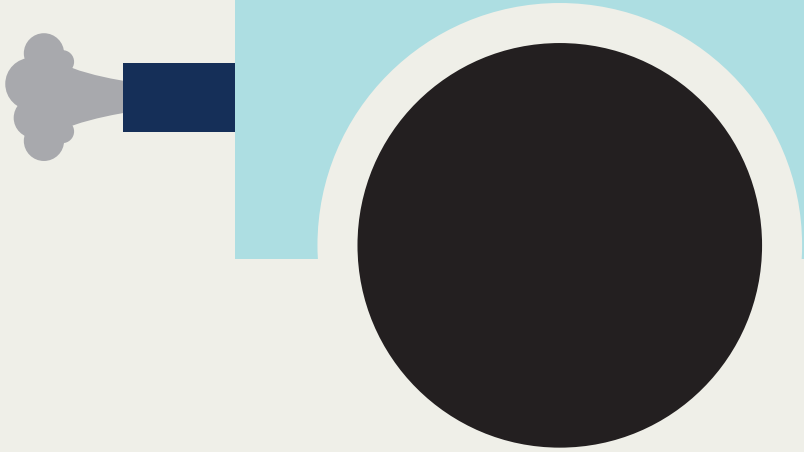
REUSABLE VS SINGLE-USE PACKAGING

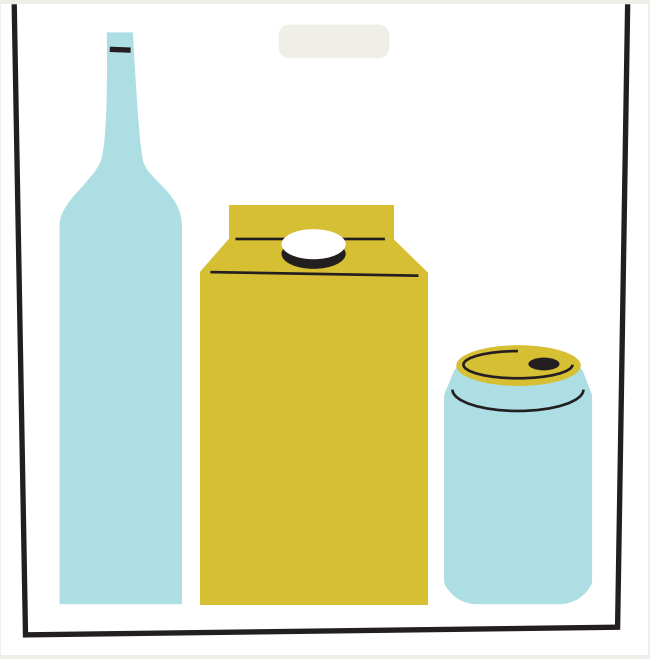
A review of environmental impacts



EXECUTIVE SUMMARY

A REVIEW OF ENVIRONMENTAL IMPACTS

As the global population has grown and society has become more fast-paced, there has been an increased demand for, and therefore production of, more convenient, easy-to-use, on-the-go products. This demand, coupled with globalisation and trade liberalisation, has translated into consumption patterns that are taking a toll on Earth's capacity to replenish itself. In Europe, packaging alone represents 36% of municipal solid waste[1]. While individual countries attempt to solve their waste management issues and resources continue to be depleted at a rate faster than they can be regenerated, the global economy loses about $80-120 billion in packaging that could be reused or recycled[2].



Currently, most waste management systems prioritise recycling as the main method of reducing the amount of waste going to disposal, which, in terms of circular economy strategies, should be considered as one of the last management options, after it has been determined that the product (or parts of it) can no longer be reused, repurposed, remanufactured or reinserted into the production line. On top of that, materials are not being recycled at a high enough rate to ensure that our waste is managed sustainably. **Reuse avoids the need for resource extraction and reduces energy use compared to the manufacturing of new products and recycling.** In addition, it can incentivise a shift toward more conscious consumption and reshape our relationship to products.

This report aims at understanding the **benefits of reuse by evaluating the multi-layered environmental impacts of both single-use and reusable types of packaging through an in-depth comparative analysis of 32 Life Cycle Assessment (LCA) studies.** This technical exercise allows for a clearer understanding of the conditions under which reusable packaging is the most environmentally friendly choice.

LIMITATIONS

It's important to acknowledge the limitations of LCA studies when assessing the environmental performance of a product or system. LCA studies depend on a large number of assumptions and scenarios regarding specific process parameters such as product design, transport processes, material types, a product's use phase, and the system in which it is integrated. In addition, they typically do not address the impacts of littering or specify the amount of waste generation, which are crucial factors that need to be looked at when assessing packaging waste. The limitations of LCAs are further explained in the report (sections 5.5 and 6).

RESULTS

This study analysed the results of 32 LCAs that compared the impact of single-use and reusable packaging alternatives, including, beverage packaging, buckets, bulk dispensers, carrier bags, crates, cups, drums, food containers, jars, kegs and transport packaging, as shown in figure 1.

