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# The sustainable consumption of domestic products: the environmental effect of packaging

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## Abstract

Today consumers are offered a wide range of packaging alternatives for the same product, including food items, cleaning products or health care articles, although these products are used for identical purposes. There is a crucial need to increase our knowledge of the environmental consequences of domestic product packaging in order to implement improvements that promote sustainability.

A life cycle assessment (LCA) case study was performed in order to detect and quantify the environmental impact of different packaging options (materials (plastics, glass, can, tetra brick) and sizes (200 ml, 1 liter, 5 liters, etc.)) for one type of domestic product (beverage). Furthermore, two final disposal options (recycling and landfilling) were compared to evaluate the impact of each method on the environment.

The results of the LCA for the different packaging types indicate that disposing of recyclable materials in landfills has a far greater environmental impact than recycling those materials. This means that recycling activities are not only beneficial in protecting the environment but also in terms of saving precious land space. Results of the life cycle impact assessment for the different packaging systems demonstrate the critical importance of recycling packaging material rather than disposing of it in landfills.

**Key words:** sustainability, sustainable packaging, waste management, responsible consumption

## 1 Introduction

With the increasing awareness of the importance of maintaining the life-support systems of our planet, methods for assessing "best practices" are becoming more important not only among a growing number of policymakers and consumers but also among industry intent on supporting sustainable business practices. Increasing concern about environmental protection and a broader awareness of sustainable development issues have focused more and more attention on the environmental impact of products through the different phases of their life cycles.

Packaging plays a vital role in society, but it is also a topic of intense public debate. A major environmental concern is the increasing amounts of solid waste, of which packaging constituents a considerable share. In Europe, packaging waste represents approximately 17% of municipal solid waste by weight and 3% of the total waste stream (Huang and Ma, 2004). Packaging has a relatively short lifetime; consequently, the amount of packaging waste approximately equals the amount of packaging on the market.

Several issues are taken into account when choosing packaging for foods. Consumers consider food quality and proper preservation as the most important aspects when choosing a product, so product packaging must therefore ensure that both of these needs are met. According to companies, a pleasant image, strong marketing appeal and correct product identification are other very important characteristics in package design. But such an approach cannot be complete if it does not pay enough attention to environmental considerations, as provided for in the 94/62/EC Directive on packaging and packaging waste (Monte, Padoano and Pozzetto, 2005).

Industry is realizing that the impact of products on the environment does not start and end with the manufacturing process. The impact a product has on the world starts with the design and ends with the ultimate disposal of the product after its useful life. Therefore, it is important not only to have a means of determining the environmental impact of the production process, but also of determining the environmental impact of the product itself and to quantify that impact. The life cycle concept means that everything put into the 'cycle' (energy, materials, etc.) as well as the output (products, energy, waste materials, etc.) is evaluated at each step of the product's life. Many studies have evaluated the environmental aspects associated with packaging systems.

It is important to increase our knowledge of the environmental consequences of domestic product packaging production and disposal in order to implement improvements that promote sustainability. Because of that it is essential to inform the consumer about the environmental implications of the whole product's life cycle. With this objective, we have developed a web application directed to the general public, that contains environmental information for different packaging options of the most commonly found products in Spanish basic market basket (APQUA, 2009).

The main objective of this work is to compare the life cycle assessments (LCA) of four packaging material alternatives used for beverages: glass, plastic, tetra brick and aluminum cans. Different packaging sizes are also assessed depending on the material (e.g. 200 ml and 1 liter tetra brick; 200 ml, 1 liter and 5 liter plastic, etc.), and the effects of recycling the material as opposed to disposing of it in landfill.

## 2 Methodology

We used LCA as an environmental assessment method in this study, following the methodology indicated by international standards (ISO 14040, 2006; ISO 14044, 2006). The functional unit was the packaging required to contain 1 liter of beverage. Therefore, all data presented here refer to this functional unit.

