



Comparative LCA of Four Types of Drinking Cups Used At Event Venues

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Content

- Study objective
- Target audience
- LCA standards, consultant & stakeholders
- External experts and peer review
- Background information of organizations involved
- Products examined and functional unit
- System boundaries
- Basic scenarios and sensitivity analysis
- Impact categories considered
- Cradle-to-pellet PLA data used
- PLA Scenarios studied
- Results Life cycle impact assessment
- Results Eco-indicator 99 LCA methodology
- Results Eco-efficiency study
- Comparison “PLA future scenario” with PLA6 and PLA/NG

Study Objective

- In order to outline a well-founded waste management policy for events OVAM, the Public Waste Agency for the Flemish Region, wanted to gain insight in the environmental impact and the costs related to the use of current drinking cup systems on small-scale indoor and large-scale outdoor events.
 - Phase I: A comparative LCA comparing the environmental impacts of four existing cup systems.
 - Phase II: Extension with an eco-efficiency analysis, including the calculation of an environmental indicator as well as a cost indicator.

Target Audiences

- Internal audience:
 - Policy makers OVAM
 - Belgium Government
- External audience:
 - Public in general (Study is published)

LCA Standards, Consultant & Stakeholders

- Study complies with LCA ISO Standards 14040-14043
- LCA Consultant
 - VITO A. Vercalsteren, C. Spirinckx, T. Geerken and P. Claeys.
- Stakeholders panel
 - FOST Plus Belgian association for packaging waste collection & recycling
 - Alken-Maes Beer producer
 - NatureWorks LLC PLA producer
 - Febelplast Belgian association of plastic converters
 - Foundation Disposables Benelux
 - FETRA Federation for paper and carton processing companies
 - Hoptimus Belgium Brewery
 - Federation Music Events
 - IVVVA Inter-municipal body for waste collection and processing
 - Vlaco Flemish Composting Association
 - BBL Federation of Flemish environmental organization
 - IVC Inter-regional packaging commission
 - XIOS Institute for higher education, Limburg
 - FEVIA Belgian federation for the foodindustry
 - Huhtamaki Packaging producer
 - FEBEM Belgian federation of waste management companies

External Experts & Peer Review

- External experts consulted
 - Cup distribution organizations and cup suppliers
 - Events organizers
 - Cup producers
 - Waste treatment companies
 - Inter-urban organizations
 - (List with names of each consulted company is provided in the report)
- Peer review
 - Tom Ligthart (chairmen), TNO (The Dutch Organization for Applied Scientific Research)
 - Bruno de Wilde, OWS (Organic Waste Systems)
 - Erwin Vink, NatureWorks LLC
 - Aafko Schanssema, PlasticsEurope

Institutes

(Background Information)