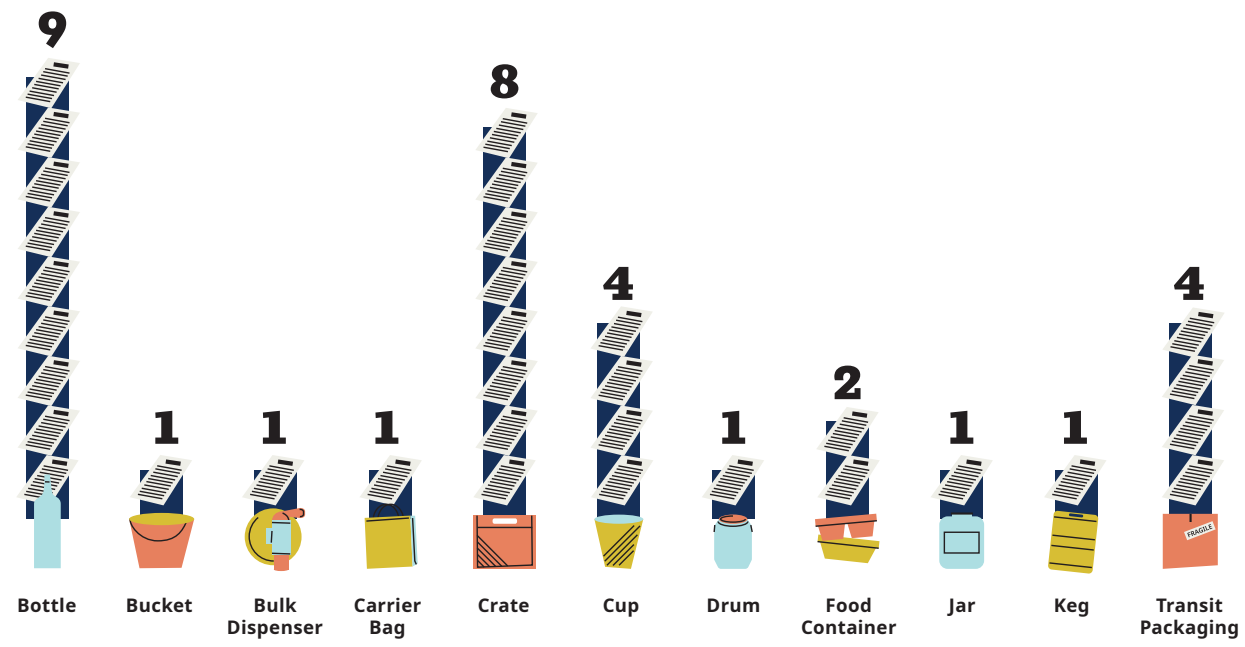


Figure 1: Selected papers by the types of packaging analysed.

[1] In tons, based on Eurostat statistics: ec.europa.eu/eurostat/databrowser/view/env_waspac/default/table
[2] World Economic Forum, "The New Plastics Economy: Rethinking the future of plastics," World Econ. Forum, vol. 1, no. January, pp. 1–36, 2016

Of the 32 LCAs analysed, **72% show positive results for the environmental impact of reusable packaging** compared to single-use.

In terms of environmental impact, it was found that **four key parameters have a substantial influence on the success of reusable packaging**: **transport; production; number of cycles; and end-of-life.** It is important to acknowledge, however, that a package, as any other product, should be analysed within a system, which goes beyond the product itself. Also, depending on the packaging type (bottles, cups, crates, food containers, etc.) and the material constitution (plastic, glass, carton, etc.), these parameters may be more or less relevant to determine the environmental performance of the packaging.

The four parameters that have the most impact on the efficiency of reuse systems are described in further detail below:

Figure 2: Percentage of studies analysed that showed positive results, negative results, and/or a mix of both, regarding the favorable environmental impact of reusable vs. single-use packaging.

In most cases, even for **reusable packaging, a package's production phase was found to have the most impacts.** This is understandable given that reusable packaging is usually of higher quality in order to withstand the rigors of multiple cycles throughout its lifetime. Nevertheless, **for the majority of reusable packaging, the production emissions become less relevant since the overall environmental impact is divided throughout the number of cycles in order to reflect the emissions per functional unit.**

Distances, weight, volume and mode of transport: **The majority of the studies found that a product's use phase was the most impactful stage of the life cycle due to transportation emissions.** The impacts of transportation are influenced by three interconnected variables: transport distances and backhauling; weight and volume of the packaging; and mode of transport.

