCA 2.0. Green Delta. Online verfügbar unter https://www.openlca.org/download/, zuletzt geprüft am 23.05.2024.

Gürlich Ulla; Kladnik Veronika; Pavlovic Katharina (2023): Packaging Design for Recycling. World Packaging Organization; Ecoplus. Vienna. Online verfügbar unter https://ecr-austria.at/2020/06/22/packaging-design-for-recycling/, zuletzt geprüft am 10.06.2024.

Hildering Packaging (2023): https://www.hildering.com/cms/de/weissblechverpackungen-und-faesser/konische-farbeimer. Hildering Packaging. Online verfügbar unter https://www.hildering.com/cms/de/weissblechverpackungen-und-faesser/konische-farbeimer, zuletzt geprüft am 10.10.2023.

Lantech (2017): Shipping damage. The hidden costs. Lantech. Online verfügbar unter https://www.lantech.com/shipping-damage-the-hidden-costs/, zuletzt geprüft am 04.06.2024.

Lestido-Cardama, Antía; Sendón, Raquel; Bustos, Juana; Nieto, María Teresa; Paseiro-Losada, Perfecto; Rodríguez-Bernaldo de Quirós, Ana (2022): Food and beverage can coatings: A review on chemical analysis, migration, and risk assessment. In: *Comprehensive reviews in food science and food safety* 21 (4), S. 3558–3611. DOI: 10.1111/1541-4337.12976.

Li, Ning; Qiu, Keqiang (2013): Study on delacquer used beverage cans by vacuum pyrolysis for recycle. In: *Environmental science & technology* 47 (20), S. 11734–11738. DOI: 10.1021/es4022552.

Menke Industrieverpackungen (2023): Weißblech Eindrückdeckel. Menke Industrieverpackungen. Online verfügbar unter https://www.menke-industrieverpackungen.de/deckel/weissblech-eindrueckdeckel-58-00-0163-15-00-028, zuletzt geprüft am 10.06.2024.

Microsoft (2022): Stretch Wrap Alternative Project. Microsoft. Online verfügbar unter https://flex.com/downloads/white-paper-stretch-wrap-alternative-project, zuletzt geprüft am 10.06.2024.

Mondi (2021): Comparison of Mondi Advantage StretchWrap to ploastic stretch film. Mondi. Vienna. Online verfügbar unter ttps://www.mondigroup.com/en/products-and-solutions/speciality-kraft-paper/speciality-kraft-paper-products/advantage-stretchwrap/, zuletzt geprüft am 28.02.2023.

Niero, Monia; Olsen, Stig Irving (2016): Circular economy: To be or not to be in a closed product loop? A Life Cycle Assessment of aluminium cans with inclusion of alloying elements. In: *Resources, Conservation and Recycling* 114, S. 18–31. DOI: 10.1016/j.resconrec.2016.06.023.

UK Government (2024): Statistics on Waste. UK Government. Online verfügbar unter https://www.gov.uk/government/statistics/uk-waste-data/uk-statistics-on-waste, zuletzt geprüft am 10.06.2024.

Umwelt Bundesamt (2024): Verpackungsabfälle. Umwelt Bundesamt Deutschland. Online verfügbar unter https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/verpackungsabfaelle#verpackungen-uberall, zuletzt geprüft am 10.06.2024.

van Oers, L.; Koning, A. de; Guinee, J. B.; Huppes G. (2002): Abiotic resource depletion in LCA. Ministerie van Verkeer en Waterstaat, Netherlands. Online verfügbar unter https://web.universiteitleiden.nl/cml/ssp/projects/lca2/report\_abiotic\_depletion\_web.pdf, zuletzt geprüft am 3.6.20024.