An Ecological Footprint Analysis of Different Packaging Systems

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Introduction

This report was prepared at the request of Alexander de Roo MEP. At the time this report was commissioned Mr. De Roo was working as the Environment Adviser to the European Union Green Group

It presents the results of an Ecological Footprint Analysis of a number of different packaging systems based on the data contained within the Life Cycle Assessment (LCA) reports prepared by Ekvall *et al.* 1998 [Miljøprojekt nr.399, Danish Environmental Protection Agency].

Ecological Footprint Analysis

Ecological Footprint Analysis (EFA) is an emerging methodology, which aims to represent simply, and communicate effectively, issues of environmental impact and sustainability. EFA follows the same holistic principles as LCA but, significantly, allows for the aggregation of a range of impacts into a single indicator. It therefore facilitates the comparison of different types of environmental loads (for example, those of aluminium and sulphur dioxide).

The indicator used is based on the concept of appropriated carrying capacity, defined as the amount of land required to supply the necessary resources and assimilate the outgoing wastes.

The use of EFA to measure resource use is well established – a growing number of academics and practitioners now use the methodology [see Simmons & Chambers 1998, Simmons 1998, Earth Council 1997, CSIRO 1997, Bicknell *et al.* 1996, IIED 1995]. However, the conversion of some pollutants to their land-area equivalents is still in its early stages due mainly to problems of system complexity and data availability. Nonetheless, a number of studies have been published which provide enough credible data to attempt a pollution analysis [see Krotscheck & Narodoslawsky 1996, Folke *et al.* 1996, Wackernagel *et al.* 1999].

Methodology

Our analysis uses 'significant impact' data from the LCA reports and does not seek to question or vary the assumptions made. Thus, this report can be seen as providing both a 'second opinion' on the LCA findings as well as seeking to clarify the conclusions by offering an aggregated quantification of impact (rather than the inventory-based summary presented in the LCA reports).

The EFA method used is known as EcoIndex and is based on data from a wide variety of sources collated by Best Foot Forward – a UK environmental consultancy specialising in EFA. Two alternative sets of results are presented based on two different approaches to the modeling of pollution. The first (EF 1) uses conversion factors under development by BFF. The second method (EF II) uses values developed by the University of Graz in Austria [Krotscheck & Narodoslawsky 1996]. The second methodology results in larger footprints for two reasons. Firstly, a more precautionary approach is taken to calculating the ‘damage’ caused by pollution and, secondly, the method of accounting for land is additive thereby increasing the likelihood of the ‘double counting’ of impacts. These differences in calculation are not considered fundamental where comparative, rather than absolute, impacts are being measured although, as will become apparent, the different approaches to modelling pollution tend to emphasise different pollutants.

A particular note of caution is expressed with regard to the categories of waste labelled hazardous, slag and ashes, and nuclear. These are not currently included in the EcoIndex methodology and therefore any toxic effects are excluded from our analysis.

Results

As stated in the original LCA study, the results from any study of this nature need to be treated with caution. No methodology is perfect – each has its strengths and weaknesses – and this is equally true with EFA where the measurement of pollution is problematic due in part to a lack of robust research.

However, all three methods of impact assessment (LCA, EF 1 and EF 2) show a remarkable degree of consistency.

A calculation table for each packaging type is provided in the accompanying Appendix.

Table 1 (Parts A to C) reports the EFA results for EF 1 and EF 2 using the same functional unit as the LCA analysis. All results are rounded up to the nearest square metre.

Part A (25 and 33cl containers) show the glass packaging systems (both disposable and refillable) to have a lower footprint than the aluminium and steel packaging systems although the difference between disposable green glass (33cl) and aluminium (33cl) is small.

Part B (50cl containers) show the refillable PET to have clearly the lowest footprint. The order of the other types of container varies by method.

Part C (150cl containers) shows the refillable PET to have a significantly lower footprint that the disposable PET.

Table 1: *Comparison of the ecological footprints of different packaging systems.*
[Rankings appear in square brackets; 1 is best, 4 is worst]

PART A

System: *25 & 33cl*	**Footprint per 1000 litres EF 1 (m^2)**	**Footprint per 1000 litres EF 2 (m^2)**
Refillable Glass 33cl Green	**1535 [1]**	**10887 [1]**
Disposable Glass 33cl Clear	**1653 [2]**	**19921 [3]**
Refillable Glass 25cl Clear	**1703 [3]**	**12436 [2]**
Disposable Glass 33cl Green	**2014 [4]**	**21775 [4]**
Aluminium Cans 33cl	**2514 [5]**	**22134 [5]**
Steel Cans 33cl	**3898 [6]**	**27804 [6]**

PART B

System: *50cl*	**Footprint per 1000 litres** **EF 1 (m^2)**	**Footprint per 1000 litres** **EF 2 (m^2)**
Refillable PET 50cl	**489 [1]**	**7392 [1]**
Disposable PET 50cl	**1496 [2]**	**28391 [4]**
Aluminium Cans 50cl	**1994 [3]**	**17837 [2]**
Steel Cans 50cl	**3945 [4]**	**21714 [3]**

PART C

System: *150cl*	**Footprint per 1000 litres** **EF 1 (m^2)**	**Footprint per 1000 litres** **EF 2 (m^2)**
Refillable PET 150cl	**388 [1]**	**6043 [1]**
Disposable PET 150cl	**799 [2]**	**16596 [2]**

Figure 1 shows these same results as a bar chart to illustrate the scale of differences reported by these 2 EFA methodologies.

