EPPA
European Paper Packaging Alliance

SINGLE-USE VS MULTIPLE-USE

USING SCIENCE TO CHALLENGE THE MISCONCEPTIONS

Single-use paper packaging in Quick Service Restaurants is better for the environment than reusable tableware, says new European study from Ramboll.

Study challenges common perception that reusable tableware has lower environmental impacts.

January 2021

Life Circle Assesment Study carried out by RAMBOLL for
EPPA - European Paper Packaging Alliance

Document type
Executive Summary

INTRODUCTION

Ramboll[1], has been appointed by the European Paper Packaging Alliance (EPPA[2]) as technical consultant for conducting a comparative Life Cycle Assessment (LCA) study between a paper single-use dishes system and equivalent multiple-use dishes in Quick Service Restaurants (hereafter "QSRs") in accordance with ISO standards 14040 and 14044 as a basis for discussion with authority representatives on the current legal developments within the European Union plus the United Kingdom regarding circular economy and waste prevention.

In particular, EPPA wishes to provide policy makers with technical, scientific data to support the application of the 2008 Waste Directive, so that *"when applying the waste hierarchy, Member States shall take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where this is justified by life-cycle thinking on the overall impacts of the generation and management of such waste"* (Directive 2008/98/EC, article 4§2)

This assessment is embedded in an ongoing debate around the environmental performance of single-use and multiple-use products and it is focused on a systemic approach (comprehensive dishes options for in-store consumption in QSR) which is used to reflect both systems and **compare equal functions of single-use and multiple-use product items in an average**.

The functional unit was the in-store consumption of foodstuff and beverages with single-use or multiple-use dishes (including cups, lids, plates, containers and cutlery) in an average QSR for 365 days in Europe in consideration of established facilities and hygiene standards as well as QSR-specific characteristics (e.g. peak times, throughput of served dishes).

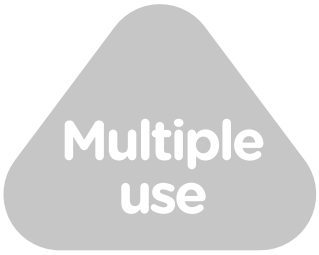
[1] Ramboll is an independent engineering Danish company ranked second in environmental consulting in Western Europe and current consultant to the European Commission on various issues.

[2] EPPA is an association representing suppliers and manufacturers of renewable and sustainable paper board and paper board packaging for Food and Foodservice Industry. They include, e.g., AR Packaging, CEE Schisler Packaging Solutions, Huhtamaki, Iggesund/Holmen, Mayr-Melnhof Karton, Metsä Board, Paper Machinery Corporation, Reno De Medici, Seda International Packaging Group, Smith Anderson, Stora Enso, WestRock.

1. Comparative assesment

For the comparative assessment, two fundamentally distinct systems are taken into consideration:

VS



Single-use

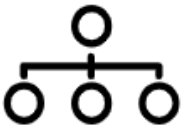
The current system in QSRs based on single-use products made of paperboard

if coated, polyethylene content < 10% w/w

Multiple-use

Alternative system based on multiple-use different options, made of plastic-PP and ceramic, glass, metal and plastic-PP; washed and dried either in-store or out-of store

The distinctive features of this study compared to other assessments within this field of research are the following:



1. Geographical Scope

This geographical boundary is reflected in the assumptions around the systems (e.g. recycling rates) and background datasets (e.g. electricity from grid) as inventory data for the manufacturing stage of certain products will be site-specific or representing average production scenarios (e.g. global, EU).

2. System approach

The main goal of the LCA study is to compare for the first time through a system approach the environmental performance of single-use and multiple-use dishes options for in-store consumption in QSR in Europe and not focused on the environmental performance of a single product;

3. Robustness of the data

The study incorporates from primary sources data and information with regards to the functional unit, inventory data as well assumptions around the systems. Primary data and information (reflected in the functional unit) ffrom QSRs for the system description are obtained from EPPA members which market shares cover more than 65% of QSRs in Europe. This is particularly relevant since previous LCA studies based on secondary data for paper upstream processes are not anymore representing state-of-the art for the investigated single-use system.