The system boundaries considered include the production of the packaging and its final disposal in landfill or by means of recycling. In the recycling scenario only the recovered material was considered as avoided load. In any case, for the recycling scenario, we did not consider the beneficial environmental load of avoiding landfilling. As this is a packaging comparative study, the impact of the beverage was not considered. The packaging options studied are detailed in table 1, including the packaging materials, the beverage content and the packaging weight related to 1 liter of beverage. The recycled scenario was based on 100% of the packaging being recycled. The loss rates for recovered material considered are indicated in table 1, and they are expressed as ton of product made per ton of recovered material (EPA, 2002). These values are representative of a general situation and consider the percentage of recovered materials retained in the recovery stage, and the percentage of recycled material obtained at the recycling stage.

The LCA inventory was made and the environmental loads calculated by adapting data from the ecoinvent v2.01 database (Swiss Centre for Life-Cycle Inventories, 2007) to the Spanish energy mix and the European model for transport and water. We calculated two indicators: Global Warming (GWP, kg $CO_2$ eq) and Cumulative Energy Demand (CED, MJ).

| **Material** | **Types** | **Sizes** | **Weights (g)** | **Recovered rate** | **Uses** |
|---|---|---|---|---|---|
| Brick | Brick | 200 ml | 55.0 | 78 % | Milk, juice, wine |
| Brick | Brick | 1 l | 37.7 | 78 % | Milk, juice, wine |
| Can | Aluminum can | 330 ml | 48.5 | 93 % | Beer, soft drinks |
| Can | Aluminum can | 500 ml | 34.7 | 93 % | Beer |
| Glass | Green (G) | 750 ml | 727.5 | 88 % | Wine |
| Glass | White (W) | 1 l | 501.5 | 88 % | Milk, juice |
| Glass | Brown (B) | 1 l | 470.4 | 88 % | Beer |
| Plastic | HDPE | 200 ml | 92.8 | 78 % | Juice |
| Plastic | HDPE | 1 l | 35.4 | 78 % | Milk, juice |
| Plastic | PET | 330 ml | 47.8 | 78 % | Water |
| Plastic | PET | 1,5 l | 24.3 | 78 % | Water |

| | | | | | |
|---|---|---|---|---|---|
| Plastic | PET | 5 l | 22.8 | 78 % | Water, wine |
| Plastic | PET | 8 l | 19.3 | 78 % | Water |

*Table 1: Beverage packaging types studied*

## 3 Results and discussion

The results for the CED and GWP indicators are presented in figures 1 and 2 respectively, in percentage format. The value of 100% was assigned to the highest impact and the remaining percentages were calculated based on that impact.

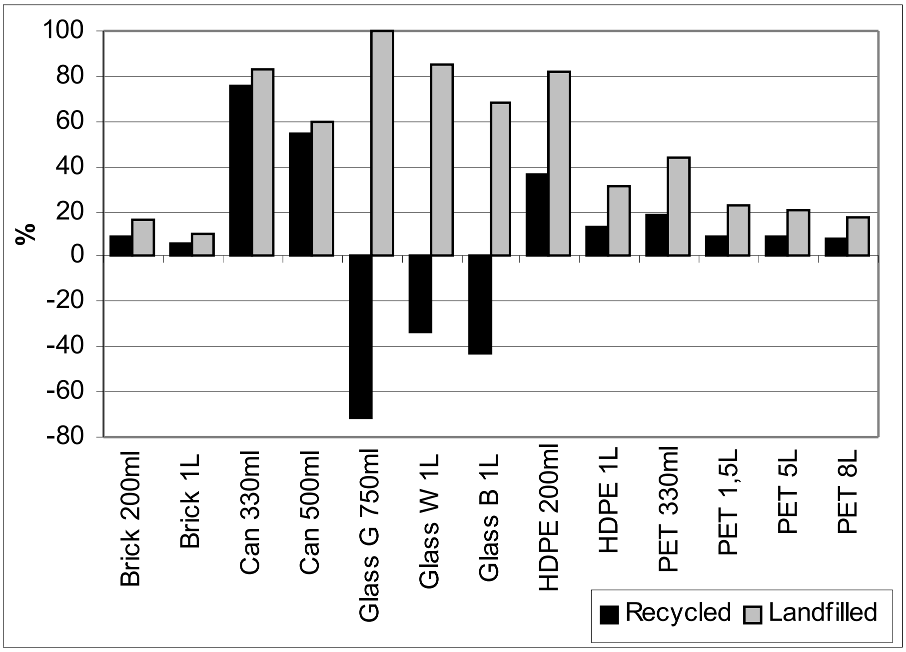


*Figure 1: Cumulative Energy Demand (CED) for different beverage packaging alternatives*