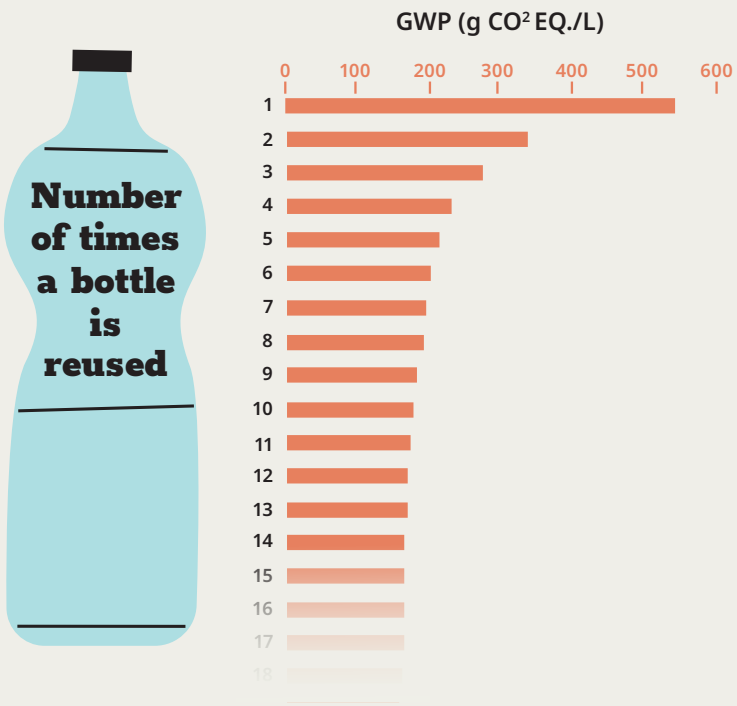
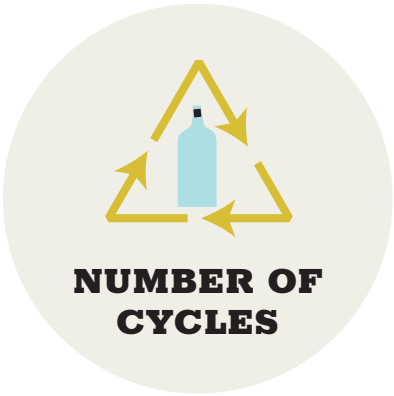


Figure 3: Number of times a glass bottle is reused and the decrease in Global Warming Potential (g C2 eq/l).



Several LCAs highlight a steep reduction of impacts within the first number of cycles, which then gradually reaches a plateau. This can be explained by the fact that **a reusable package's production impacts are distributed across the life cycle**, whereas the impacts associated with transportation and sanitisation (when necessary) are present in every cycle.

End of life, recycled content and recycling credit: Different end of life scenarios can be addressed in a LCA. The most common ones to be included within an LCA's scope are recycling, incineration and landfilling. Recycling is generally the environmentally preferable option, packaging that incorporates recycled content will have lower production emissions compared to packaging manufactured using only virgin material, since resources and extraction emissions are lower for the production of a new packaging. The manner in which avoided emissions from the recycling process are credited in the system can also impact LCA results.

INTERACTION BETWEEN THE KEY PARAMETERS:

THE PACKAGING FORMATS AND MATERIALS

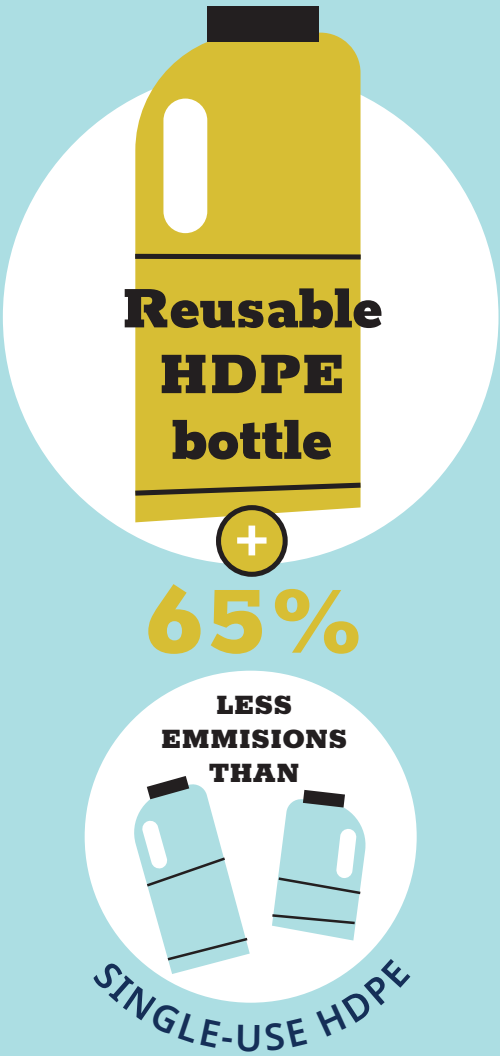
Since most of the LCAs pointed to **transport as the most impactful stage of the reusable packaging's life cycle**, an analysis was done to understand the relation between the transport distance and the CO2 emissions. **This analysis took into consideration the two packaging types most commonly assessed by the studies selected: packaging containers and crates.**

PACKAGING CONTAINER

Overall, the studies show that reusable packaging containers have a lower environmental impact than single-use ones. Nevertheless, the results depended heavily on which single-use and reusable packaging materials were being compared (e.g. glass, plastic, aluminium cans, etc.). Figure 4 summarises how different packaging materials can affect the emissions results of single-use and reusable packaging containers.