The comparative LCA study has taken into account a comprehensive use of 24 different food and beverage containers which are used in Quick Service Restaurants*:

** other food containers/packaging (i.e. shovel for coffee, placemat, drinking straw) are not included in the LCA study.*

In total, the comparative LCA assessment incorporates the life cycles of:

10 **different single-use product items made of paperboard** *if coated, polyethylene content is < 10% w/w*

14 **different multiple-use product items** *represented in different scenarios and sensitivity analyses with 2 dishes set options: one set made of polypropylene and one set combining PP, ceramic, glass and steel for sensitivity analyses.*

2. Baseline scenarios

For the baseline scenarios the following key assumptions have been made:

• **Products are made solely from virgin paper** sourced from European renewable, certified, sustainable forest. **The reforestation is contributing in very positive and sizeable manner to the absorption of CO_2.**

• **Paper manufacturing refers to the European geographical context** of the paper mill or manufacturer from which primary data is used and is considered representative for EU-average supply chain

• **Intermediate transport from paper producers** to converters is modelled **according to primary data provided by converters**

• **Paper converting stage is modelled based on primary data** obtained from converters **located in representative European countries**

• **End-of-life** (paper products)
o 30% paper recycling and 70% incineration with energy recovery for paper
o Transport of waste from QSR to incineration facility is assumed to be 100 km.
Paper fibers can typically be recycled up to 7 times

• **Types and amounts of packaging materials** (cardboard and PE foils) for all single-use product items (except for wooden cutlery) are based on primary data from converters

• **Production paper wastes during converting** (i.e. post-industrial wastes) are materially recycled as indicated in primary information obtained from converters.
Paper and board packaging is the most recycled material in Europe with a rate of 85.6%

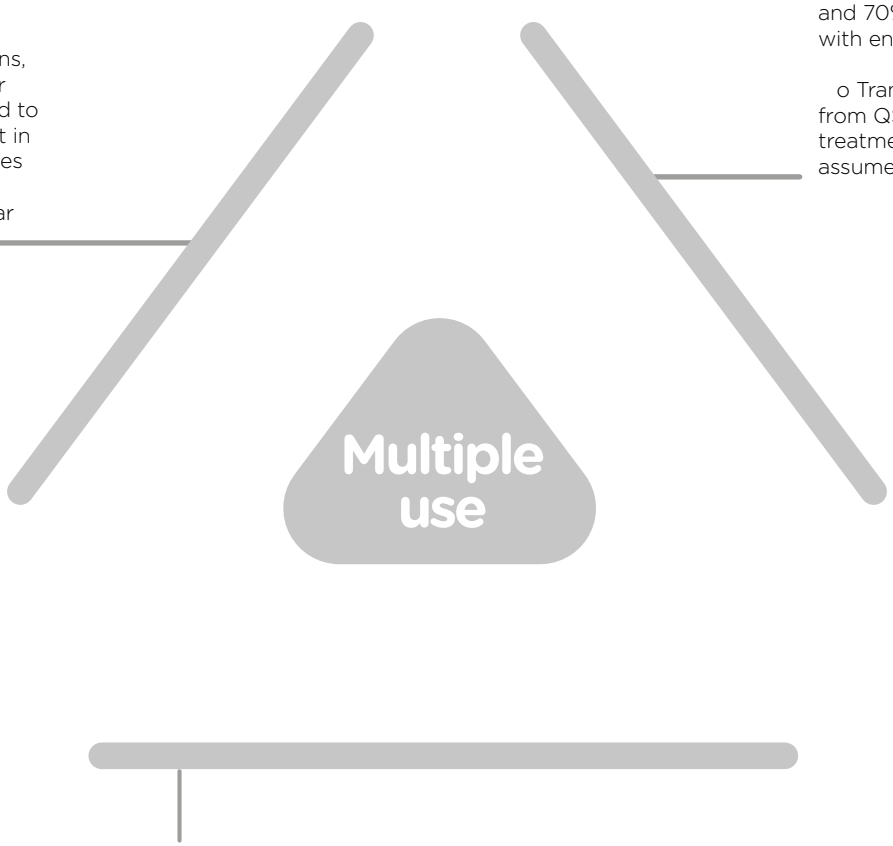
• **Polypropylene (PP) items assumed to be manufacturing in Europe**