When comparing the final disposal scenarios, we observed that for both indicators the recycling scenario is better than the landfill disposal scenario as it implies a lesser environmental impact. The difference between the two disposal options depends not only on the treatment operation but also, in the case of recycling, on the material recovered. The environmental loads related to the recycling of glass bottles are negative for the CED indicator, thus representing an environmental benefit. It is also important to consider that the CED of glass reflects the savings in energy and raw materials that the production of new glass would entail.

When comparing different packaging materials, the lowest environmental impact for both GWP and CED in the landfilling scenario are caused by brick and plastic packaging (both PET and HDPE of more than 1 liter). The same comparison for the recycling scenario indicates that, according to the GWP indicator, brick and PET materials also have the lowest environmental impacts. However, the CED indicator shows an environmental benefit for glass bottles due to avoided loads.

Recycling has a beneficial effect on the total amount of equivalent $CO_2$ emitted as a consequence of material production.

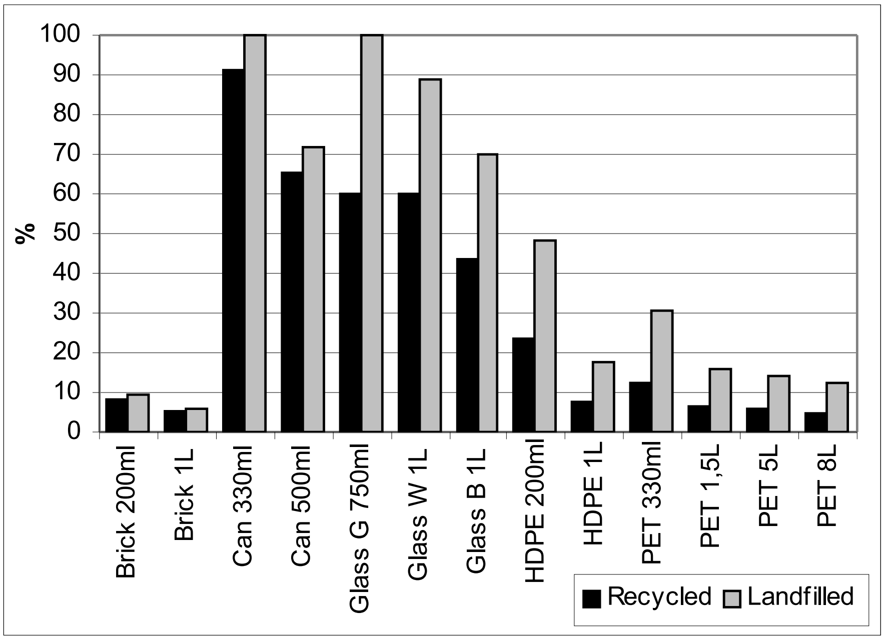


*Figure 2: Global Warming Potential (GWP) for different beverage packaging alternatives*

When comparing different packaging sizes for the same material, we found that as a consequence of the reduction of packaging material per unit of product, the higher the volume content of the packaging, the lower the environmental impact for the same amount of beverage (1 liter).

# 4 Conclusions

4. Recycling beverage packaging materials induces a lower environmental impact than disposing of such materials in landfills, for all materials and sizes compared.
5. Brick and plastic packaging (for more than 1 liter of content) present the lowest environmental impact for both indicators and disposal scenarios.
6. Glass recycling, because of the energy and raw material savings it entails, is recommended according to the CED indicator, when recycling is ensured and the quality of the product is reliant on its packaging.
7. Larger packages are always better than smaller ones for the same amount of liquid. Optimal packaging sizes should always be considered.
8. The goal is to encourage the use of packaging that requires the least amount of energy

and natural resources and has the lowest emission levels possible.

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