CO2 EMISSIONS:

Single-use VS Reusable HDPE bottle



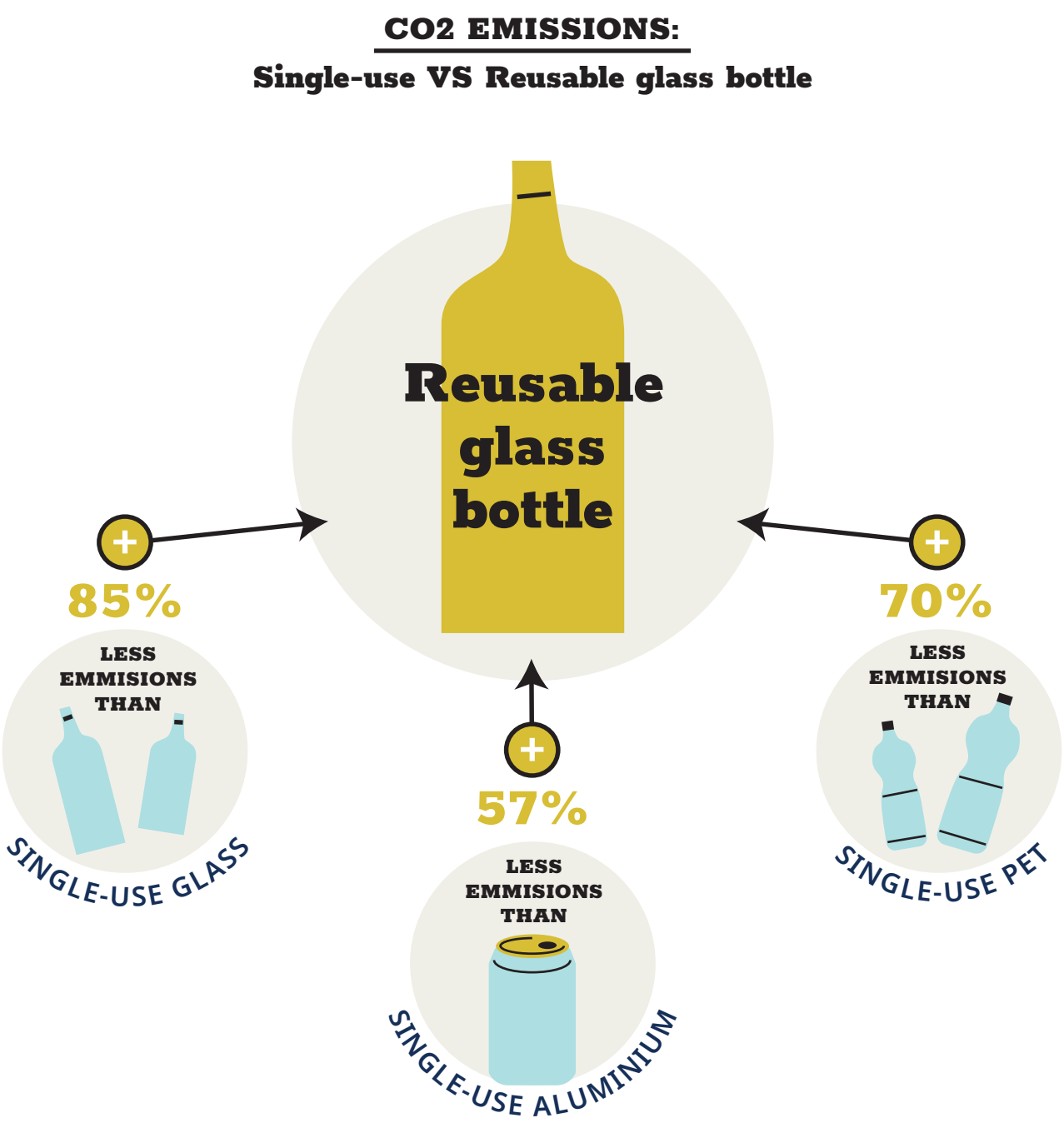


Figure 4: The percentages shown in the figure are based on the average results of the LCAs analysed in the study, which represents the relation between the distance vs. CO2 emissions of one entire life cycle of a reusable glass bottle (on top) and reusable HDPE bottle (on the left) compared to other single-use packaging types.

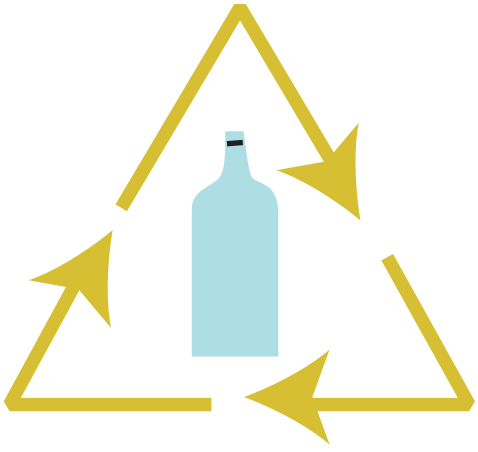
REUSABLE GLASS BOTTLES VS SINGLE-USE PET, ALUMINIUM CANS, BEVERAGE CARTONS OR BAG-IN-BOX

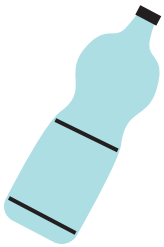
The LCAs reviewed found that **reusable glass bottles have lower emissions than single-use bottles made of glass, polyethylene terephthalate (PET) or aluminium,** when they are reused for a certain number of cycles (which varies by material). As regarding single-use cartons or bag-in-box containers compared to reusable packaging, the latter had lower emissions when the transport distance was extremely reduced (in this case to less than 100km). The findings are further detailed on the next pages:

REUSABLE GLASS BOTTLES VS SINGLE-USE GLASS BOTTLES

The comparison between reusable glass bottles vs. single-use glass bottles presented the most significant decrease in CO2 emissions from all packaging observed. In fact, single-use glass has the highest overall impact compared to any other packaging materials (i.e. PET, aluminium and beverage carton). This is attributed to the glass production phase, which has an extremely high energy requirement. In fact, **40% of the emissions associated with glass production are reduced after a bottle has been reused two or three times. This emphasises the importance of Deposit Return Schemes (DRS) that facilitate the collection and refill of glass bottles.**

Two types (conventional and lightweight) and two volumes (750ml and 1L) of single-use glass bottles were analysed. The results showed that **when reusable glass bottles were reused at least 5 times, the overall CO2 emissions of the product life cycle were reduced by over a third compared to single-use glass bottles.** It is important to highlight that the authors could not find data about the maximum number of cycles. The assumption of 5 reuse cycles is low (especially when compared to the trip rate of beer bottles, which can undergo 25-30 cycles), and therefore the emissions reduction is very likely underestimated. Because **increasing the number of cycles leads to a decrease in environmental impact**, there would be an even further **reduction in emissions if the number of cycles were increased (decreasing the number of cycles would have the opposite effect).**



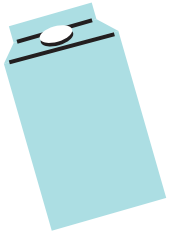


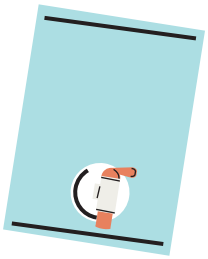
REUSABLE GLASS BOTTLES VS SINGLE-USE PET BOTTLES

The comparison between reusable glass bottles and single-use PET bottles (green bars) presented a significant reduction in CO2 emissions in all examples, pointing to reusable glass as the best option. In terms of number of cycles, the analysis shows that after 3 cycles, the reusable glass bottle becomes environmentally preferable to the 0,5L single-use PET bottle, and the same happens for the 2L format bottle after 25 cycles. These trip rates are feasible since reusable glass bottles reach 25 to 30 cycles, on average.

REUSABLE GLASS BOTTLES VS SINGLE-USE ALUMINIUM CANS

The analysis shows that after **3 cycles, reusable glass bottles have lower CO2 emissions than single-use aluminum cans.**





REUSABLE GLASS BOTTLES VS SINGLE-USE BEVERAGE CARTONS AND BAG-IN-BOX CONTAINERS

A study comparing single-use beverage cartons and bag in box containers to reusable glass bottles showed an increase in CO2 emissions for the reusable glass bottles, except when the transport distance was lower than 100km. Even though this study did not find reusable packaging to be the best option, **it corroborated the findings of most other studies which point to distance as a key variable impacting the relative environmental performance of a reusable system and emphasises the relevance of locally produced products.**

REUSABLE HDPE BOTTLES VS SINGLE-USE HDPE BOTTLES

The environmental impacts of single-use polyethylene terephthalate (PET), high-density polyethylene (HDPE), and reusable HDPE for fabric softener, laundry and hand washing detergents were analysed by including different types of materials for the single-use bottles: virgin material, recycled PET and HDPE; and different volumes for the reusable HDPE bottles: 1L and 3L. **The largest reduction in CO2 emissions occurs after a reusable bottle has undergone between 2 and 10 cycles. In general, 10 to 15 cycles are recommended for all reusable bottles, due to other impact categories analysed, encouraging the continuous reuse of the bottles for as long as possible.**

CRATES

Overall, the studies show that reusable crates have a lower environmental impact than single-use ones.