• **Average reuse PP rate of 100 reuses is considered.** Reuse rates also **include potential replacement reasons** such as damages, stains, theft or loss. The latter reasons are considered to be relatively important in QSRs as higher volumes of product items are involved than in regular restaurants

• **End-of-life (PP products)**

o 30% material recycling and 70% incineration with energy recovery

o Transport of waste from QSR to waste treatment facility is assumed to be 100 km



• **Dishwashing process**

o An average scenario for in-house dishwashers is used **to reflect different grades of devices' efficiencies**
o **Internal washing is assumed with a separate drying module because of hygienic requirements and increased efforts for drying** of PP products based on literature information, 30% of total energy demand of washing and drying comes from drying; thus energy demands for washing reported in literature were increased by +30% if the device does not perform sufficient drying for PP products
o **State-of-the-art detergent and rinse agent compositions are assumed**
o **Average rewashing rate for all items of 5% is considered**, this assumption is made to avoid persistent residues that might remain after washing
o Production of simplified dishwashers is considered (generic assumption of two additional devices to be installed inside a QSR to perform in-house washing; ten-year lifetime of the dishwasher)

For the EoL (End-of-Life) assumption of the baseline scenarios it should be noted that generic plastic packaging shows EU average recycling figures (about 40% below the European target set 55 % on 25 %)[2] lower than paper packaging (about 85%[3] and the european target is 75%). For data symmetry reasons in the comparison and due to the lack of product-specific recycling rates, 30% material recycling and 70% incineration with energy recovery are assumed for both baseline scenarios, provided that appropriate sorting of post-consumer waste fractions is facilitated at the EoL stage.

Sensitivity analyses are performed for 0% recycling and 100% incineration with energy recovery and for 70% material recycling and 30% incineration with energy recovery for both systems.

[2] https://ec.europa.eu/eurostat/databrowser/view/ten00063/default/table?lang=en
[3] https://ec.europa.eu/eurostat/databrowser/view/ten00063/default/table?lang=en

	PAPER SINGLE-USE SYSTEM	MULTIPLE-USE SYSTEM
Climate change	✓ VERY SIGNIFICANT BENEFITS FOR SINGLE-USE	+177% HIGHER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Freshwater Consumption	✓ VERY SIGNIFICANT BENEFITS FOR SINGLE-USE	+267% HIGHER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Fossil Depletion	✓ VERY SIGNIFICANT BENEFITS FOR SINGLE-USE	+238% HIGHER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Fine Particulate Matter Formation	✓ VERY SIGNIFICANT BENEFITS FOR SINGLE-USE	+132% HIGHER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Terrestrial Acidification	✓ VERY SIGNIFICANT BENEFITS FOR SINGLE-USE	+72% HIGHER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Stratospheric Ozone Depletion	NOTICEABLE BENEFITS FOR MULTIPLE-USE SYSTEM	-11% LOWER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Metal Depletion	NOTICEABLE BENEFITS FOR MULTIPLE-USE SYSTEM	-12% LOWER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Ionizing Radiation	SIGNIFICANT BENEFITS FOR MULTIPLE-USE SYSTEM	-37% LOWER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO
Freshwater Eutrophication	VERY SIGNIFICANT BENEFITS FOR MULTIPLE-USE SYSTEM	-81% LOWER IMPACTS OF MULTIPLE-USE BASELINE SCENARIO

Terminology used for interpretation based on relative difference in % based on the respective indicated single-use system as reference value (e.g. baseline scenario): <5%: marginal difference (i.e. uncertainty threshold); 5 to 10%: minor difference; 10-20%: noticeable difference; 20-30%: moderate difference; 30-50%: significant difference; >50%: very significant difference

Impact Assessment categories
Explanations

Climate change

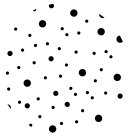
Climate Change is the defining issue of our time and we are at a defining moment. From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly.
The most abundant GHG, accounting for about two-thirds of GHGs, carbon dioxide (CO2), is largely the product of burning fossil fuels.

