Key findings of LCA study on Tetra Recart

Study title: Comparative Life Cycle Assessment of shelf stable canned food packaging

commissioned by Tetra Recart AB

Stefanie Markwardt & Frank Wellenreuther

Institute for Energy and Environmental Research, Heidelberg, Germany
Who is ifeu?

ifeu – Institute for Energy and Environmental Research ...  
...founded in 1978 by a group of scientists from the University of Heidelberg.

Today...  
...ifeu is an independent non-profit ecological research institute without any party political and economical influence. Financing solely project-bounded means orders 2/3 from public sector 1/3 from private enterprises.

An important part of the institute...  
... is the commitment of its employees to a sustainable society.

Clients...  
... include international institutions, federal and state ministries and agencies, governments, well-known companies, business associations, NGOs, public utilities, transport and logistics service providers.

Research and consulting for a sustainable society

70 Scientists working on

Resource protection and waste

Energy
Evaluation of technologies, development of strategies and policies for a sustainable and efficient energy system, development of climate action plans

Food and Biomass
Environmental assessment and sustainability analyses of foodstuffs, animal feed, bioenergy and all aspects of renewable raw materials from different biomass sources

Industry and Products
Environmental impact assessment, resource and risk analysis of products, processes, technologies, sustainable urban development

Mobility
Analysis of energy consumption and emissions from all motorised transport systems, evaluation of strategies designed to reduce the environmental impact of transport.
Industry and Products

Longstanding experience in
- Life Cycle Assessment (LCA) and GHG emission calculation
- Development of methodologies and standards, e.g. German Federal Environment Agency (UBA) and ISO Standards for LCA

In recent years
- LCA of packaging systems and cooperation with packaging producers worldwide
- Special focus on beverage packaging systems including many LCA studies
- General environmental consultancy for Tetra Pak and ACE

Neutral and independent
- Commissioned also by competitors like bottle or can producers
- Consultancy also for European Commission, ministries and agencies
Content

- Goal and Scope of the study
- Results Germany
- Results Italy
- Results scenario variants European market
- Conclusions and recommendations
Goal and Scope of LCA Tetra Recart

Main objectives

- Assessment of the environmental strengths and weaknesses of the Tetra Recart retortable carton.
- Comparison of the environmental performance of Tetra Recart with those of its competing packaging systems in the packed food segment on the markets Germany, Italy, EU 28+2.
- Provision of quantitative data to substantiate that the environmental profile is a key sales argument for Tetra Recart, to be used in external communication including comparative claims.
- This study is performed in compliance with the ISO framework on LCA (ISO 14040 and ISO 14044).
Goal and Scope of LCA Tetra Recart

LCA framework according to ISO 14040/44

Goal and scope definition
- Functional unit
- System boundaries
- Data requirements

Inventory analysis
- Data gathering and selection
- System model
- Databases

Impact assessment
- Selection of impact categories and indicators
- Quantification of the environmental impacts

Interpretation
- Determination of significant issues
- Evaluations (sensitivity, completeness, consistency)
- Conclusions

Critical review panel of LCA Tetra Recart
- Manfred Russ, thinkstep (Germany)
- Leigh Holloway, Eco3Design Ltd (United Kingdom)
- Gian Luca Baldo, Life Cycle Engineering (Italy)

Publication of LCA
Goal and Scope of LCA Tetra Recart

System boundaries

‘Cradle-to-grave’ LCA

Raw materials

Manufacturing

Distribution

End of life/recycling

Emissions

Wood carton; tray
Oil Polymers
Bauxite Aluminium

Converting Filling

Transport to point of sale

Waste collection and sorting Recycling Incineration, landfilling

Environmental impact categories, examples:

• Climate Change / Global Warming Potential (CO₂ equivalents)
• Terrestrial / Aquatic Eutrophication (PO₄ equivalents)
• ...
### Goal and Scope of LCA Tetra Recart

#### System boundaries: cradle-to-grave

**Included life cycle elements**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base materials</strong></td>
<td>• Extraction, production, converting and transport of the primary base materials used in the primary packaging elements (including chemicals, additives)</td>
</tr>
<tr>
<td><strong>Converting</strong></td>
<td>• Converting and transport of primary packaging elements (including closure and label)</td>
</tr>
<tr>
<td><strong>Transport packaging</strong></td>
<td>• Production, converting and transport of transport packaging (i.e. stretch foil, pallets, cardboard trays)</td>
</tr>
<tr>
<td><strong>Filling</strong></td>
<td>• Transport of materials to filler and filling processes</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>• Transport from fillers to potential central warehouses and final distribution to the point of sale</td>
</tr>
<tr>
<td><strong>Recycling &amp; disposal</strong></td>
<td>• Sorting, recycling and disposal processes for primary packaging and transport packaging (including energy recovery)</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td>• Credits for energy recovery (replacing e.g. grid electricity) and material recycling</td>
</tr>
</tbody>
</table>
Goal and Scope of LCA Tetra Recart

