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TNO report

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Single use Cups or Reusable (coffee) Drinking Systems: An Environmental Comparison

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Summary

The question “What is better for the environment, drinking coffee out of a disposable or reusable cup?” has already been the subject of study in the past. In the early nineties, TAUW Milieu undertook the studies “Reusable versus Disposable” and “Recycling Polystyrene (coffee)cups, sense or nonsense?!” These concerned environmental analyses where the following systems were compared:

- Cup and saucer (porcelain, reusable)
- Cup (cardboard, disposable)
- Cup (polystyrene, disposable; 0% recycling)
- Cup (polystyrene, disposable, 25% recycling)

The method for environmental comparison used in the said studies was not yet complete and in addition there was some discussion regarding the data and assumptions adopted. At the present time, various methods are available for a comparative environmental analysis that are generally accepted in the Netherlands and elsewhere. Changes have also occurred with regard to the drinking cups themselves, the possible washing up of cups and waste processing. Because the question “What is better for the environment, drinking coffee out of a disposable or reusable cup?” still has a certain topicality, the Stichting Disposables Benelux has commissioned TNO to conduct an updated environmental comparison.
The objective of the investigation was consequently to update the said TAUW studies (including examination of the influence of changes observed). This concerns the LCA methods applied, the assumptions adopted and the values of the various parameters used to make the different comparisons. In addition, the sensitivity of the LCA results to certain assumptions or parameter values was evaluated.

Part I; in conformity with the ISO 14040 and ISO 14044 standards

To compare systems equally to with each other, they have to be placed under the same denominator. This is done by defining the so-called functional unit that describes the function to be undertaken by the systems in a clear, quantitative way. The function is to provide hot drinks from a drinks vending machine or dispenser in an office or factory environment. The functional unit examined in this connection is as follows:

The dispensing of 1000 units of hot drinks (tea/coffee/hot chocolate) from a vending machine or dispenser in an office or factory environment.

The drinking systems compared in the present study are:
- Reusable porcelain cup and saucer
- Reusable earthenware mug
- Disposable polystyrene cup
- Disposable polystyrene insert cup with reusable cup holder
- Disposable paper cup.

Generally spoken, these systems are representative for the Western European situation. The environmental analysis includes:
- Production of raw materials
- Production of disposable and reusable systems
- Use of the systems (cleaning of the cup and saucer/mug where applicable)
- Collection of disposable or reusable systems used (including the specific collection transports)
- Waste processing and recycling
- Transport of materials and of cups to the customer and transport to recycling and waste processing
- Cleaning of reusable systems also includes the treatment of waste water in a sewage purification plant (RWZI).

The effect categories concerned in undertaking the environmental analysis are:
- Abiotic mineral resources depletion potential (ADP)
- Global warming potential (GWP)
- Ozone depletion potential (ODP)
- Human toxicity potential (HTP)
- Fresh water aquatic eco-toxicity potential (FAETP)
- Marine aquatic eco-toxicity potential (MAETP)
- Terrestrial eco-toxicity potential (TETP)
- Photochemical ozone creation potential (POCP)
- Eutrophication potential (EP)
- Acidification potential (AP)

The LCA was carried out in accordance with the procedure described in the ISO 14040 series.
ISO 14040 permits comparisons of alternative drinking systems only by individual effects category. This comparison is illustrated with the aid of Figure S1.