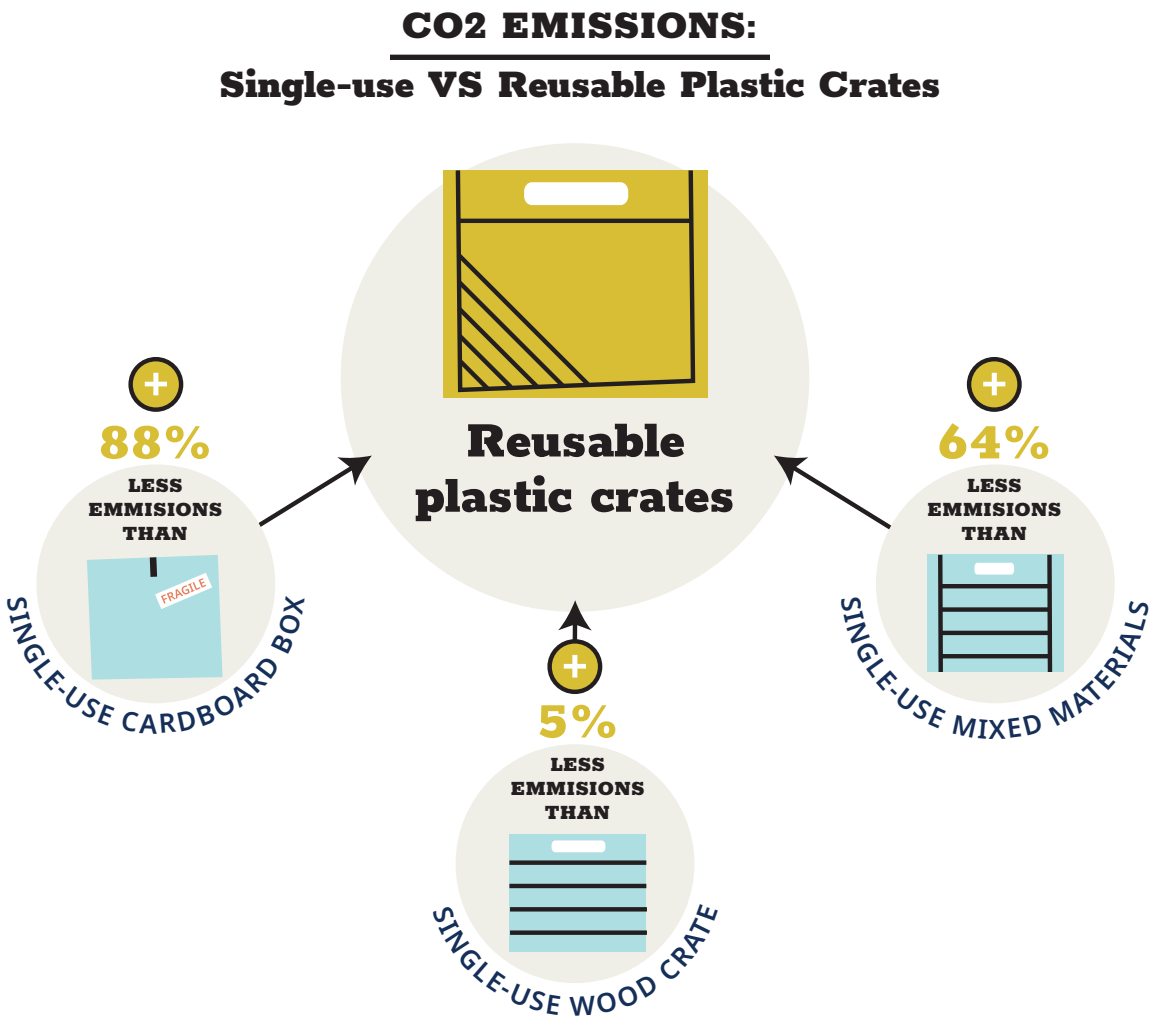


Figure 5: The percentages shown in the figure are based on the average results of the LCAs analysed in the study, which represents the relation between the backhaul and resupply distances vs. CO2 emissions of one entire life cycle of a reusable plastic crate compared to other single-use packaging types.

The interaction between **weight, distance and transport mode determines the overall CO2 emissions.** Making use of smaller, lighter trucks, for example, could further reduce the transport impacts for the reusable system. It's worth noting that the difference in CO2 emissions between single-use wooden boxes and reusable crates is not as significant as the one observed between single-use cardboard boxes and reusable crates. There are two reasons for this: 1) the CO2 emissions from the production of single-use wooden boxes are lower (less energy-intensive) than those of single-use cardboard boxes; and, 2) wooden boxes have more embodied energy credits at their end of life than cardboard boxes.

BREAK EVEN POINTS

Break even points refer to the number of cycles a reusable package must undergo to have comparable or lower environmental impacts than a single-use package. Because every product has a specific life cycle that may result in a different environmental impact – depending not least on the material used, recycled content, travel distances and other factors – break-even points do not have a clear boundary. Consequently, these should not be accepted as a strict rule since crucial aspects could differ and influence the outcome.

The break even point (in terms of environmental impacts) for reusable glass compared to single-use packaging (i.e.: glass, aluminium, PET, carton) seems to occur after the 2nd or 3rd use. Depending on the specific case scenario, at least 10 cycles are required for the break-even to be achieved.

The break even points (in terms of environmental impacts) for reusable plastic crates compared to single-use crates (i.e.: wooden boxes, cardboard boxes) seems to occur on average between the 3rd to the 15th use

Regardless of the break even point, and as a general rule, the authors recommend that reusable packaging should be reused for as long as possible to further decrease the impact of the entire products' life cycle.

INTERACTION BETWEEN THE KEY PARAMETERS:

MAKING REUSABLE PACKAGING ENVIRONMENTALLY PREFERABLE

It is important to understand the interaction between the different stages of a packaging's life cycle. **Depending on which stage of the life cycle has the most environmental impacts (i.e. production phase, use phase, etc.), certain measures can be taken to reduce it.** In cases where the production phase is deemed to have the highest emissions, ensuring that the package undergoes a sufficient number of cycles (reuse) will reduce the overall impact of the package's life cycle. In addition production emissions can alco be counterbalanced at the end of life, for example, by producing packaging with higher recycled content and by recycling a greater amount of material at the end of the product's life (higher recycling credits). Glass bottles offer one example, as depicted in figure 6. Initially, glass bottles have high production impacts due to relatively high energy requirements, however, if a bottle is reused enough times these impacts can be drastically reduced. Producing the bottles with recycled glass and making sure the bottles will be recycled at the end of life can further decrease the overall impact of the product's life cycle.