Freshwater Consumption

Water scarcity is a rapidly growing concern around the globe, but little is known about how it has developed over time. Water scarcity is analysed using the fundamental concepts of shortage (impacts due to low availability per capita) and stress (impacts due to high consumption relative to availability) which indicate difficulties in satisfying the needs of a population and overuse of resources respectively. While water consumption increased fourfold within 1900s to 2000s, the population under water scarcity increased from 0.24 billion (14% of global population) in the 1900s to 3.8 billion (58%) in the 2000s. Nearly all sub-national trajectories show an increasing trend in water scarcity.

Fossil Depletion

This impact category indicator is related to the use of fossil fuels. Fossil fuels provide a valuable source of energy and feedstock for materials such as plastics. Although there are alternatives, these are only able to replace a small proportion of our current use. Fossil fuels are a finite resource and their continued consumption will make them unavailable for use by future generation.



Fine Particulate Matter Formation

Fine particulate matter (PM) in the ambient air is implicated in a variety of human health issues throughout the globe. Vehicular traffic has a significant influence on PM2.5 levels in urban areas; followed by combustion activities (biomass, industrial, and waste burning) and road dust. In urban atmosphere, fine particles are mostly associated with different health effects with old aged people, pregnant women, and more so children being the most susceptible ones. Fine PM chemical constituents severely effect health due to their carcinogenic or mutagenic nature.

Impact Assessment categories
Explanations

Terrestrial Acidification

Atmospheric emissions of acidifying substances such as sulphur dioxide (SO2) and nitrogen oxides (NOx), mainly from the burning of fossil fuels, can persist in the air for up to a few days and thus can be transported over thousands of kilometres, when they undergo chemical conversion into acids (sulphuric and nitric). The primary pollutants sulphur dioxide, nitrogen dioxide and ammonia (NH3), together with their reaction products, lead after their deposition to changes in the chemical composition of the soil and surface water. This process interferes with ecosystems, leading to what is termed 'acidification'. Acidifying substances also play a role in the greenhouse effect Furthermore, nitrogen oxides contribute to the ozone problems (build-up of tropospheric ozone, depletion of stratospheric ozone), and, together with ammonia, contribute to the nitrogen fertilisation of natural terrestrial ecosystems; with phosphate they contribute to eutrophication in water.

Stratospheric Ozone Depletion

The so-called ozone layer is located between 10 and 50 km above the Earth's surface and contains approximately 90 per cent of all atmospheric ozone. Under undisturbed conditions stratospheric ozone is formed as the result of a photochemical equilibrium involving oxygen molecules, oxygen atoms and solar radiation. The ozone layer protects life on the Earth's surface since ozone is the only efficient absorbent of the ultraviolet-B radiation (wavelengths 280 to 310 nm) from the sun. UV-B radiation is harmful to organisms in many ways.

Metal Depletion

Technological advancements dictate the productivity growth in all industries, including extractive ones. In the peculiar case of metallic mineral industries, this growth is also impacted by the natural variation in the metal content and chemical composition of the ore input, in the course of cumulative extraction and depletion of resources.

Ionizing Radiation

This category includes the generation of electricity from both coal and nuclear power plants, the transportation of nuclear materials, and the storage of nuclear wastes. It also includes the exposures from fallout from the international nuclear weapons testing programs. These sources make up less than one percent of the annual radiation exposure. Others sources include naturally occurring radioactive material, cosmic radiation and nuclear medicine

Freshwater Eutrophication

A process of pollution that occurs when a lake or stream becomes over-rich in plant nutrient; as a consequence it becomes overgrown in algae and other aquatic plants. The plants die and decompose. In decomposing the plants rob the water of oxygen and the lake, river or stream becomes lifeless. Nitrate fertilizers which drain from the fields, nutrients from animal wastes and human sewage are the primary causes of eutrophication.