System boundaries: cradle-to-grave

Excluded life cycle elements

• production and disposal of infrastructure and their maintenance
• production of food and transport to fillers
• Retorting
• distribution of food from the filler to the point-of-sale
• environmental effects from accidents
• environmental effects related to storage phases
• losses of food at different points in the supply and consumption chain which might occur for instance in the filling process, during handling and storage
• transport of filled packages from the point of sale to the consumer
• follow up use phase of packages at the consumers (e.g. potential washing processes of the packages by the user after emptying)
Goal and Scope of LCA Tetra Recart

System boundaries: flowcharts of systems

Food carton Tetra Recart

Material Production:
- Liquid packaging board (LPB)
- Polymer¹
- Aluminium
- Paper
- LDPE
- Wood

Production of Packaging & Filling:
- Converting to sleeves
- Food production & retorting excluded
- Filling
- Cardboard trays production
- LDPE foil production
- Pallet production

Distribution and Point of sale:
- Distribution
- Point of sale
- Pallets for reuse

End-of-Life:
- Recycling & recovery
- MSWI
- Landfill*

Credits:
- displaced Primary fibres, bauxite**, & heat energy
- displaced energy - electric - heat

¹ exact composition is aggregated to „Polymer“ due to confidentiality.
**only valid for Germany
*Not valid for Germany
Goal and Scope of LCA Tetra Recart

**System boundaries: flowcharts of systems**

**Steel can**

- **Material Production**
  - Tinplate
  - Paper
  - LDPE
  - Wood

- **Production of Packaging & Filling**
  - Converting to can
  - Converting to closure & lid
  - Converting to labels
  - Cardboard sheets production
  - LDPE foil production
  - Pallet production

- **Distribution and Point of sale**
  - Food production & retorting excluded
  - Pallets for reuse
  - Distribution
  - Point of sale

- **End-of-Life**
  - Recycling & recovery
  - MSWI
  - Landfill*

- **Credits**
  - Displaced primary tinplate
  - Displaced energy - electric - heat

*Not valid for Germany
Goal and Scope of LCA Tetra Recart

System boundaries: flowcharts of systems

Glass jar

Material Production
- Glass
- Tinplate
- LDPE
- Paper

Production of Packaging & Filling
- Converting to jar
- Converting to caps
- Converting to labels
- Filling

Distribution and Point of sale
- Distribution
- Point of sale
- Pallets for reuse

End-of-Life
- Recycling & recovery
- MSWI
- Landfill*

Credits
- displaced primary glass
- displaced energy - electric - heat

*Not valid for Germany

Food production & retorting excluded

Transport packaging components
- Paper
- LDPE
- Wood

Primary packaging components
- Paper
- LDPE
- Tinplate

Cardboard sheets production
- LDPE foil production
- Pallet production

Distribution

Landfill*

*Not valid for Germany

Filling

Cardboard sheets production

LDPE foil production

Pallet production

Food production & retorting excluded

Pallets for reuse
Goal and Scope of LCA Tetra Recart

System allocation approach

How are the impacts and benefits of recycling and recovery processes considered in the system model?

Base scenarios: Allocation factor 50%

Half of the burdens and credits from recovery and recycling processes are allocated to the system under examination, the other half is allocated to the subsequent system.

Sensitivity analysis: Allocation factor 100%

All burdens and credits are allocated to the system under study.

➢ Results of one allocation approach are not more correct than those of another.

➢ ISO requirements: Application of two different allocation approaches to verify the influence of this methological choice on the results.
Impact categories represent the environmental issues of concern, to which life cycle inventory analysis results per functional unit are assigned, **BUT do not reflect actual environmental damages.**
**Goal and Scope of LCA Tetra Recart**

**Environmental impact assessment**

<table>
<thead>
<tr>
<th>Impact categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate Change</strong></td>
<td>Addresses the impact of anthropogenic emissions on the radiative forcing of the atmosphere. Greenhouse gas emissions enhance the radiative forcing, resulting in an increase of the earth’s temperature.</td>
</tr>
<tr>
<td><strong>Stratospheric Ozone Depletion</strong></td>
<td>Anthropogenic impact on the earth’s atmosphere, which leads to the decomposition of naturally present ozone molecules, thus disturbing the ozone layer in the stratosphere.</td>
</tr>
<tr>
<td><strong>Photo-Oxidant Formation</strong></td>
<td>Also known as summer smog, is the photochemical creation of reactive substances (mainly ozone), which affect human health and ecosystems. This ground-level ozone is formed in the atmosphere by nitrogen oxides and volatile organic compounds in the presence of sunlight.</td>
</tr>
<tr>
<td><strong>Acidification</strong></td>
<td>Affects aquatic and terrestrial ecosystems by changing the acid-basic-equilibrium through the input of acidifying substances.</td>
</tr>
<tr>
<td><strong>Terrestrial Eutrophication</strong></td>
<td>Eutrophication means the excessive supply of nutrients and can apply to both surface waters and soils.</td>
</tr>
</tbody>
</table>
| **Aquatic Eutrophication**    | *terrestrial*: eutrophication of soils by atmospheric emissions  
*aquatic*: eutrophication of water bodies by effluent releases                                                                                                                                             |
| **Particulate Matter**        | Covers effects of fine particulates with an aerodynamic diameter of less than 2.5 µm (PM 2.5) emitted directly or formed from precursors as NOₓ and SO₂. A correlation between the exposure to particulate matter and the mortality from respiratory diseases as well as a weakening of the immune system exists. |
| **Total Primary Energy**      | Quantification of the primary energy consumption of a system. It is calculated by adding the energy content of all used fossil fuels, nuclear and renewable energy (including biomass). |
| **Non-renewable Primary Energy** | Considers the primary energy consumption based on non-renewable, i.e. fossil and nuclear energy sources.                                                                                                     |
## Goal and Scope of LCA Tetra Recart