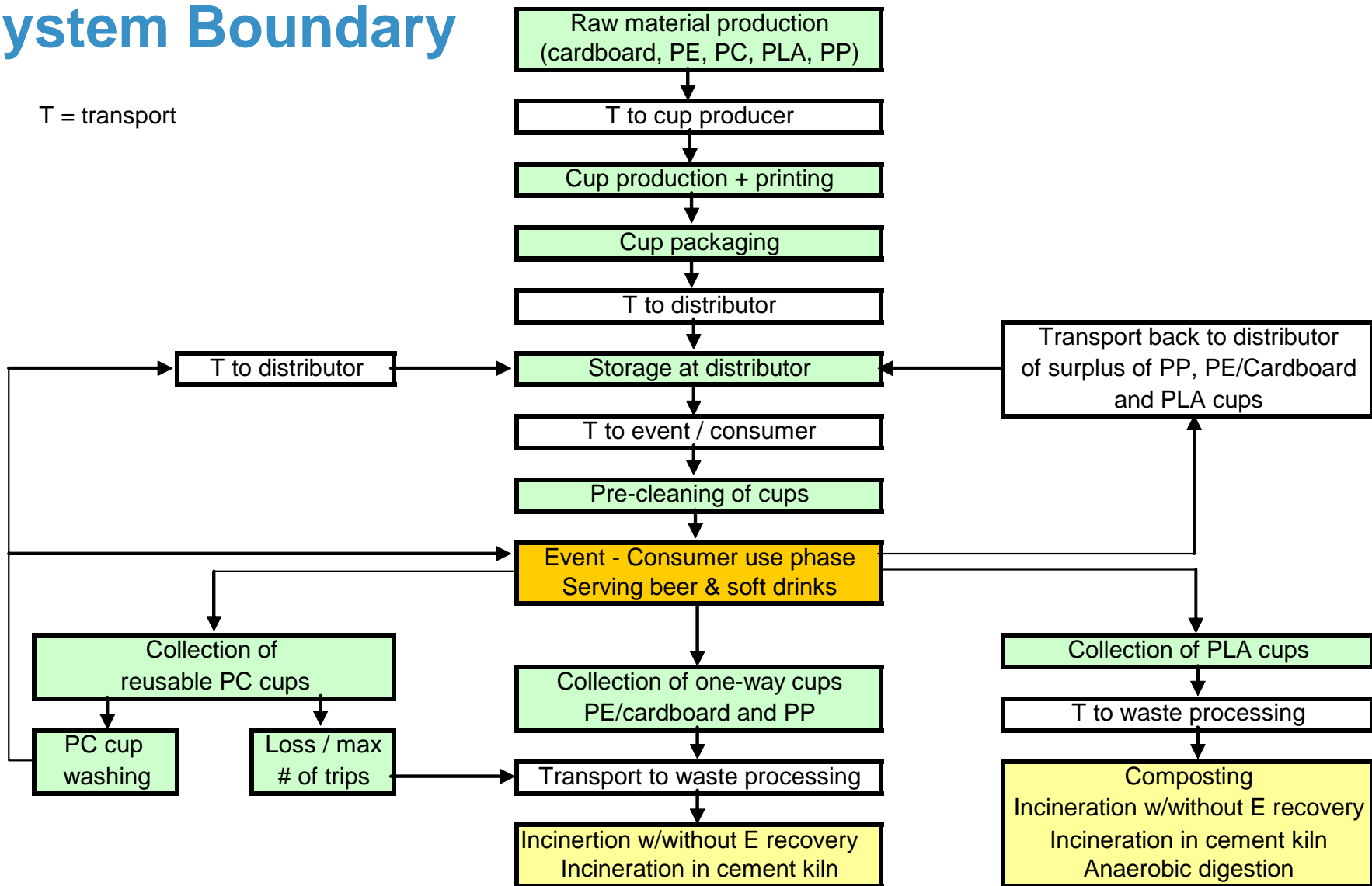
- **OVAM:** The Public Waste Agency for the Flemish Region in Belgium.
- **VITO:** The Flemish Institute for Technological Research. LCA Consultant.
- **PlasticsEurope:** PlasticsEurope represents the plastics manufacturers in Europe. The association has more than 60 member companies, producing over 90% of polymers across Europe's 25 members.

Products Examined

- **Product systems studied:** four types of cups were studied:
 - Re-usable Polycarbonate (PC) cups;
 - One-way polypropylene (PP) cups;
 - One-way Polyethylene (PE) - coated cardboard cups and
 - One-way Polylactide (PLA) cups.
- **The functional unit:** the recipients needed for serving 100 litre beer or soft drinks on a small-scale indoor (2000-5000 visitors) or a large-scale outdoor event (>30,000 visitors). This definition includes the production of the cups, the consumption phase (on the event) and the processing of the waste.

System Boundary

T = transport



Basic Scenarios and Sensitivity Analysis

- Basic scenarios for small-scale and large scale events
 - Re-usable PC cups (EOL* is incineration)
 - One-way PP cups (EOL is a mix of incineration and use in cement kiln)
 - One-way PE-coated cardboard cups (EOL is a mix of incineration and use in cement kiln)
 - One-way PLA cups (EOL is 50% composting and 50% incineration)
- Sensitivity analysis for small-scale and large scale events
 - PC cups with best case trip rate
 - PC cups with worst case trip rate
 - PC cups 100% machine cleaning after event
 - PC cups doubling of water & detergent use for cleaning during event
 - PC cups transport producer - distributor conform market
 - PP cups transport producer - distributor conform market
 - PP cups EOL = 100% incineration
 - PP cups EOL = 100% use in cement kiln
 - PE coated cups transport producer – distributor conform market
 - PE coated cups EOL = 100% incineration
 - PE coated cups EOL = 100% use in cement kiln
 - PLA cups future production scenario (5.5g; new fermentation technology, anaerobic digestion)
 - PLA cups EOL = 100% composting
 - PLA cups EOL = 100% incineration
 - PLA cups transport producer – distributor conform market
 - PLA cups reduced cup weight (6.5 g \Rightarrow 5.5 g)

