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- Hauptteil -

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16. Abstract <p>Continuing the investigations concerning the ecological relevance of packaging materials the Federal Environmental Agency commissioned life cycle assessments on packing systems for non-alcoholic drinks and wine. The investigation aims at compiling information on environmentally relevant material and energy flows of those packaging systems with a significant importance in the specified beverage market segments, on the basis of representative and average framework conditions (reference year 1996) and comparison of their potential ecological impacts. The life cycle assessment was conducted in accordance with the ISO-standards 14040 to 14043. The Critical Review was performed corresponding to ISO 14040 chapter 7.3.3.</p> <p>The analysed packaging systems were chosen on basis of their market relevance (in general more than 5 % market share). For the life cycle steps filling and distribution a comprehensive data collection has been carried out. The unit processes of the life cycle have been described in the report with some characteristic features and more detailed in the separate volume. An impact assessment and a conclusive interpretation of the results are further parts of the investigation.</p>		
17. Keywords Life Cycle Assessment, Drinks Packaging, Bottle, Beverage Can, Glass, PET, Aluminium, Tinplate, Beverage Carton, One-way, Returnable, Distribution		
18. Price	19.	20.

Summary

The German environmental policy aims at reducing the environmental burdens caused by packaging materials. Life cycle assessment has turned out to be a suitable method for ecological evaluation of packaging materials. After conducting studies on beverage packing for beer and fresh milk the German environmental agency has commissioned an life cycle assessment on packaging systems for non-alcoholic drinks and wine now. The study was conducted by a project team consisting of Prognos (management), IFEU, Gesellschaft für Verpackungsmarktforschung (GVM) und PackForce.

The complete study consists of two parts, Status-Quo-Analysis (part I) and future scenarios (part II). This report contains the results of the Status-Quo-Analysis for the reference year 1996. The **objective** of the life cycle assessment is as follows:

Compiling information on environmentally relevant material and energy flows of those packaging systems with a significant importance in the specified beverage market segments, on the basis of representative and average framework conditions and comparison of their potential ecological impacts.

The life cycle assessment was conducted in accordance with the DIN/EN/ISO-standards 14040 to 14043. The **Critical Review** was performed corresponding to ISO 14040 chapter 7.3.3. Chairman of the panel is Mrs. A. de Groot-van Dam (TNO, Delft). As further independent experts have been nominated Dipl.-Ing. C.-O. Gensch, Prof. Dr. W. Klöpffer and Dr. H.-J. Klüppel. The Critical Review covers all working steps of the life cycle assessment. The related parties (industry, environmental and consumer-associations) were integrated into the project by a project attending committee.

The analysed packaging systems were chosen on basis of their market relevance (in general more than 5 % market share). GVM prepared a market analysis on that issue (see separate volume: Materials).

Analysed Packaging Systems

Beverage market segment		Analysed packaging systems	
		Buying in stock	Immediate consumption
Mineral water (incl. spring-, table- and medicinal water)	returnable	<ul style="list-style-type: none"> • Glass: 0,7 l-/0,75 l GDB • PET: 1,5 l 	<ul style="list-style-type: none"> • Glass: 0,25 l (Vichy)
	one-way	<ul style="list-style-type: none"> • Glass: 1 l-narrow bottle neck • Liquid packaging board 1 l 	<ul style="list-style-type: none"> • Glass: 0,33 l narrow bottle neck
Drinks without CO ₂	returnable	<ul style="list-style-type: none"> • Glass: 1 l-/0,7 l-narrow bottle neck 1 l/0,75 l- wide bottle neck 	–
	one-way	<ul style="list-style-type: none"> • Glass: 0,75 l- narrow bottle neck, 1 l/0,75 l- wide bottle neck • Liquid packaging board 1 l 	–
Soft drinks (with CO ₂)	returnable	<ul style="list-style-type: none"> • Glass: 0,7 l (GDB); • PET: 1 l, 1,5 l 	<ul style="list-style-type: none"> • Glass: 0,33 l
	one-way	<ul style="list-style-type: none"> • Glass: 1 l 	<ul style="list-style-type: none"> • Glass: 0,33 l • Can 0,33 l tinplate • Can 0,33 l aluminium
Wine	returnable	<ul style="list-style-type: none"> • Glass: 1 l 	–
	one-way	<ul style="list-style-type: none"> • Glass: 1 l/0,75 l • Liquid packaging board 1 l 	–