### Environmental impact assessment

<table>
<thead>
<tr>
<th>Impact categories</th>
<th>Elementary Flows</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Climate Change</strong></td>
<td>CO(_2)(^*)</td>
<td>kg CO(_2)-e</td>
</tr>
<tr>
<td></td>
<td>CH(_4)(^**)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N(_2)O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C(_2)F(_2)H(_4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CF(_4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CCl(_4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C(_2)F(_6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R(_2)(_2)</td>
<td></td>
</tr>
<tr>
<td><strong>Stratospheric Ozone Depletion</strong></td>
<td>CFC-11</td>
<td>kg CFC-11-e</td>
</tr>
<tr>
<td></td>
<td>N(_2)O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HBFC-123</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCFC-22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Halon-1211</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methyl Bromide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methyl Chloride</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetrachlormethane</td>
<td></td>
</tr>
<tr>
<td><strong>Photo-Oxidant Formation</strong></td>
<td>CH(_4)</td>
<td>kg O(_3)-e</td>
</tr>
<tr>
<td></td>
<td>NMVOC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formaldehyde</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VOC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethanol</td>
<td></td>
</tr>
<tr>
<td><strong>Acidification</strong></td>
<td>NO(_x)</td>
<td>kg SO(_2)-e</td>
</tr>
<tr>
<td></td>
<td>NH(_3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SO(_2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRS(^***)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCl</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H(_2)S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HF</td>
<td></td>
</tr>
<tr>
<td><strong>Terrestrial Eutrophication</strong></td>
<td>NO(_x)</td>
<td>kg PO(_4)-e</td>
</tr>
<tr>
<td></td>
<td>NH(_3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SO(_x)</td>
<td></td>
</tr>
<tr>
<td><strong>Aquatic Eutrophication</strong></td>
<td>COD</td>
<td>kg PO(_4)-e</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NH(_4^+)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO(_3^-)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO(_2^-)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td></td>
</tr>
<tr>
<td><strong>Particulate Matter</strong></td>
<td>PM2.5</td>
<td>kg PM2.5-e</td>
</tr>
<tr>
<td></td>
<td>SO(_2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO(_X)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NH(_3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NMVOC</td>
<td></td>
</tr>
</tbody>
</table>

* CO\(_2\) fossil and biogenic / ** CH\(_4\) fossil and CH\(_4\) biogenic included / *** Total Reduced Sulphur
Goal and Scope of LCA Tetra Recart

Functional unit & Selection of packaging systems

• The function examined is the packaging of retorted food for retail. The functional unit for this study is the provision of 1000 L packed food to the point of sale.

• The focus of this study lies on the food carton Tetra Recart.

• The food category canned tomatoes was chosen as this is one of the key categories to Tetra Recart.

• The chosen competing packaging systems glass jar and steel can have a high relevance in the countries Italy and Germany as well as on the European market.

• Specifications of the Tetra Recart and for transport packaging are provided by Tetra Pak.

• The specifications of the competing packaging systems were determined by Tetra Pak in 2016 and are based on existing products and market relevance in the markets of Germany and Italy. Recycled content of steel can and glass jar has been included based on industry references.
# Goal and Scope of LCA Tetra Recart

## Selection of packaging systems

### Germany*

<table>
<thead>
<tr>
<th>Packaging Type</th>
<th>Tetra Recart Germany</th>
<th>Steel can Germany</th>
<th>Glass jar Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food content</td>
<td>Canned tomatoes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td>17.0 g</td>
<td>59.5 g</td>
<td>223.2 g</td>
</tr>
<tr>
<td>Tinplate</td>
<td></td>
<td>50.5 g</td>
<td></td>
</tr>
<tr>
<td>Label paper</td>
<td>2.0 g</td>
<td>1.2 g</td>
<td></td>
</tr>
<tr>
<td>Closure / lid-tinplate</td>
<td>7.0 g</td>
<td>5.0 g</td>
<td></td>
</tr>
<tr>
<td>Secondary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tray corrugated cardboard</td>
<td>62.0 g</td>
<td>27.0 g</td>
<td>56.0 g</td>
</tr>
<tr>
<td>Tertiary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallet</td>
<td>24,462 g</td>
<td>24,575 g</td>
<td>24,427 g</td>
</tr>
<tr>
<td>Type of pallet</td>
<td>EURO</td>
<td>EURO</td>
<td>EURO</td>
</tr>
<tr>
<td>Stretch foil per pallet</td>
<td>462 g</td>
<td>575 g</td>
<td>427 g</td>
</tr>
<tr>
<td>Pallet configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packages per tray</td>
<td>16</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Trays per layer</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Layers per pallet</td>
<td>16</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