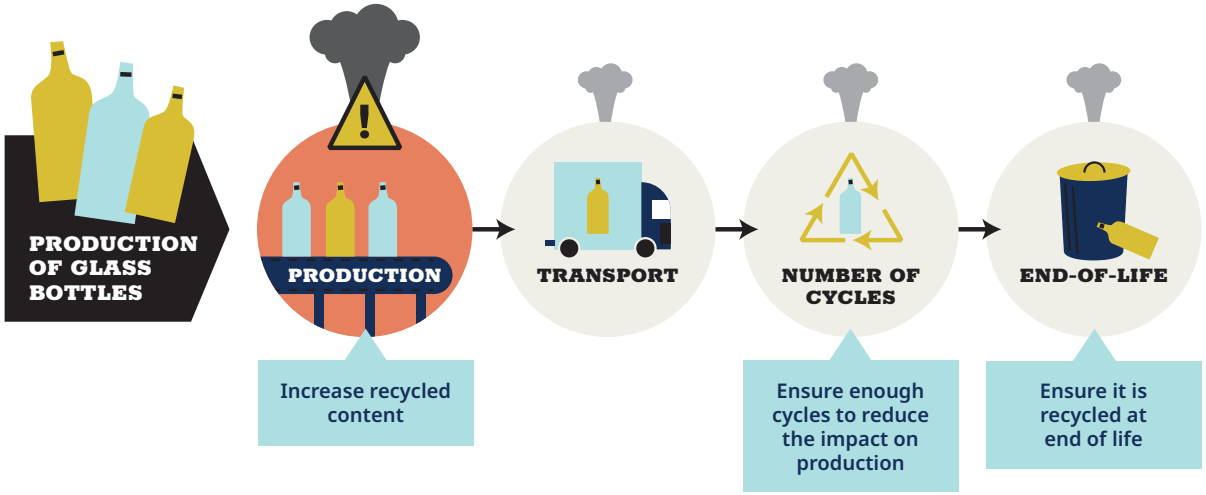


Figure 6: Production as the main impact stage of the life cycle and the interaction between key parameters that can make reusable packaging environmentally preferable to single-use.

When transport is responsible for the highest emissions, as it is with reusable crates for example (figure 7), some actions can be taken to reduce it. For example, using a different mode of transport or using a decentralised logistics model (which reduces travel distances) can drastically reduce transport emissions, which are generated in every reuse cycle of a reusable product. Reducing a package's weight or choosing a lighter material can further reduce these impacts.

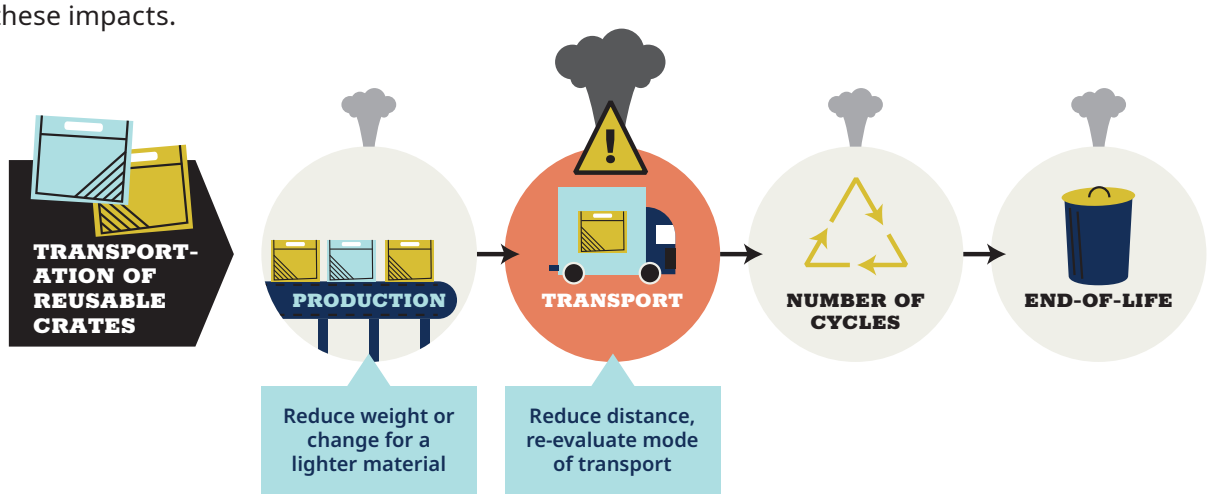


Figure 7: Transport as the most impactful stage of the life cycle and the interaction between key parameters that can make reusable packaging environmentally preferable to single-use.

In some cases, such as for cups or food containers, the cleaning and production stages of a product's life cycle can have the highest emissions, especially when transport distances are small or when no transportation is required at all (e.g. when washing of the packaging and its distribution to consumers happen at the same location, such as in cafés, at restaurants, or events). In these situations, ensuring that the packaging is cleaned in a dishwasher as opposed to by hand can help ensure a reduction in water usage. As well as ensuring that the cup/container will achieve a number of cycles in order to break even with single-use to reduce the relevance of production emissions.