The **structure of the life cycle** of the packaging systems investigated has been depicted in the report in a simplified manner. For the life cycle steps filling and distribution a comprehensive data collection has been carried out. The single modules of the life cycle have been described in the report with some characteristic features (chapter 2.5). More detailed descriptions

and the basic data can be found in the standard reports (see separate volume on documentation of results).

Recycling of packaging and parts of the packaging was modelled by two methods, „Cut Off“ (without credit for recycling) and credit-method (chapter 4.2).

The data sets used are qualified to give an approximate representation of the actual production and consumption structures of beverage packaging systems in Germany (chapter 2.8.2). For all data but a few exemptions the reference period is the middle of the 1990ies.

Sensitivity analyses were performed basically to check the impact of the limitations of the life cycle analysis on the results (chapter 2.10). This concerns mainly the modelling of the distribution, the ratio of secondary aluminium in can aluminium production, the credits given for the recycling of aluminium, trip rates, electricity models for aluminium and the credit method used for pulp production for liquid packaging boards.

The **impact assessment** was conducted using the following ecological impact categories.

Impact Categories used

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- Photochemical oxidant formation
 - Aquatic eutrophication
 - Terrestrial eutrophication
 - Acidification
 - Toxic effects to humans
 - Toxic effects to ecosystems
 - Resource use
 - Land use
 - Global Warming
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The impact assessment was performed according to ISO 14042 including the optional elements **normalisation** and **ranking**. Ranking, i.e. the prioritisation of different impact categories by their ecological priority, was carried out according to the methodology proposed by the Federal Environmental Agency [UBA, 1999]. It has to be pointed out that this ranking is based not solely on objective facts, but also, to a large extent, on value choices of the Federal Environmental Agency.

The **interpretation**, i.e. the collation of the various results in order to formulate conclusions, the verification of the soundness of these conclusions and the derivation of recommendations, was carried out by the Federal Environmental Agency according to the proposed method [UBA, 1999] and in observance of the rules laid down in ISO 14043

The interpretation aims to compare the results obtained for the various packaging systems in inventory analysis and impact assessment while taking into account method- and data-related uncertainties. As a basis for these comparisons, the respective reuse system with the largest market share was established as reference system for each sector. The results for the other packaging systems were then compared with those of the reference system indicator by indicator. In addition, the indicator results of the impact categories examined were subjected to valuation according to the UBA method referred to above, in order to derive statements as to the overall environmental relevance.

In sum, the results of the interpretation show the following picture:

- For mineral water and carbonated refreshment drinks, the existing returnable PET bottle systems are preferable to the existing returnable glass bottle systems from an environmental viewpoint.
- For mineral water, non-carbonated drinks and wine, assessment using the method outlined above reveals no comprehensive environmental advantage or disadvantage for the existing returnable glass bottle systems and the existing carton packaging systems.
- For carbonated refreshment drinks, throw-away glass bottles as well as tinplate and aluminium cans are distinctly more environmentally unfavourable than comparable re-use systems.
- These environmental impacts are in the order of those caused by

several 10,000 to several 100,000 Germans, or in the range of 0.1% of the respective total impact in Germany.

In the view of the Federal Environmental Agency, the study permits the following recommendations to be made:

- Beverage distribution (transportation processes) makes a considerable contribution to the results of the LCA. For returnable packaging systems, this can already clearly be seen from the available results. Given inclusion of the content of the packaging, distribution will presumably also prove to be of considerable relevance for throw-away packaging. In future environmental-policy activities in the field of drinks packaging, more attention should be paid to the distribution stage.
- To clarify questions that are still open, it is necessary to also include the content of the packaging in LCA. This aspect should be included in the scenarios to be dealt with in Phase 2.