### Italy

<table>
<thead>
<tr>
<th>Packaging Type</th>
<th>Tetra Recart Italy</th>
<th>Steel can Italy</th>
<th>Glass jar Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food content</td>
<td>Canned tomatoes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td>17.0 g</td>
<td>59.5 g</td>
<td>220.7 g</td>
</tr>
<tr>
<td>Tinplate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Label paper</td>
<td>2.0 g</td>
<td>1.2 g</td>
<td></td>
</tr>
<tr>
<td>Closure / lid-tinplate</td>
<td>7.0 g</td>
<td>4.45 g</td>
<td></td>
</tr>
<tr>
<td>Secondary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tray corrugated cardboard</td>
<td>62.0 g</td>
<td>64.85 g</td>
<td>59.2 g</td>
</tr>
<tr>
<td>Stretch foil</td>
<td>15.9 g</td>
<td>48.95 g</td>
<td>21.5 g</td>
</tr>
<tr>
<td>Tertiary packaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallet</td>
<td>24,462 g</td>
<td>24,575 g</td>
<td>24,575 g</td>
</tr>
<tr>
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<td>EURO</td>
</tr>
<tr>
<td>Stretch foil per pallet</td>
<td>462 g</td>
<td>575 g</td>
<td>575 g</td>
</tr>
<tr>
<td>Pallet configuration</td>
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<td>12</td>
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<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Layers per pallet</td>
<td>16</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

*Specifications of German market applied for European scenario*
### Goal and Scope of LCA Tetra Recart

#### End-of-life

<table>
<thead>
<tr>
<th>Country</th>
<th>Packaging system</th>
<th>Collection quota</th>
<th>Recovery quota</th>
<th>Reference year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>Food carton</td>
<td>85.3%*</td>
<td>76.8%</td>
<td>2014</td>
<td>[UBA 2016]</td>
</tr>
<tr>
<td></td>
<td>Steel can</td>
<td>99.9%*</td>
<td>95.9%</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glass jars</td>
<td>91.1%*</td>
<td>88.8%</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>Food carton</td>
<td>28.4%*</td>
<td>25.6%</td>
<td>2015</td>
<td>Tetra Pak</td>
</tr>
<tr>
<td></td>
<td>Steel can</td>
<td>84.5%</td>
<td>73.4%</td>
<td>2015</td>
<td>[Ricrea 2016]; <a href="http://www.consortzioricrea.org">www.consortzioricrea.org</a></td>
</tr>
<tr>
<td></td>
<td>Glass jars</td>
<td>77.9%</td>
<td>70.9%</td>
<td>2015</td>
<td>[CoReVe 2016]; <a href="http://www.coreve.it">www.coreve.it</a></td>
</tr>
<tr>
<td>EU28+2</td>
<td>Food carton</td>
<td>48.9%*</td>
<td>44.0%</td>
<td>2015</td>
<td>ACE; <a href="http://www.beveragecarton.eu">www.beveragecarton.eu</a></td>
</tr>
<tr>
<td></td>
<td>Steel can</td>
<td>79.2%*</td>
<td>76.0%</td>
<td>2014</td>
<td>APEAL; <a href="http://www.apeal.org">www.apeal.org</a></td>
</tr>
<tr>
<td></td>
<td>Glass jars</td>
<td>74.9%*</td>
<td>73%</td>
<td>2015</td>
<td>FEVE; <a href="http://www.feve.org">www.feve.org</a>; collection quota</td>
</tr>
</tbody>
</table>

*assumption for share of sorting residues

<table>
<thead>
<tr>
<th>Country</th>
<th>MSWI/Landfill</th>
<th>Quota</th>
<th>Reference year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>MSWI</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landfill</td>
<td>0.00%</td>
<td></td>
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</tr>
<tr>
<td>Italy</td>
<td>MSWI</td>
<td>42%</td>
<td>2014</td>
<td>[Eurostat 2016]</td>
</tr>
<tr>
<td></td>
<td>Landfill</td>
<td>58%</td>
<td></td>
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<tr>
<td>EU28+2</td>
<td>MSWI</td>
<td>40%</td>
<td>2014</td>
<td>ACE; <a href="http://www.beveragecarton.eu">www.beveragecarton.eu</a></td>
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<tr>
<td></td>
<td>Landfill</td>
<td>60%</td>
<td></td>
<td></td>
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</tbody>
</table>

1. calculated based on [Eurostat 2016]
Results Germany

- Emission related
  - Climate change
  - Stratospheric Ozone Depletion
- Ressource related
  - Particulate matter
  - Photo-Oxidant Formation
  - Acidification
  - Terrestrial Eutrophication
  - Aquatic Eutrophication
- Inventory level
  - Freshwater use
  - Non-renewable Primary Energy
  - Total Primary Energy
- Use of nature
Result graphs – How to read them?