EOL = end of life = final waste disposal

Impact Categories Considered

- Damage category: Human Health
 - Carcinogenics
 - Respiratory effects caused by organics
 - Respiratory effects caused by inorganics
 - Climate change
 - Ozone layer
- Damage category: Ecosystem Quality
 - Ecotoxic emissions
 - Acidification / Eutrophication
- Damage category: Resources
 - Extraction of minerals
 - Extraction of fossil fuels

Cradle-to-Pellet PLA Data Used

- **PLA:** Represents the current (= May 2005) cradle-to-pellet PLA production system.
 - Data as available published May 2005.
- **PLA – future scenario:** Represents the future cradle-to-pellet PLA production system.
 - This PLA is expected to be available within a few years.
 - It is based on the implementation of new process technology, which will reduce energy and raw material use and co-product creation.
 - Data as available per May 2005.
- **Note:** In this LCA no Renewable Energy Certificates nor Green Power are utilized for PLA production.

PLA scenarios studied

“PLA Basic”

- May 2005 PLA production data
- 6.5 g cup
- EOL = 50% composting and 50% incineration
- Production in US (Transport distance between pellet and cup production is 8000 km)

“PLA Cup sensitivity – future scenario”

- Data based on new process technology, expected within few years
- 5.5 g cup
- EOL = 90% anaerobic digestion and 10% incineration
- Assumed PLA production in EU (Transport distance between pellet and cup production is 100 km)