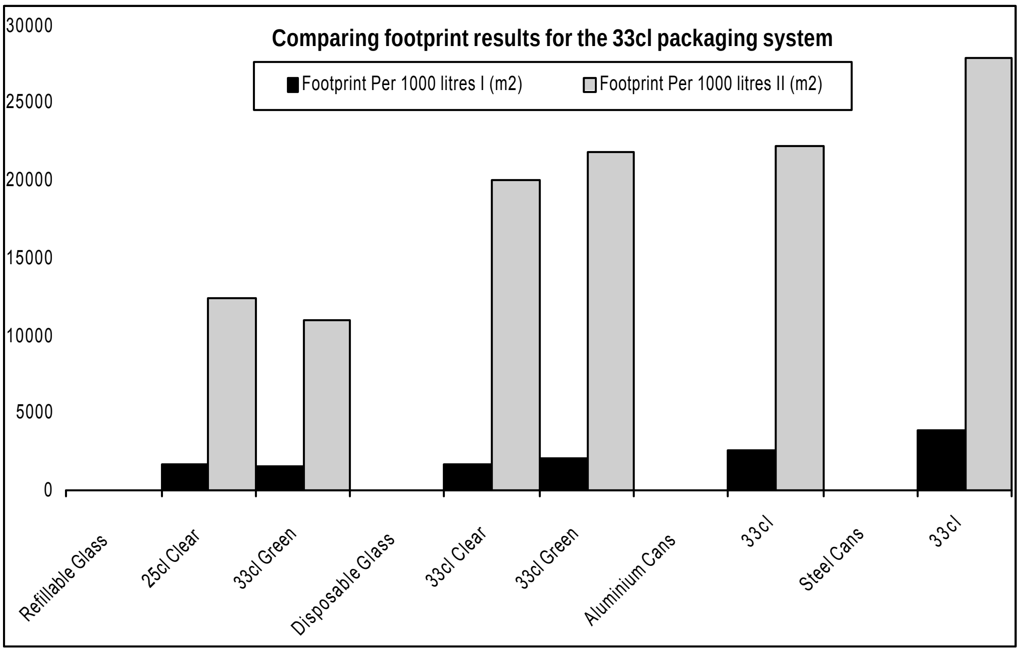

Figure 1: *The results of EF1 and EF2 for the different packaging systems within the 3 size classes*

In an attempt to try and assess the comparability with the LCA, the EF 1 and EF 2 rankings were compared with the modal rankings for each LCA impact category considered, i.e. resource, environmental and waste. That is, the most frequently occurring LCA ranking is used.

Table 2 (Parts A to C) presents the results of this exercis e and indicates the strong correlation between the different methods.

Table 2: Comparative ranking of results between EF 1, EF2 and the LCA study (1 is best, 4 is worst)

PART A

System: ***33cl & 25cl Systems:***	**EF 1**	**EF 2**	**LCA**
Refillable Glass 33cl Green	**1**	**1**	**1**
Disposable Glass 33cl Green	**2**	**2**	**2**
Aluminium Cans 33cl	**3**	**3**	**3**
Steel Cans 33cl	**4**	**4**	**4**

PART B

System: ***50cl Systems:***	**EF 1**	**EF 2**	**LCA**
Aluminium Cans 50cl	**3**	**2**	**2**
Steel Cans 50cl	**4**	**3**	**4**
Refillable PET 50cl	**1**	**1**	**1**
Disposable PET 50cl	**2**	**4**	**2**

PART C

System: ***150cl Systems:***	**EF 1**	**EF 2**	**LCA**
Refillable PET 150cl	**1**	**1**	**1**
Disposable PET 150cl	**2**	**2**	**2**

Summary and Conclusions

For the 50cl and 150cl packaging systems, the EF analyses indicate a clear 'leader':

- 50cl Systems – Refillable PET
- 150cl Systems – Refillable PET

For 25cl and 33cl packaging systems the EF analyses show the differences between the glass containers to be relatively small although the 33cl refillable green glass has the lowest footprint rating. Both aluminium and steel cans rank lower than all the glass alternatives.

The main differences between the EF1, EF2 and LCA rankings are for the 50cl packaging systems. This can be traced to the method used to assess, in particular, SO_2 and NOx emissions.

In conclusion, it must be repeated that although the results can be seen as generally supportive of the LCA findings, the treatment of pollution within EFA is still in its early stages.

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Appendices omitted from online version.