**BURDENS – left stacked bar:**

- **Glass:** production and transport of glass including converting to bottle
- **Tinplate:** production and transport of tinplate
- **LPB:** production and transport of liquid packaging board
- **Plastics for sleeve:** production and transport of plastics and additives for carton
- **Aluminium foil:** production and transport of aluminium & converting to foil
- **Converting:** converting processes of cartons
- **Closure & label:** production and transport of base materials for closures and label
- **Transport packaging:** production and transport of transport packaging: wooden pallets, LDPE shrink foil and corrugated cardboard trays
- **Filling:** filling process including packaging handling
- **Distribution:** retail of the packages from filler to the point-of-sale
- **Recycling & disposal:** sorting, recycling and disposal processes of primary and transport packaging

**CREDITS – negative stacked bar:**

- **CO₂ reg. (EOL):** CO₂ emissions from incineration of biobased and renewable materials
- **Credits material:** credits for material recycling
- **Credits energy:** credits for energy recovery (replacing e.g. grid electricity)
- **CO₂-uptake:** Uptake of atmospheric CO₂ during the plant growth phase
Results base scenario Germany

Climate Change

- Tetra Recart Germany base
- Glass jar Germany base
- Steel can Germany base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results sensitivity analysis allocation factor 100%
Germany

Climate Change

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Acidification

kg SO2-equivalents / 1000 L

-0.5
0.0
0.5
1.0
1.5
2.0
2.5

Tetra Recart Germany base
Glass jar Germany base
Steel can Germany base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Photo-Oxidant Formation

-5 0 5 10 15 20 25 30 35

kg O3-equivalents/1000 L

Tetra Recart Germany base

Glass jar Germany base

Steel can Germany base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Ozone Depletion Potential

- Tetra Recart Germany base
- Glass jar Germany base
- Steel can Germany base

Legend:
- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Terrestrial Eutrophication

-50 0 50 100 150 200 250

<table>
<thead>
<tr>
<th>Product</th>
<th>Net Results</th>
<th>Credits Energy</th>
<th>Credits Material</th>
<th>CO2 Reg (EOL)</th>
<th>Recycling &amp; Disposal</th>
<th>Distribution</th>
<th>Filling</th>
<th>Transport Packaging</th>
<th>Converting</th>
<th>Aluminium Foil</th>
<th>Plastics for Sleeve</th>
<th>LPB</th>
<th>Tinplate</th>
<th>Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetra Recart</td>
<td></td>
<td></td>
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<tr>
<td>Steel can</td>
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<td>Germany base</td>
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<tr>
<td>Glass jar</td>
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<td>Germany base</td>
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<tr>
<td>Steel can</td>
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<tr>
<td>Germany base</td>
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</tr>
</tbody>
</table>

*Note: The diagram shows the results for different products and their environmental impacts in terms of Terrestrial Eutrophication.*
Results base scenario Germany

Aquatic Eutrophication

- Tetra Recart Germany base
- Glass jar Germany base
- Steel can Germany base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Particulate Matter

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- net results

Tetra Recart Germany base
Glass jar Germany base
Steel can Germany base

kg PM 2.5-equivalents / 1000 L
Results base scenario Germany

**Total Primary Energy**

- **Tetra Recart Germany base**
- **Glass jar Germany base**
- **Steel can Germany base**

- **CO2 reg (EOL)**
- **recycling & disposal**
- **distribution**
- **filling**
- **transport packaging**
- **closure & label**
- **converting**
- **aluminium foil**
- **plastics for sleeve**
- **LPB**
- **Tinplate**
- **Glass**
- **credits energy**
- **credits material**
- **CO2 uptake**
- **net results**
Results base scenario Germany

Non-renewable Primary Energy

- Tetra Recart Germany base
- Glass jar Germany base
- Steel can Germany base

Non-renewable Primary Energy

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Germany

Use of Nature

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass

- credits energy
- credits material
- CO2 uptake
- net results

Tetra Recart Germany base
Glass jar Germany base
Steel can Germany base

m²-e*year / 1000 L

Tetra
Recart
Germany
base

Glass jar
Germany
base

Steel can
Germany
base
Results base scenario Germany

Water use (related to water input)

- Tetra Recart Germany base
- Glass jar Germany base
- Steel can Germany base

Water use:
- Water cool
- Water process
- Water unspecified

The chart shows the water use for different packaging options in Germany, with the highest water use observed for Steel can Germany base.
# Results base scenario Germany