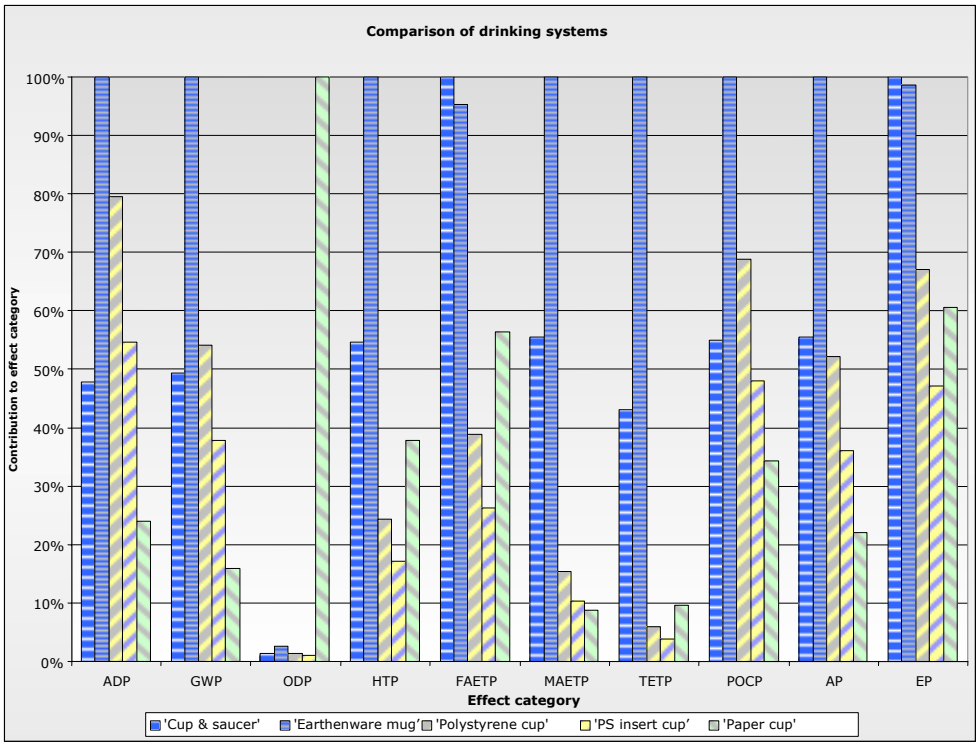

Figure S1 Comparison of the five drinking systems examined.

The scores as shown indicate that the reusable earthenware mug is the most environmentally polluting system in seven (ADP, GWP, HTP, MAETP, TETP, POCP and AP) out of the 10 categories. The reusable porcelain cup and saucer scores the highest for two categories (FAETP and EP).
For ODP, the disposable paper cup scores highest of all. The disposable paper cup is the least environmentally polluting system in 5 out of the 10 categories (ADP, GWP, MAETP, POCP and AP). For the other five categories, the disposable polystyrene insert cup is the least environmentally polluting system. The disposable polystyrene cup does not score highest nor lowest when considering the scores for the ten categories.

However, when comparing the various drinking systems, account must be taken of the major uncertainties in variation in the values of the key parameters, such as period of utilisation of the porcelain cup and saucer or earthenware mug, the method of washing up, waste processing of disposable systems, etc.

No final conclusions can therefore be drawn a priori from the comparisons shown in Figure S1. Sensitivity analyses were therefore carried out.

The following subjects were evaluated in a sensitivity analysis:
- Number of utilisation times of reusable porcelain cup and saucer
- The cleaning frequency of reusable systems; porcelain cup and saucer or earthenware mug
- Energy use of dishwasher
- The use of a professional (industrial) dishwasher
- Water and energy consumption when washing up a reusable earthenware mug oneself
- The cup weight for the disposable systems
- Number of utilisation times made of the disposable systems
- Allocation of the recycling of plastics based on economic value
- Alternative end-of-life routes for disposable polystyrene (insert) cups (100% waste incineration or 100% sub-coal use).

The results of the sensitivity analyses show that cleaning the cup and saucer and earthenware mug for the reusable systems is of very strong influence on the environmental burden by these drinking systems, with a contribution of between 90 and 100%. The utilisation of the porcelain cup (varying between 500 and 3,000 times used) only slightly affects the environmental profile of this drinking system.

For the disposable systems, the production of raw materials and the production of the cup itself very largely determine the environmental profile. Using the cup more often and/or reducing the cup weight therefore has a positive influence. Recycling into regranulate, incineration in a waste incineration plant or energy recovery in a power plant by sub-coal use all have a clearly favourable effect on the environmental profile for the disposable polystyrene (insert) cup.