Results for both scenarios are given in the next slide

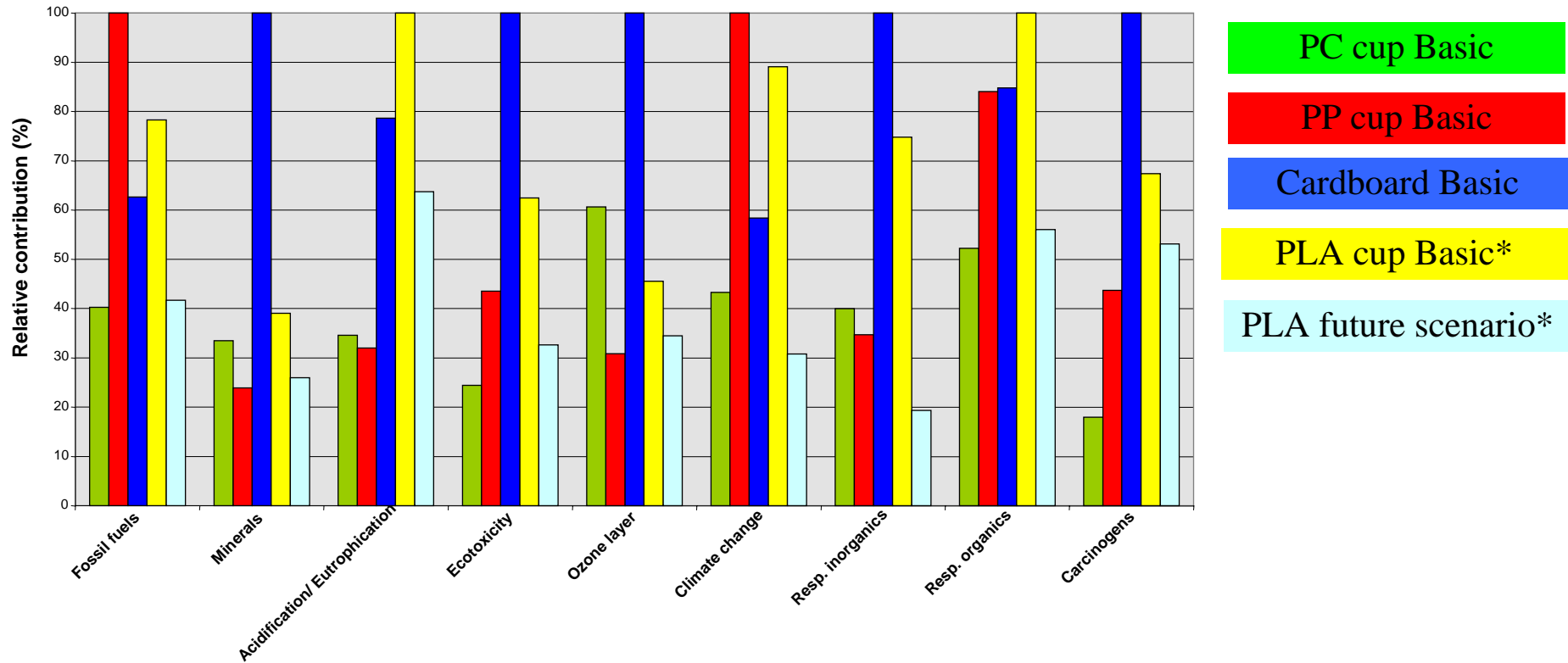


Results

Life cycle impact assessment

Results Life Cycle Impact Assessment:

Comparison of the environmental profile of the 4 cup systems on small events combined with the sensitivity analysis for PLA Future Scenario.