**Comparison of net results:** Tetra Recart versus alternative packaging systems in Germany

<table>
<thead>
<tr>
<th></th>
<th>Tetra Recart</th>
<th>Glass jar</th>
<th>Steel can</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17 g</td>
<td>223 g</td>
<td>59.5 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Germany base scenario</th>
<th>Tetra Recart</th>
<th>Germany base scenario</th>
<th>Tetra Recart Base</th>
<th>Germany base scenario</th>
<th>Tetra Recart Base</th>
<th>Germany base scenario</th>
<th>Tetra Recart Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change</td>
<td>-85% (green)</td>
<td>-84%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidification</td>
<td>-79% (orange)</td>
<td>-70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer Smog</td>
<td>-80% (orange)</td>
<td>-69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>-38% (orange)</td>
<td>16%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial Eutrophication</td>
<td>-79% (orange)</td>
<td>-67%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Eutrophication</td>
<td>78% (orange)</td>
<td>211%</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Human Toxicity: PM 2.5</td>
<td>-80% (green)</td>
<td>-68%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>-58% (green)</td>
<td>-57%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-renewable Primary Energy</td>
<td>-66% (green)</td>
<td>-64%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Applied recycling rates Germany**

- Tetra Recart: 76.8%
- Glass jar: 88.8%
- Steel can: 95.9%

The remaining share which is not recycled is disposed according to the European share:

- 0% landfill
- 100% MSWI
Comparison of net results - sensitivity analysis allocation factor 100%:
Tetra Recart versus alternative packaging systems in Germany

<table>
<thead>
<tr>
<th>Germany allocation factor 100%</th>
<th>The net results of Tetra Recart Germany AF100 are lower (green)/ higher (orange) than those of Glass jar Germany AF100</th>
<th>Steel can Germany AF100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change</td>
<td>-84%</td>
<td>-79%</td>
</tr>
<tr>
<td>Acidification</td>
<td>-81%</td>
<td>-69%</td>
</tr>
<tr>
<td>Photo-Oxidant Formation</td>
<td>-81%</td>
<td>-68%</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>-15%</td>
<td>8%</td>
</tr>
<tr>
<td>Terrestrial Eutrophication</td>
<td>-80%</td>
<td>-66%</td>
</tr>
<tr>
<td>Aquatic Eutrophication</td>
<td>34%</td>
<td>264%</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-82%</td>
<td>-67%</td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>-73%</td>
<td>-65%</td>
</tr>
<tr>
<td>Non-renewable Primary Energy</td>
<td>-73%</td>
<td>-63%</td>
</tr>
</tbody>
</table>

The ranking order among Tetra Recart and alternative packaging systems is not affected by the application of a 100% allocation factor, except in the *Ozone Depletion Potential* when compared to the steel can.

By applying an allocation factor of 100% the difference between Tetra Recart and steel can becomes insignificant.
Results Italy
Result graphs – How to read them?

BURDENS – left stacked bar:
• Glass: production and transport of glass including converting to bottle
• Tinplate: production and transport of tinplate
• LPB: production and transport of liquid packaging board
• Plastics for sleeve: production and transport of plastics and additives for carton
• Aluminium foil: production and transport of aluminium & converting to foil
• Converting: converting processes of cartons
• Closure & label: production and transport of base materials for closures and label
• Transport packaging: production and transport of transport packaging: wooden pallets, LDPE shrink foil and corrugated cardboard trays
• Filling: filling process including packaging and handling
• Distribution: retail of the packages from filler to the point-of-sale
• Recycling & disposal: sorting, recycling and disposal processes of primary and transport packaging

CREDITS – negative stacked bar:
• CO₂ reg. (EOL): CO₂ emissions from incineration of biobased and renewable materials
• Credits material: credits for material recycling
• Credits energy: credits for energy recovery (replacing e.g. grid electricity)
• CO₂-uptake: Uptake of atmospheric CO₂ during the plant growth phase
Results base scenario Italy

Climate Change

kg CO2-equivalents / 1000 L

-200
-100
0
100
200
300
400
500
600
700

Tetra Recart Italy base
Glass jar Italy base
Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate

The graph shows the climate change impact for different packaging options in the base scenario for Italy. The y-axis represents kg CO2-equivalents per 1000 L, while the x-axis lists the packaging types: Tetra Recart, Glass jar, and Steel can. Each bar is segmented into different processes contributing to the overall impact.
Results sensitivity analysis allocation factor 100%
Italy

Climate Change

<table>
<thead>
<tr>
<th></th>
<th>kg CO2-equivalents /1000 L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetra Recart</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
</tr>
<tr>
<td>AF100</td>
<td></td>
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<tr>
<td>Glass jar</td>
<td></td>
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<tr>
<td>AF100</td>
<td></td>
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<tr>
<td>Steel can</td>
<td></td>
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<tr>
<td>Italy</td>
<td></td>
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<tr>
<td>AF100</td>
<td></td>
</tr>
</tbody>
</table>

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Italy

Acidification

<table>
<thead>
<tr>
<th></th>
<th>Acidification (kg SO2-equivalents/1000 L)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tetra Recart Italy base</strong></td>
<td>-0.5</td>
</tr>
<tr>
<td><strong>Glass jar Italy base</strong></td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Steel can Italy base</strong></td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Legend:**
- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Italy

Photo-Oxidant Formation

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Italy

Ozone Depletion Potential

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass

- credits energy
- credits material
- net results
Results base scenario Italy

Terrestrial Eutrophication

- G PO4-equivalents / 1000 L

-50 0 50 100 150 200 250 300

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass

Credits energy
Credits material
CO2 uptake
Net results
Results base scenario Italy