Part II; not in conformity with the ISO 14040 and ISO 14044 standards

The environmental effects are aggregated by means of the shadow prices method. Shadow costs express the environmental burden of a product or other system in a monetary unit: the Euro. They are based on the shadow price per environmental effect category and by using the shadow prices method, various environmental effect categories can easily be aggregated (the advantage of this method is that it dovetails with the use of market-conforming instruments). The shadow price per effect category is based on emission reduction objectives for the substances covered by the category concerned and on the cost of emission reducing measures that must be adopted per unit in order to achieve the objective. The shadow price in this case is the price per unit of emission reduction for the most expensive measure still to be adopted to achieve the objective.

The aggregated shadow costs for the drinking systems compared are shown in Figure S2.

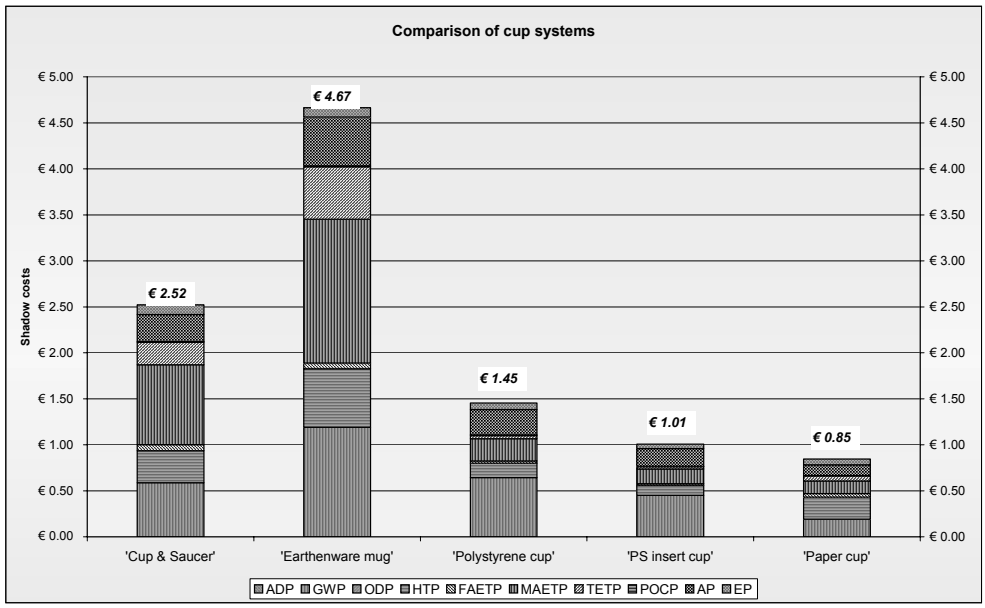

Figure S2 Comparison of the five coffee and other drinking systems investigated on the basis of shadow costs.

A comparison of the drinking systems investigated shows that the reusable mug is the system with the highest environmental impact at a shadow cost of € 4.67. The reusable mug is followed by the reusable porcelain cup and saucer (€ 2.52). For these two systems, the differences with the other systems are always more than 20%. They are followed by the disposable polystyrene cup (€ 1.45) and then by the disposable polystyrene insert cup (€ 1.01). The disposable paper cup scores lowest (€ 0.85)

As the cleaning frequency of the reusable systems reduces, these systems will score more equally when compared with the disposable systems; see Figure S3.