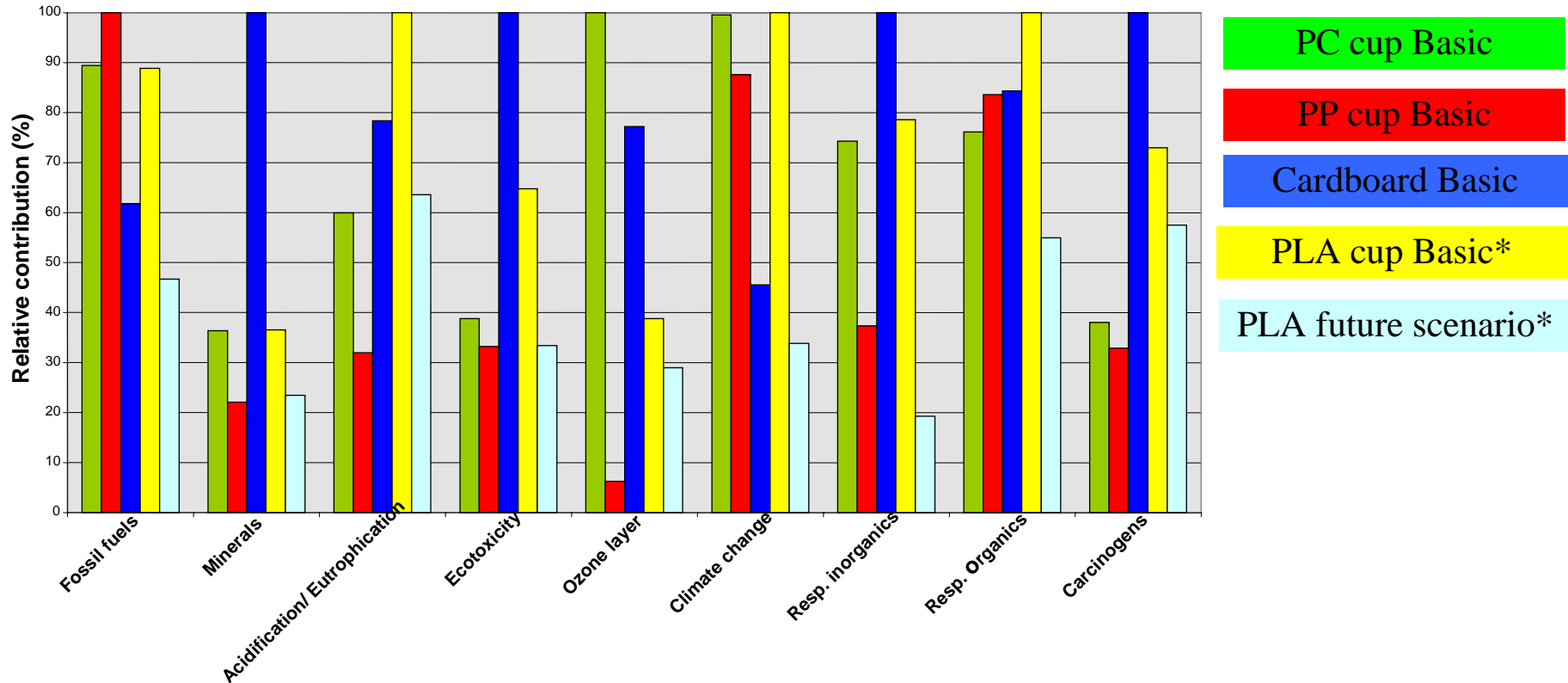


1. It is impossible to make an unambiguous statement about the preferred Basic cup system since no cup system scores best in all categories.
2. The Future Scenario for PLA production decreases the relative contributions with 20-80%.
3. The most important drivers for the lower environmental impact of the PLA Future Scenario are PLA pellet production and cup weight.

* Specified on previous slide

Results Life Cycle Impact Assessment:

Comparison of the environmental profile of the 4 cup systems on large events combined with the sensitivity analysis for PLA Future Scenario.



1. It is impossible to make an unambiguous statement about the preferred cup system since no cup system scores best in all categories.
2. The Future Scenario for PLA production decreases the relative contributions with 20-80%.
3. Most important reasons for the lower environmental impact of the Future Scenario for PLA are: PLA pellet production and cup weight.

* Specified on previous slide

Conclusions Life Cycle Impact Assessment

1. For both types of events it can be concluded that none of the cup systems has the highest or the lowest environmental score for each environmental category.
2. Based on these results it was not possible to make straightforward conclusions for the selection of the most favourable cup system since the different environmental impact categories do not have the same denominator and can therefore not be compared directly with each other.
3. If the small-scale indoor results are compared with the large-scale outdoor results for the individual cup systems the environmental burden for the PC cups increase significantly moving to larger scale events, while the burden stays the same for the three one-way cup systems.
4. Further the LCA sensitivity analysis confirms that the trip rate for the PC cups is a very determining factor for the results of the study.



Results

Eco-indicator 99 LCA Methodology

Eco-indicator 99 LCA Methodology

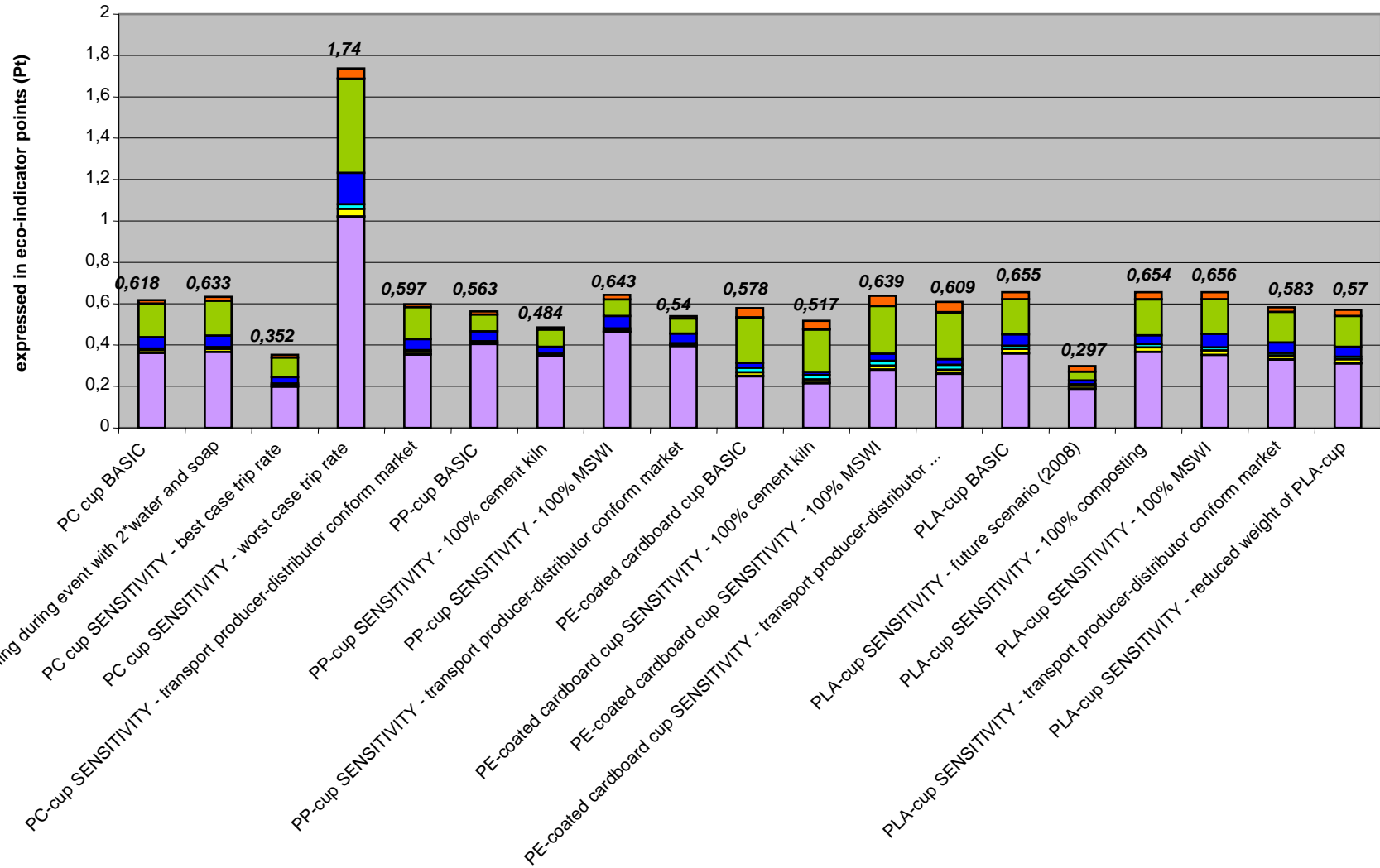
- For an Eco-efficiency analysis it is required to express the total environmental impact as one single indicator.
- The Eco-indicator 99 LCA methodology aggregates the different damage (impact) categories into 1 indicator: the Eco-indicator, by attributing weights to the different environmental impacts.
- These methods are not fully scientific and objective, but need some subjective choices.
- According to ISO 14040 it is not allowed to calculate 1 single environmental indicator within a comparative LCA study disclosed to the public domain, therefore OVAM published the Eco-efficiency study as a separate study from the LCA study.
- The Eco-indicator 99 methodology is discussed in detail in Annex 1 of the LCA and Eco-efficiency report.