Aquatic Eutrophication

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- g PO4-equivalents / 1000 L
- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Italy

Particulate Matter

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- CO2 uptake
- net results

kg PM2.5-equivalents / 1000 L
Results base scenario Italy

Total Primary Energy

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- credits energy
- credits material
- CO2 uptake
- net results
Results base scenario Italy

Non-renewable Primary Energy

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass
- credits energy
- credits material
- net results
Results base scenario Italy

Use of Nature

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

- CO2 reg (EOL)
- recycling & disposal
- distribution
- filling
- transport packaging
- closure & label
- converting
- aluminium foil
- plastics for sleeve
- LPB
- Tinplate
- Glass

- credits energy
- credits material
- CO2 uptake
- net results

m²-e*year/1000 L

Tetra Recart Italy base
Glass jar Italy base
Steel can Italy base
Results base scenario Italy

Water use (related to water input)

- Tetra Recart Italy base
- Glass jar Italy base
- Steel can Italy base

Water use-related data is shown in the chart.
**Results base scenario Italy**

**Comparison of net results:** Tetra Recart versus alternative packaging systems in Italy

<table>
<thead>
<tr>
<th></th>
<th>Tetra Recart</th>
<th>Glass jar</th>
<th>Steel can</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>17 g</td>
<td>221 g</td>
<td>59.5 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Italian base scenario allocation factor 50%</th>
<th>The net results of Tetra Recart are lower (green)/higher (orange) than those of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glass Jar</td>
</tr>
<tr>
<td>Climate Change</td>
<td>-78%</td>
</tr>
<tr>
<td>Acidification</td>
<td>-79%</td>
</tr>
<tr>
<td>Summer Smog</td>
<td>-81%</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>-51%</td>
</tr>
<tr>
<td>Terrestrial Eutrophication</td>
<td>-80%</td>
</tr>
<tr>
<td>Aquatic Eutrophication</td>
<td>20%</td>
</tr>
<tr>
<td>Human Toxicity: PM 2.5</td>
<td>-81%</td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>-55%</td>
</tr>
<tr>
<td>Non-renewable Primary Energy</td>
<td>-66%</td>
</tr>
</tbody>
</table>

**Applied recycling rates Italy**

- Tetra Recart: 25.6%
- Glass jar: 70.9%
- Steel can: 73.4%

The remaining share which is not recycled is disposed according to the European share:

- 58% landfill
- 42% MSWI
Comparison of net results - sensitivity analysis allocation factor 100%: Tetra Recart versus alternative packaging systems in Italy

<table>
<thead>
<tr>
<th>Italy allocation factor 100%</th>
<th>The net results of Tetra Recart Italy AF100 are lower (green)/</th>
<th>Steel can Italy AF100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass jar Italy AF100</td>
<td>-71%</td>
<td>-62%</td>
</tr>
<tr>
<td>Acidification</td>
<td>-79%</td>
<td>-64%</td>
</tr>
<tr>
<td>Summer Smog</td>
<td>-80%</td>
<td>-65%</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>-47%</td>
<td>28%</td>
</tr>
<tr>
<td>Terrestrial Eutrophication</td>
<td>-80%</td>
<td>-63%</td>
</tr>
<tr>
<td>Aquatic Eutrophication</td>
<td>11%</td>
<td>91%</td>
</tr>
<tr>
<td>Human Toxicity: PM 2.5</td>
<td>-81%</td>
<td>-62%</td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>-57%</td>
<td>-42%</td>
</tr>
<tr>
<td>Non-renewable Primary Energy</td>
<td>-65%</td>
<td>-51%</td>
</tr>
</tbody>
</table>

The ranking order among Tetra Recart and alternative packaging systems is not affected by the application of a 100% allocation factor.
Results Europe

- Emission related
  - Climate change
  - Particulate matter
  - Photo-Oxidant Formation
- Resource related
  - Stratospheric Ozone Depletion
- Inventory level
  - Total Primary Energy
  - Non-renewable Primary Energy
- Freshwater use
- Aquatic Eutrophication
- Terrestrial Eutrophication
- Acidification

Results scenario variants on the European market

For European scenario specifications of German market were applied for steel can and glass jar*

Glass jar: 223 g
Steel can: 59.5 g

Applied recycling rates EU 28+2
Tetra Recart: 44%
Glass jar: 73%
Steel can: 76%

The remaining share which is not recycled is disposed according to the European share:
60% landfill
40% MSWI

Differences in results compared to Germany result from:
- lower recycling rates for all systems analysed
- higher share of landfill (no landfill in Germany)
- different electricity grid mix.

