

life cycle assessment carton/PET

# Comparative life cycle assessment of beverage cartons and disposable PET bottles

→ IFEU Institute (2006)

## → Comparison beverage carton / PET bottle mixed milk drinks (0,5 l)

Ecological priority	indicator categories	beverage cartons in % worse than PET	beverage cartons in % better than PET
very high	Global warming potential		199%
high	Terrestrial eutrophication		29%
	Resource consumption (fossil)		217%
	Acidification		53%
	Summer smog		18%
medium	Aquatic eutrophication	90%	
	Land use (forest)	1.836%	
no classification	Energy consumption (total)		63%

1) beverage carton 0,5 l without aluminium foil, with closure IFEU 2006  
 2) disposable PET-monolayer-bottle 0,5 l without barrier (20 g)

## → Comparison beverage carton / PET bottle Ice tea (1,5 l)

Ecological priority	indicator categories	beverage cartons in % worse than PET	beverage cartons in % better than PET
very high	Global warming potential		117%
high	Terrestrial eutrophication		1%
	Resource consumption (fossil)		119%
	Acidification	11%	
	Summer smog	92%	
medium	Aquatic eutrophication	138%	
	Land use (forest)	1.325%	
no classification	Energy consumption (total)		14%

1) beverage carton 1,5 l with closure IFEU 2006  
 2) disposable PET-monolayer-bottle 1,5 l without barrier (41,5 g)

### Background

The 2000/2002 life cycle assessments (LCAs) carried out by UBA (Umweltbundesamt = Federal Environmental Agency) provide little specific data about packaging systems for fruit-based beverages, ice tea and fresh milk drinks. This is particularly relevant to disposable PET bottles which, prior to 2003, were essentially insignificant in the market. However, just two years later, PET had largely displaced disposable glass bottles and reusable containers as packaging systems for fruit-based drinks. Since then, PET now ranks second behind beverage cartons as the most commonly sold packaging system for fruit juices. Experience from other countries indicates that, in the case of fresh milk drinks, a similar development cannot be excluded. Moreover, the fact that the life cycle assessment data of the Federal Environment Agency on fresh milk packaging systems (UBA I) were already 10 years old, an update had become necessary.

The FKN (Fachverband Kartonverpackungen für flüssige Nahrungsmittel e.V. = Association of Beverage Carton Manufacturers) commissioned the IFEU (Institut für Energie und Umweltforschung = Institute for Energy and Environmental Research), Heidelberg to undertake this first comprehensive LCA on beverage cartons and PET bottles. The study is in conformance with ISO standards and the methodology applied is similar to that used by the Federal Environmental Agency. The supervisory project group included representatives from the beverage filling and waste disposal sectors. Unfortunately no industrial association representative from the polymers industry was available to participate. In accordance with ISO requirements, the LCA was subsequently subjected to a critical review process.

### Scope of the study?

The investigations covered beverage cartons and disposable PET bottles for fruit-based drinks (fruit juices and nectars), ice tea and fresh milk drinks (pasteurised milk, ESL milk<sup>1)</sup>, milk-mix drinks) in the 200 ml to 1500 ml fill volume range. Packaging systems that were available on the German market in 2005 were studied. With regard to beverage cartons, all varieties were considered in relation to their respective market shares. As such, the study is representative of the market overall. Moreover, technologically conceivable improvements to PET bottles (e.g. reduced bottle weights, recycled content of 25%) were simulated in a "future scenario 2010" and compared against current beverage cartons. Whereas there are also optimisation potentials for beverage cartons, a corresponding sensitivity analysis was not undertaken – to remain on the safe side. A further future scenario concerned the 1000 ml PET milk bottle. At the time of the assessment, this packaging system did not exist in Germany but was, for example, being offered in Italy.

1) Minimum shelf life of up to 21 days.



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The composition of packaging materials is highly dependent on the required minimum shelf life (MSL) of the respective fill product. To allow comparison of packagings having the same protection function, three case categories were established:

1. Fruit juice/nectar packaging systems with an MSL of at least 12 months;
2. Fruit juice/nectar/ice tea packaging systems with an MSL of 6–7 months;
3. Fresh milk drink packaging systems with an MSL of 10–12 days.

**Results:**

→ Regarding 1-litre packaging systems for **fruit-based drinks** with extended shelf lives, the beverage carton performs considerably better than the disposable PET bottle in six out of eight impact categories. For smaller volume packaging systems (500 ml, 200/330 ml) the picture is similar. “Noteworthy are the substantial differences in the global warming and fossil resource consumption.” The ecological importance of these impact categories is rated by the Federal Environmental Agency as being “very high” and “high”.

→ Differences between the 1.5-litre **ice tea** packaging systems are not so distinct. There, PET monolayer bottles without barrier properties are being used. Here again, however, much the same applies: “In the categories global warming and fossil resource consumption, the indicative values for the carton are considerably lower than those for the PET bottle.”

→ Comparison of packaging systems for **milk-mix drinks** with short minimum shelf lives showed that in all impact categories, the beverage carton is ecologically more favourable, with the exception of aquatic eutrophication and space requirements forest. “With regard to the global warming and fossil resource consumption, the system differences between the carton and PET bottle are more pronounced than is the case of packaging systems for juices and ice tea.” This is due to the absence of an aluminium layer in the beverage carton.

→ Regarding the 1-litre **fresh milk** packaging systems “... the overall environmental impact is largely equivalent to the results for investigated packaging systems destined for milk-mix drinks”. Here again, no barrier layers are necessary in these packaging systems.

*“Overall, it can be said that, given the benefits of the beverage carton in case categories 1 and 3, plus the advantages regarding the particularly significant categories of fossil resource consumption and the global warming, the ecological advantages of the beverage carton over the disposable PET bottle are evident. This applies to all the packaging systems compared within the scope of this assessment.”*

→ **Comparison beverage carton / PET bottle fruit juice, nectar (1,0 l, 0,5 l)**

Ecological priority	indicator categories	beverage cartons in % worse than PET	beverage cartons in % better than PET
very high	Global warming potential		1,0 l 167% 0,5 l 162%
	Terrestrial eutrophication		1,0 l 37% 0,5 l 41%
high	Resource consumption (fossil)		1,0 l 164% 0,5 l 152%
	Acidification		1,0 l 23% 0,5 l 27%
	Summer smog	42% 1,0 l 43% 0,5 l	
medium	Aquatic eutrophication		1,0 l 26% 0,5 l 39%
	Land use (forest)	999% 1,0 l 892% 0,5 l	
no classification	Energy consumption (total)		1,0 l 48% 0,5 l 55%

1) beverage carton 1,0 l/0,5 l with closure  
2) disposable PET-multilayer-bottle 1,0l/0,5 l (38 g/28 g)

IFEU 2006