Eco-Indicator values for the use of cups on SMALL events



■ Fossil fuels
 ■ Minerals
 ■ Acidification/ Eutrophication
 ■ Ecotoxicity
 ■ Ozone layer
 ■ Climate change
 ■ Resp. inorganics
 ■ Resp. organics
 ■ Carcinogens

Eco-Indicator values for the use of cups on LARGE events



■ Fossil fuels
 ■ Minerals
 ■ Acidification/ Eutrophication
 ■ Ecotoxicity
 ■ Ozone layer
 ■ Climate change
 ■ Resp. inorganics
 ■ Resp. organics
 ■ Carcinogens

Conclusions Eco-indicator 99

- For each scenario studied the fossil fuel use and human health effects of inorganics (dust, NO_x, SO_x) are the biggest contributors.
- The PC cups show the lowest environmental burden of the 4 Basic scenarios for the small event. This burden increases significantly moving to the large events, while the total burden stays the same for the three one-way cups.
- The trip rate for the PC cup is the dominating factor for the results of the study. The effect on the Basic scenarios is significant.
- The choice for PLA composting or incineration has no significant influence.
- 15% PLA cup weight reduction shows 13% reduction in indicator score, so reduction of cup weight is an important optimization parameter.
- For the small events the PLA future cup is comparable with the PC Basic cup and is significant better than the PP and PE-coated carton cups.
- For the large events the PLA future cup is significantly better than the PC and the PP and PE-coated carton Basic cups.