<table>
<thead>
<tr>
<th>EU 28+2 status quo allocation factor 50%</th>
<th>Glass jar EU28+2</th>
<th>Steel can EU28+2</th>
<th>The net results of Tetra Recart EU28+2 are lower (green)/ higher (orange) than</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Change</td>
<td>-81%</td>
<td>-81%</td>
<td></td>
</tr>
<tr>
<td>Acidification</td>
<td>-80%</td>
<td>-72%</td>
<td></td>
</tr>
<tr>
<td>Photo-Oxidant Formation</td>
<td>-82%</td>
<td>-73%</td>
<td></td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>-50%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Terrestrial Eutrophication</td>
<td>-81%</td>
<td>-71%</td>
<td></td>
</tr>
<tr>
<td>Aquatic Eutrophication</td>
<td>19%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-83%</td>
<td>-72%</td>
<td></td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>-58%</td>
<td>-57%</td>
<td></td>
</tr>
<tr>
<td>Non-renewable Primary Energy</td>
<td>-73%</td>
<td>-72%</td>
<td></td>
</tr>
</tbody>
</table>

*Due to the disproportionate effort to gather data in each European country to derive European average specifications for glass jar and steel can, specifications of German market were chosen as one of the two most relevant market for canned tomatoes in Europe.
Results scenario variants on the European market

- Effects of varying recycling rates within a certain value range on the results were examined.
- Additional scenarios provide indications about environmental performance of the different packaging systems, if the recycling quota of the competing packaging systems is varying:
  - recycling rate 50%
  - middle range recycling rates (close to 75%)
  - high range recycling rates (100%)
- An allocation factor of 50% is applied.
Results scenario variants on the European market

**Climate Change**

- Tetra Recart (EU) RR 44%
- Glass jar (EU)
- Can (EU)

**Photo-Oxidant Formation Potential**

- Tetra Recart (EU) RR 44%
- Glass jar (EU)
- Can (EU)
Results scenario variants on the European market

- Acidification
  - Tetra Recart (EU) RR 44%
  - Glass jar (EU)
  - Can (EU)

- Terrestrial Eutrophication
  - Tetra Recart (EU) RR 44%
  - Glass jar (EU)
  - Can (EU)
Results scenario variants on the European market

Ozone Depletion Potential

Aquatic Eutrophication
Results scenario variants on the European market

Particulate Matter

- Tetra Recart (EU) RR 44%
- Glass jar (EU)
- Can (EU)

Total Primary Energy

- Tetra Recart (EU) RR 44%
- Glass jar (EU)
- Can (EU)

Non-renewable Primary Energy

- Tetra Recart (EU) RR 44%
- Glass jar (EU)
- Can (EU)
Results scenario variants on the European market

- Scenario variants for the European market confirm the pattern as observed for Italy and Germany.
- The result may be used as an indication on how country-specific parameters may influence overall results, i.e. varying recycling rates.
- Apart from the electricity grid mix, recycling rates are one of the major parameters expected to differ considerably between countries.
Conclusions
Most significant parameters

- Major impact in most of environmental impact indicators in both markets due to the production of base materials, especially the production of plastics, aluminium, tinplate and glass.
- Production of LPB for Tetra Recart plays a less important role in many impact categories.
- But LPB still main contributor to the results of Tetra Recart in Aquatic Eutrophication, Summer Smog, Acidification, Terrestrial Eutrophication and Particulate Matter.
- Included polymers in Tetra Recart cause high contribution to the Ozone Depletion Potential.
- Production of transport packaging of glass jar and steel can shows high contributions in Aquatic Eutrophication potential.
- Transport related impacts of glass jar and steel can in Terrestrial Eutrophication and Summer Smog. Impacts for scope of Germany are higher due to the longer transport distances.
- High share of Tetra Recart and glass jar due to landfilling in Italy: major contribution to Aquatic Eutrophication, however to a lesser extent for Tetra Recart.
Conclusions
Comparison of TRC with competing systems

- **Glass jar** shows higher environmental impacts in all impact categories compared to Tetra Recart, except in Aquatic Eutrophication.

- **Steel can** shows higher environmental impacts in all impact categories than Tetra Recart except in *Aquatic Eutrophication* and *Ozone Depletion Potential*: Results of the can match those of the Tetra Recart within the scope of Germany if an allocation factor of 100% is applied.

- The robustness and validity of the results regarding the allocation factor used for open-loop recycling are generally confirmed by the sensitivity analyses.

- The sensitivity analysis with varying recycling rates for the alternative packaging systems on the European market confirms the pattern, when the Tetra Recart is compared with the glass jar and steel can.

- Findings are only valid within this LCA study’s framework conditions. Accordingly, several limitations must be considered and are documented in detail in the full report.
Overarching conclusions and recommendations

- Food carton Tetra Recart clearly shows a more favourable environmental performance compared to glass jar and steel can.
- The robustness and validity of the results are confirmed by the applied sensitivity scenarios regarding the allocation factor and varying recycling rates for glass jar and steel can.
- Environmental impacts of Tetra Recart are primarily defined by the production of base materials for primary packaging.
- The share of LPB made of renewable sources, the production of it using a high share of renewable energy sources and the lightweight of Tetra Recart are an advantage.
- Optimisation efforts for the Tetra Recart should be directed towards the weight and type of polymers included in Tetra Recart.
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