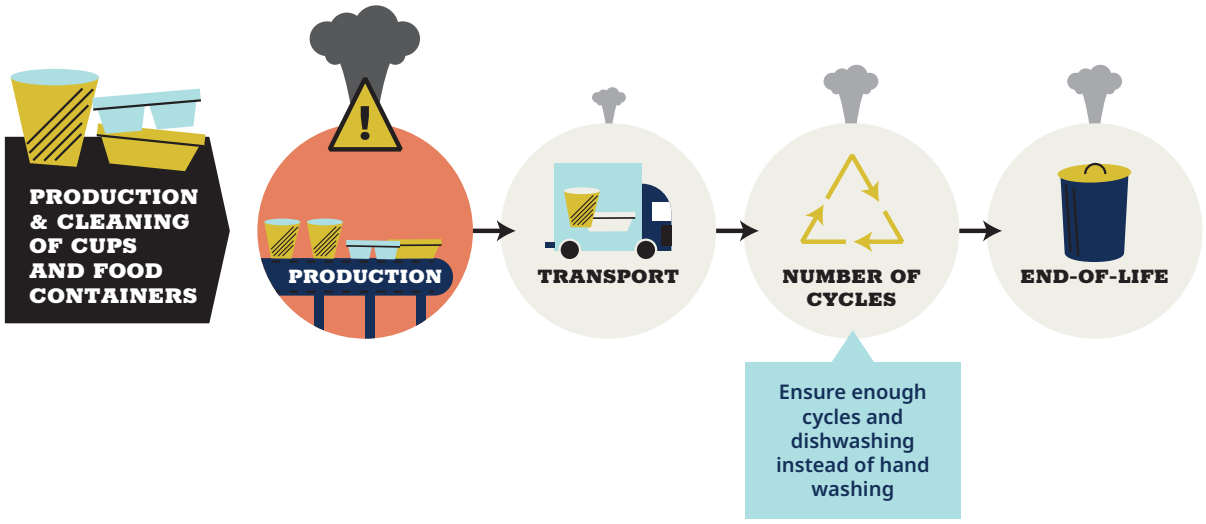
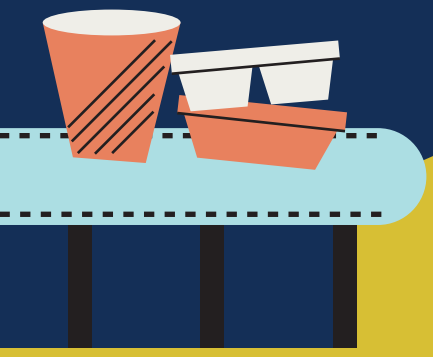


Figure 8: Cleaning and production stages are the most impactful stage of the life cycle and the interaction between key parameters that can make reusable packaging environmentally preferable to single-use.



OTHER CONSIDERATIONS

In terms of comparable economic benefits, conclusive results could not be drawn due to a lack of cost analyses in the LCA studies reviewed. In addition, some key issues, such as littering, resource depletion and circularity remain mostly absent from LCA studies, which highlights an overall shortcoming with their methodologies. Indeed, impacts related to these topics are currently not well addressed, or completely neglected by the studies. It is very likely that if these impacts were included in the scope of these studies, the evidence for reusable packaging, as being the environmentally preferred, option would be even greater. In this regard, well designed reuse systems undoubtedly reduce the risk of littering while increasing overall recycling rates.

The report also outlines a number of key measures that can further increase the efficiency and benefits of reusable systems, including economic instruments (i.e. deposit return schemes, price and discount/reward systems), standardisation, pooling systems, and accessibility to consumers. Lastly, the report discusses how future trends such as e-commerce, and European standardisation and decarbonisation of transport and electricity also have the potential to contribute to the long term success of reusable systems.

RELOOP PLATFORM & ZERO WASTE EUROPE
November 2020

Zero Waste Europe is the European network of communities, local leaders, experts, and change agents working towards the elimination of waste in our society. We advocate for sustainable systems and the redesign of our relationship with resources, to accelerate a just transition towards zero waste for the benefit of people and planet.

Reloop is a global platform of pragmatic thought-leaders and change-makers working together with a united vision for a circular economy. With members coming from different sectors of the value chain, the platform aims to work as a catalyst in order to generate economic and environmental opportunities for all stakeholders in the global economy, including producers, distributors, recyclers, academia, NGOs, trade unions, green regions, and cities.

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AUTHORS:

Patricia Megale Coelho – Utrecht University

Blanca Corona – Utrecht University

Ernst Worrell – Utrecht University

CONTRIBUTORS:

Larissa Copello – Zero Waste Europe

Clarissa Morawski – Reloop Platform

Joan Marc Simon – Zero Waste Europe

Nathan Dufour – Zero Waste Europe

Enzo Favoino – Zero Waste Europe

Kaisa Karjalainen – Zero Waste Europe

Justine Maillot – Rethink Plastic alliance

Alba Cabrera - Rezero

EDITOR:

Rossella Recupero - Zero Waste Europe

DESIGN & LAYOUT:

Noble.Studio

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