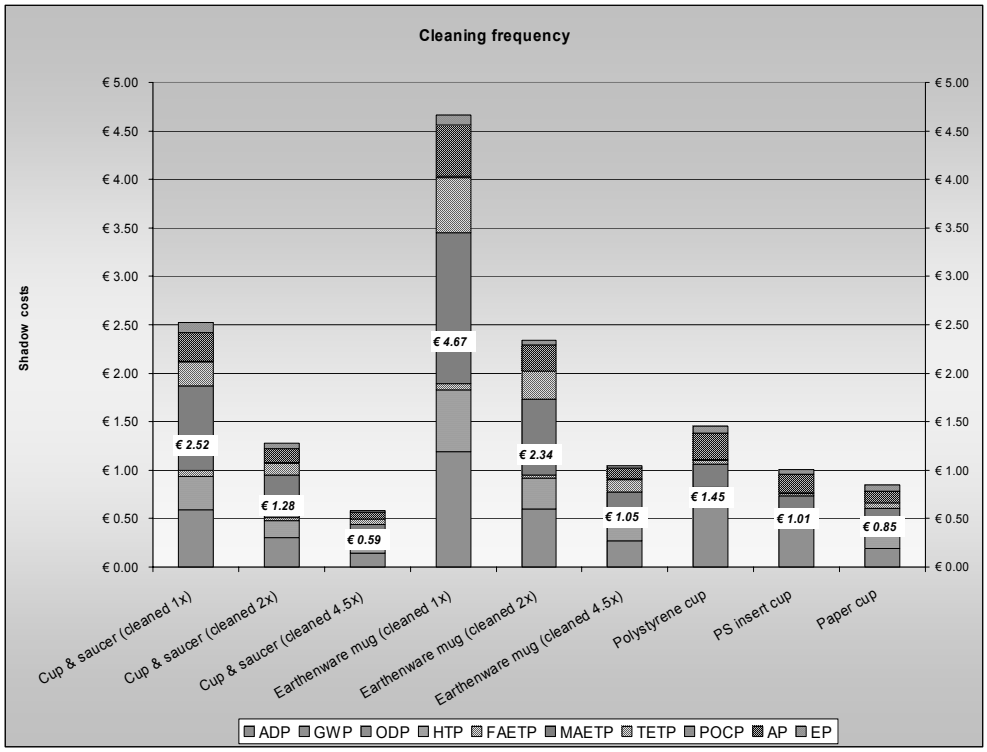

Figure S3 *Influence of the change in cleaning frequency[1] of the reusable systems on shadow costs. Under the basic scenario, reusable systems are cleaned after each use. In the sensitivity analysis, (cleaned 2x) means cleaning after being used twice, (cleaned 4.5x) means cleaning after being used 4.5 times on average.*

[1] In light of the Hazard Analysis and Critical Points (HACCP) principles, question marks can be placed regarding the hygiene of the system when the cleaning frequency is strongly reduced as this increases the hazard for the consumer [37].

The same trend can be observed when the energy consumption of washing up is reduced. On the other hand, if the disposable cup is used more often, it continues to perform clearly better than the reusable systems; see Figure S4.

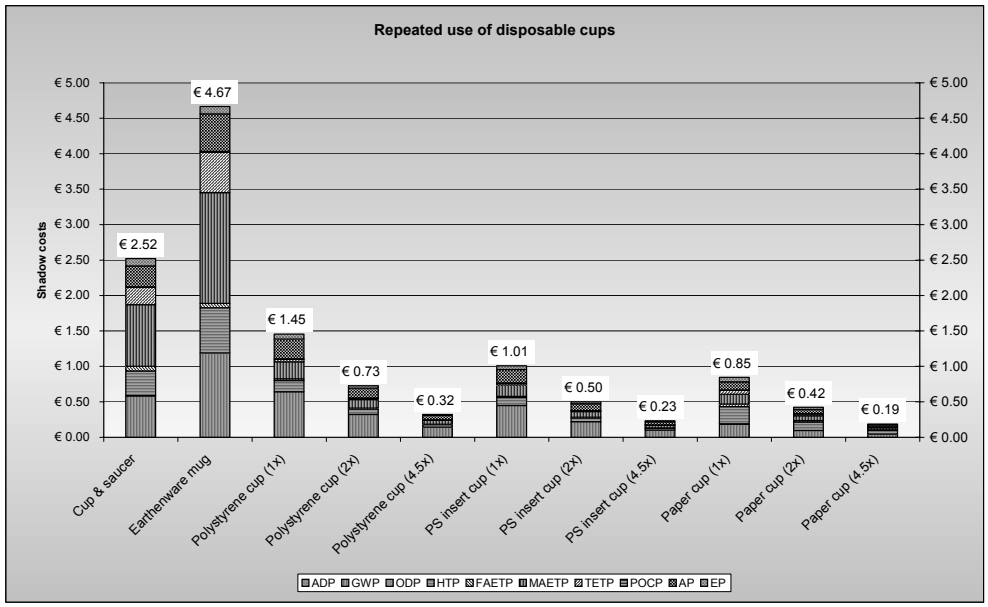

Figure S4 *Influence of increased use of the disposable cups on shadow costs. Under the basic scenario, the disposable cups are used only once. Alternatives are: '2x' used twice '4.5x' used 4.5 times.*

A reduction in the weight of disposable cups also results in an immediate reduction of the integral environmental burden. In addition to the disposable polystyrene vending cup and the disposable PS insert cup, the disposable PS drinking cup is also used in practice (2.8 – 3.2 grams). Because its weight lies between that of the disposable polystyrene vending cup and that of the PS insert cup, the environmental performance of a disposable PS drinking cup will score between that of the disposable PS vending cup and that of the disposable PS insert cup.