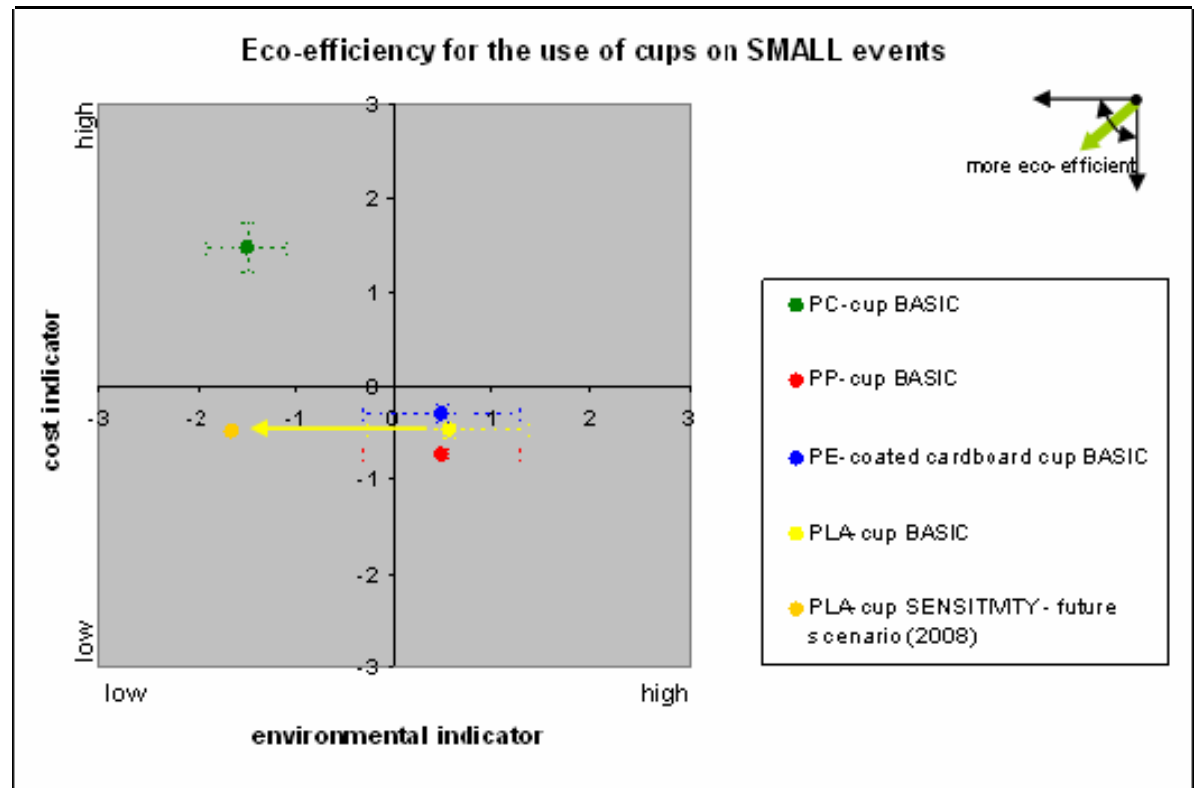


Results

Eco-efficiency study

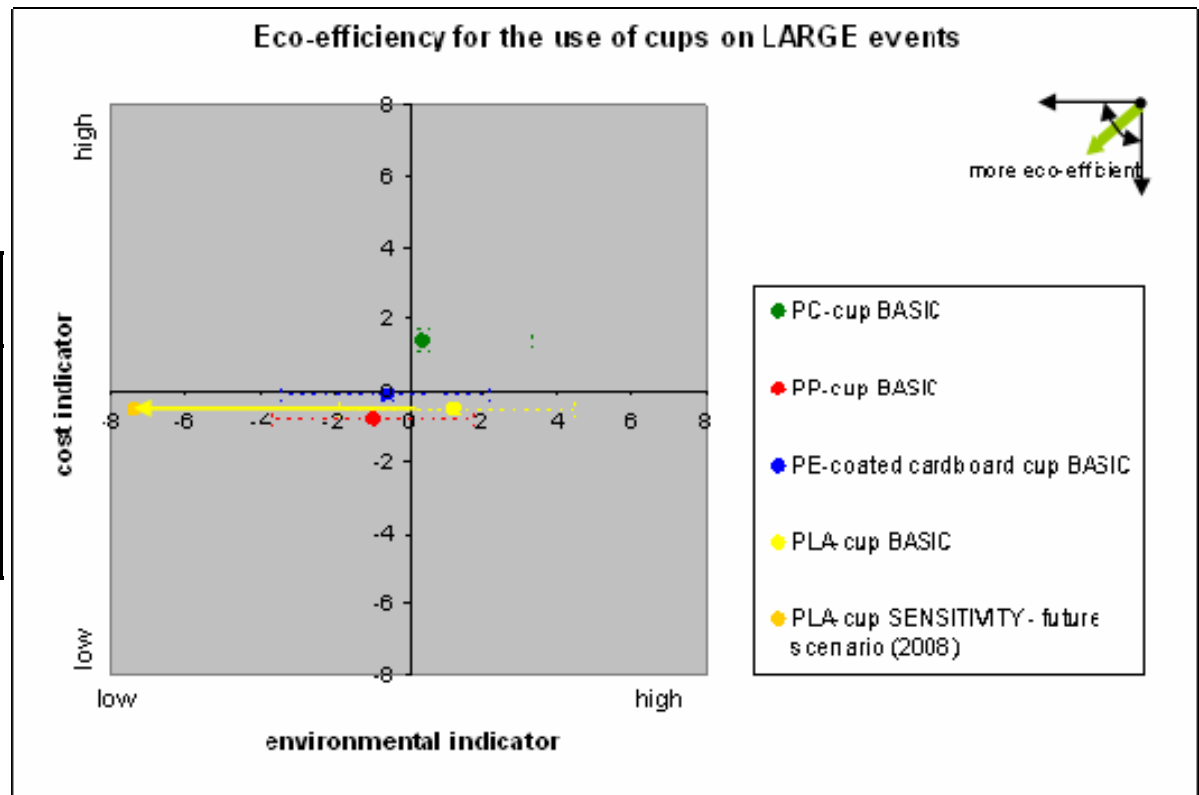
With this methodology the Environmental indicator is combined with a Life cycle costs indicator to determine the most eco-efficient cup systems.

