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Critical Review of the Life Cycle Assessment (LCA) Study
**The Sustainability of Packaging Systems
for Fruit and Vegetable Transport in Europe
based on Life-Cycle-Analysis**

Prepared for:
**Dept. Life Cycle Engineering
at University of Stuttgart
and PE Europe**

Prepared by:
Five Winds International



www.fivewinds.com



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SUMMARY

The *Department Life Cycle Engineering* at the University of Stuttgart and *PE Europe* were commissioned by *Stiftung Initiative Mehrweg (SIM)* to conduct a Life Cycle Assessment (LCA) study on different fruit and vegetable transport packaging systems.

Since this comparative LCA study examines the strengths and weaknesses of different packaging systems and materials – cardboard, wood, and plastics – a Critical Review by an independent review panel was incorporated into the overall study plans.

Five Winds International¹ was commissioned in July 2006 to lead the Critical Review in accordance with ISO 14040/44, in collaboration with co-reviewers. The review panel comprised the following experts:

- Angeline de Beaufort-Langeveld — expertise on paper and cardboard;
- Dipl.-Ing. Sebastian Rüter and Prof. Dr. Arno Frühwald, University of Hamburg — expertise on wood;
- Dr.-Ing. Ivo Mersiowsky, Five Winds International — co-ordination and expertise on plastics.

The review process comprised the following steps:

- two telephone conferences of the review panel in order to identify gaps in information (methods and data) based on the draft report and to evaluate the responses of the practitioners;
- one face-to-face meeting with the practitioners in order to discuss certain key assumptions and to conduct spot checks on the LCA model and database.

The conclusions of the Critical Review are:

- The study was conducted in accordance with ISO 14040 and 14044.
- The purpose and intended use of the study as well as the life cycle model and the data categories are transparently documented. The data, models and methods employed are appropriate, given the goal and scope of the study. The modelling, calculations and aggregation into indicator results were supported by a professional life cycle assessment software (*GaBi 4*, www.gabi-software.com).
- The unit process data were derived from surveys in industry and expert organisations or from the *GaBi* life cycle assessment database. Data quality was demonstrated in terms of consistency, geographic and temporal scope.
- Some assumptions remain contentious between experts. These issues are noted and commented upon below. Since they are transparently documented, this circumstance was not deemed to affect the overall outcome of the critical review.
- While the study was conducted in such a way as to potentially support a comparative assertion of the examined packaging systems, this critical review does not imply an endorsement of any such comparative assertion based on this LCA study.

¹ Since December 2006, Five Winds International and PE International have a Joint Venture (PE Americas) to promote LCA in North America.



RESULTS OF THE CRITICAL REVIEW PROCESS

SPECIFIC COMMENTS

The following issues (mentioned in no particular order of priority) were discussed in the review panel meetings and brought to the attention of the practitioners. Thus they were resolved to the satisfaction of the review panel:

1. The review panel appreciates that the declared goal and intended use of the study is the identification of optimisation potentials of the three different packaging systems. Therefore, the summary and conclusion chapters were re-organised to clearly point out the optimisation potentials for each material and only then compare them by life cycle phase and indicator.
2. The review panel recognises that the study aims to fill gaps in the existing knowledge about the different packaging systems. To this aim, a literature review (annex) had been conducted and evaluated. Previous studies examined specific situations of single countries. The introduction was modified to highlight that this study examines a more general scope which aims to be representative and relevant for a European transport scenario.
3. The review panel noted that the study addresses economic and social aspects as well: it was emphasised that only the environmental aspects as examined with the Life Cycle Assessment methodology were subject to the critical review according to ISO 14040 and 14044.
4. The review panel and the practitioners discussed the multi-functional nature of packaging systems and their implications for the definition of the functional unit. While the functional unit is based exclusively on the carrying capacity of each system, further properties like design aspects, suitability for specific logistics systems, and occupational health and safety issues are acknowledged as potentially relevant for the decision-maker.
5. The review panel acknowledged the choice of life cycle impact indicators, in particular the omission of toxicity indicators. In view of scientific debates around the development of appropriate toxicity indicators and the expected relevance for the investigated packaging systems, the rationale for not addressing these impact categories has been made more transparent.
6. The review panel noted that life cycle inventory (LCI) data for plastics were derived from studies of the German Environmental Agency (*UBA*) rather than from industry federation *PlasticsEurope*: a sensitivity analysis showed that this choice renders overall comparable and rather conservative results.
7. The review panel noted that the dimensions of the cardboard box examined in the report by industry federation *FEFCO* are somewhat smaller than the generic cardboard box considered in the present study: in order to address the effect and any possible bias due to the scale-up, appropriate margin indicators were introduced in the presentation of the life cycle impact indicator results.
8. The review panel and the practitioners discussed the logistics model (transport matrix) and found it to be conclusively explained and appropriate for the study. While this study considers a European weighted average to achieve the requisite representativeness, the investigation of distance-related optimisation potentials is outside the present scope and would likely hold potential for future studies.