3. Sensitivity analysis

For the sensitivity analysis and respective scenarios only one parameter or assumption has been changed per system in order to maintain transparency and ensure traceability of results.

The following sensitivity analyses have been performed:

1. Single-use system: Different recycling rates of post-consumer paperboard (0%; 70%);

2. Multiple-use system: Different recycling rates of post-consumer PP items (0%; 70%);

3. Multiple-use system: Varied demand for multiple-use items (30% higher; 30% lower);

4. Multiple-use system: Optimised washing scenario;

5. Multiple-use system: External washing with band transport dishwasher;

6. Multiple-use system: Alternative multiple-use items (dishes made from ceramic (500 or 250 reuses), glass (500 or 250 reuses), stainless steel (1000 reuses) and PP (100 reuses);

7. Both systems: Different EoL allocation approach for avoided energy and material production (50:50)

Environmental benefits for the single-use system are consistent throughout all considered scenarios in terms of Climate Change, Freshwater Consumption, Fossil Depletion, Fine Particulate Matter and Terrestrial Acidification

4. Key findings and Conclusion

Ramboll LCA is unique in its approach based on a "system to system" comparison, different from the usual "product to product" approach that does not consider the cumulative impacts of the different products on the environment

Ramboll LCA is an ISO 14040 and 14044 compliant study based on primary updated data from:

- QSR in the functioning and quantification of the system studied
- Paper manufacturer and converters for Single-Use food packaging products
- Dishwashers and driers process

Realistic and symmetric hypothesis are taken for both systems

Sensitivity analysis demonstrates that **Paper Single-Use environmental advantages are consistent throughout all considered scenarios.**

While the single-use system is characterised by rather centralised large, industrialised operators with continuous environmental improvement systems in place, **the environmental implications of multiple-use system may be characterised by decentralised and less organised actors.**

As QSR are rather standardized stores, the main differences between EU countries mostly rely on:

- The electricity mix, and its carbon impact level
- The end of Life and recycling required rates

This LCA meets ISO standards **and has been independently assessed by Germany's TÜV (Technischer Überwachungsverein).** All significant parameters are available and representative and have been systematically derived and duly assessed. All type approvals have been checked. The assessments and the underlying data collection and calculation procedures are transparent and traceable

4. Key findings and Conclusion

Additional Single-Use advantages not included in the LCA

PAPER SINGLE-USE

- **Paper Single-Use dishes are sourced and manufactured in Europe, opposite to plastic, ceramic or glass dishes that are sourced and/or manufacture out of Europe, mostly in Asia and China.** In the case of plastic, the most realistic and base case scenario, a massive substitution could lead to hundreds million plastic tons per year mostly coming from China whereas paper/board dishes are coming from EU sustainable forests

- **Single-Use dishes and food packaging are a perfect fit for a circular economy because of their complete and effective recyclability:** they provide valuable fiber products that can be re-used up to seven times for paper or board production, and the thin plastic layer they contain is also recyclable. Enhancing the existing recycling system is one of EPPA's priorities.

- **Single-Use paper dishes and packaging are hygienic products: they best protect the food and prevent cross-contamination**, as demonstrated in many studies and is the "only feasible option for maintaining adequate food hygiene, public health and consumer safety" (Professor McDowell 2020 report)

- **If the study scope was take-away, additional environmental burden would have to be taken into account :**
  - **An additional ride** to take back the multiple use dishes
  - **A less performant dishwasher energy consumption** related to a larger number of small restaurants
  - *A higher non-return rate for multiple use packaging related to deposit scheme*

- **Single-use food packaging is a critical enabler of the whole value chain**, as demonstrated in Covid times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