The way in which the end-of-life route of the disposable polystyrene (insert) cup is employed affects the integral environmental burden; see Figure S5. Use of cups as fuel (sub-coal) in a power plant has a favourable effect on the environmental performance. The sub-coal route is therefore strongly recommended for the future.

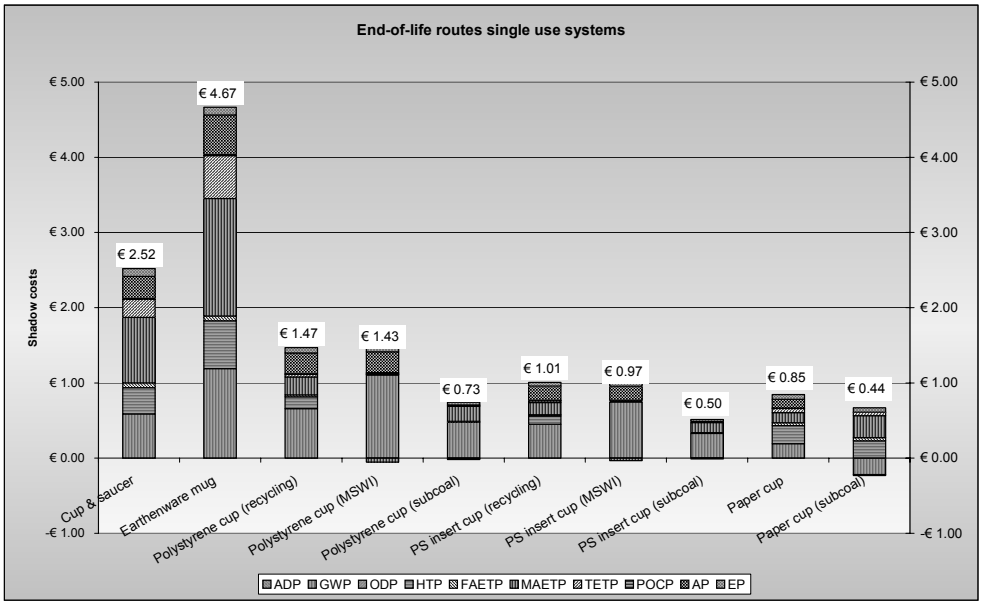

Figure S5 *Influence of the choice of end-of-life scenario for disposable PS (insert) and paper cups. Disposable PS (insert) cups are recycled in the basic scenario, while the paper cups are incinerated in an MSWI.*

Conclusions (Part I and Part II)

The main conclusion from the present study is that it has become clear that the way in which the individual user uses the reusable or disposable systems directly influences the score of the total drinking system. For the reusable porcelain cup and saucer and for the reusable earthenware mug, cleaning directly influences the level of environmental burden. The frequency of cleaning and use of energy per cleaning are crucial here. Because the user is left plenty of freedom for this, the ultimate burden on the environment is therefore strongly user-related. The life time of the porcelain cup and saucer (is varied from 500 to 3,000 times utilisation) influences to a lesser degree the environmental profile of this (coffee) drinking system. It is also a fact for disposable systems that the user largely determines the ultimate environmental burden by the number of times the disposable cup is used.

The question “What is better for the environment, drinking coffee out of a disposable or reusable cup?” can therefore only be answered on the basis of the specific operating situation.

The results of the comparisons made, based on the shadow prices method, clearly point in the direction that disposable (coffee) drinking systems being the least environmentally burdening.
It is therefore recommended that a weighing-up is made per individual user situation with regard to an eventual choice.

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