9. The review panel and the practitioners discussed the presentation of the primary energy demand indicator with regard to the special case of incorporated solar energy that is fixed in biomass. It was emphasised that the primary energy demand indicator addresses the use of raw energy resources for the production of a product (technosphere) as opposed to the effective energy or the calorific value of a product. The energy embodied in wood and paper mainly originates from solar energy (photosynthesis) and has therefore to be specified as such.

ISSUES FOR FURTHER RESEARCH

Upon conclusion of the critical review process, the following issues remained where expert opinions diverged or where further research may be warranted.

Recycling of Corrugated Board

The question arose whether the study appropriately reflects the current practice of recycling corrugated board from the investigated packaging system.

The study was conducted with the understanding that due to the shortening of fibres during recycling, recycled board will not allow for sufficient carrying capacity as to be used in fruit and vegetable transport again, in particular due to the potential exposure to moisture in cooled vehicles. Hence, the assumption was made that the majority of used cardboard boxes are disposed of in municipal waste incineration – a practice confirmed by logistics companies – and a credit for possible energy recovery was awarded. Industry federation *FEFCO* indicates that transport boxes are almost exclusively made from virgin material, which seems to support this approach.

By contrast, the view is held that, although the majority of the fruit and vegetable corrugated boxes are made from primary fibre, this does not mean that the crates are not recycled. On the contrary, *CEPI* statistics show that 80 % of packaging board are in fact recycled. Throughout the EU, efficient collection systems for commercial paper-based packaging have been set up to ensure compliance with the Packaging Waste Directive recycling targets. Very high collection rates are achieved, already clearly exceeding the 60 % target set for end of 2008.

Corrugated material is baled and collected separately at the super markets. It is a valuable raw material for the corrugated base materials, which contain over 80 % of recycled fibres, most of it originating from corrugated boxes. It would even be impossible to reach such a level of recycled fibre if products containing mainly primary fibre were incinerated and not recycled. Producers have to pay for packaging they put on the market and get refunds when it is recycled. They would not benefit from incineration of the material. The collection rate of paper based packaging from households may be lower, but fruit and vegetable corrugated boxes are not consumer packaging.

As a consequence, the review panel concluded that further evidence would be needed to fully confirm the validity of the assumptions for the recycling of corrugated board. The practitioners refer to the pertinent parameter variation (parameter 9) to address the effect of these assumptions.



Recycling Models for Corrugated Board and for Plastics

In conjunction with the above issue, the question was raised whether the differing recycling models for corrugated board and for plastics imply a bias.

For plastic crates, a material recovery was assumed, with recycled plastics being used for beer crates (as a non-food contact application), i.e. an open-loop recycling into a different product system. Material credits, discounted for value losses, were awarded accordingly.

For cardboard boxes, however, mainly incineration was assumed as described above, awarding energy credits. By contrast, the view is held that used corrugated fruit and vegetable packaging could rather be recycled into different other types of corrugated packaging. This would imply a material credit rather than an energy credit.

The rationale for the assumptions in the study is given above. The practitioners refer to the pertinent parameter variation (parameter 13–14) to address the effect of these assumptions.

Life Cycle Interpretation

In order to facilitate the interpretation of life cycle inventory and impact analysis, the practitioners conducted contribution and sensitivity analyses. The review panel noted that the contribution of the service life (vehicle transport processes) to emissions is found to be substantial in case of the plastic crates whereas it is of significantly less importance in case of both wooden and cardboard boxes.

The sensitivity analysis addressed several parameters relevant for the production and waste management stages of the life cycle. The review panel acknowledged that uncertainties and variations pertaining to the service life were addressed with the conservative and technical scenarios, i.e. in terms of the total transport performance (lifespan and number of tours). This variation showed only minor effects on the relative performance of the three different packaging systems, so that the qualitative outcome of the study remains unaffected. Further variations of the transport-related service life parameters were not part of the goal and scope.

As a consequence, the review panel emphasised that the conclusions need to be viewed in light of the underlying scenario of a generic European transport situation as defined in the goal and scope of the study: while addressing a pan-European scope, the given transport task, as reflected in the functional unit, imposes specific logistic needs. Therefore, a general preferability of any single packaging system or material cannot be deduced; rather, other specific transport tasks would need to be investigated with a similar methodological framework in order to derive the specific strengths and optimisation potentials of the various eligible packaging systems.