Small events	Eco - Indicator	Costs - Indicator
PC Basic	0.33	71.16
PP Basic	0.65	12.49
Carton Basic	0.66	23.92
PLA Basic	0.67	19.36
PLA future	0.31	19.10



1. The PC cups have the lowest environmental indicator of the 4 Basic scenarios. However, it has to be guaranteed that the PC cups are at least reused 32 times. Below this trip rate the advantage for PC cups is gone. A clear disadvantage of the PC cups is that the life cycle costs are 3-5 times higher.
2. If the PLA future scenario becomes reality and the other cup systems are not able to improve their environmental indicators, PLA becomes similar to PC considering the environmental indicator but with a significant lower cost indicator resulting in a higher eco-efficiency.
3. An environmental policy to promote the use of reusable PC cups (e.g. by subsidies) on small events cannot longer be considered if the PLA future scenario becomes reality.

Large events	Eco - Indicator	Costs - Indicator
PC Basic	0.62	49.17
PP Basic	0.56	13.30
Carton Basic	0.58	24.51
PLA Basic	0.66	17.15
PLA future	0.30	17.01



1. The cup systems modeled in the 4 BASIC scenarios have a similar environmental indicator. However, the costs for the PC cups are significantly higher. One way cups are therefore more eco-efficient.
2. The effect of the PLA future scenario on large scale events is identical to the small scale events. The cost indicator remains the same, the environmental indicator improves significantly, causing an increase in eco-efficiency of this system.
3. If the PLA future scenario becomes reality and the other cup systems are unable to improve, the PLA cup system becomes the environmentally best option.

Comparing “PLA future scenario” with PLA6 and PLA/NG

- This LCA uses data for PLA production as available per May 2005.
- Since then NatureWorks decided to utilize wind energy to drive its processes and continued optimizing its processes.
- In this study Fossil energy use and Human Health effects of inorganics (NOx and SOx) were identified as the biggest contributors. Below table compares the data used in the underlying report and the currently (start 2007) available data for those two impact / damage categories.

	PLA future scenario Data per May 2005	PLA6 Data per January 2007	PLA/NG Data per January 2007
Fossil energy use (MJ/kg)	35.6	27.4	16.6
NOx (g/kg)	5.9	2.1	2.0
SOx (g/kg)	8.2	7.4	5.9

- From above table it can be concluded that the “PLA future scenario” is already “available” today via the utilization of wind energy, as modeled in the PLA6.

Final Remark About LCA's

- LCAs do not represent a complete picture of the environmental impact of systems.
- They represent a picture of those aspects that can be or are quantified.
- Any judgment that is based on LCAs must bear in mind this limitation and, if necessary, obtain additional environmental information from other sources about for instance hygienic aspects and risks assessment.



The End