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CUP REVOLUTION
HUNGARY'S #1 REUSE NETWORK

Reusable cups, food containers, and coffee cups
LCA Background Report

Report: 2023-06| **Client:** CUP Revolution Kft.

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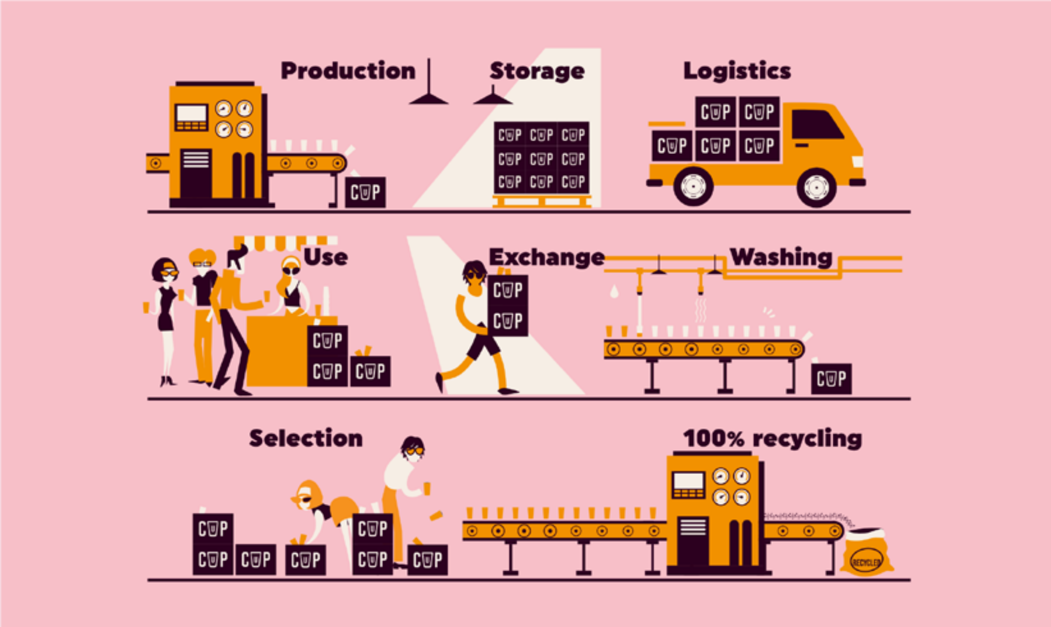

1. Executive summary

This executive summary provides a concise overview of the life cycle assessment (LCA) conducted on Cup Revolution Kft.'s reusable cup, food container, and coffee cup products. The objective of the study is to identify the relative environmental impact contributions of different life cycle stages of Cup Revolution Kft.'s products and to compare the environmental performance of these reusable products with benchmark values of disposable alternatives.

Cup Revolution Kft. aims to provide a solution for catering establishments that want to reduce the amount of single-use packaging used for food and beverage consumption, in compliance with EU and national legislation. The company's objective is to promote the use of reusable products made primarily of polypropylene (PP) for takeaway and serving of drinks and food. Cup Revolution Kft.'s system generates less waste as reusable products are collected from catering establishments, washed, sorted, and supplied for reuse.

Two subcontractors manufacture the reusable products and the tokens and Cup Revolution Kft. is responsible for the transport and the washing of these. Since Cup Revolution Kft. controls the supply chain of the products upon manufacturing, primary information was provided for most life cycle stages. The data quality and completeness of the assessment are considered to be strongly plausible, with primary information about annual energy consumption, support and storage processes, water consumption, transport of inputs and outputs, and end-of-life activities. The mass balance of inputs and outputs has further enhanced the reliability of the data.

The dominance analysis of the LCA has revealed that the production of raw materials/ingredients for Cup Revolution Kft.'s products, along with electricity usage during manufacturing, are the primary contributors to emissions across all environmental indicators. The disposal of the discarded products also has a significant impact for certain environmental indicators. Other life cycle stages, such as transportation and washing, had minimal contributions to the environmental impacts of the products.

To compare the environmental performance of Cup Revolution's reusable products with disposable and glass alternatives, benchmark values from publicly available life cycle assessments for disposable cups, glass cups, food containers, and coffee cups have been retrieved. The functional unit and the system boundary of the products under study have been considered to ensure the internal validity of the comparison. For the comparison of the reusable products with the disposable alternatives and to measure their environmental performance, the global warming potential (kg CO_2-equivalent (eq.)) has been chosen as the comparative indicator. In spite of facing difficulties to find disposable products with functional units that match the reusable products', benchmark values made of all kinds of materials were considered for comparison.

As the production of any RevoCup product comes with less CO2-eq. emissions than the production of glass cups according to publicly available life cycle assessments, RevoCup products have a better environmental performance before first use compared to the glass cups and even better after multiple uses in terms of CO_2-eq. emissions. When compared with disposable options with similar or the same functional units and with the same system boundaries, the RevoCup products have a better environmental performance after the 7th use. The breakeven point is between 5-10 uses, when the functional units of the disposable food containers are known, thus the RevoBox products have a better environmental performance after less than a dozen uses. When compared with disposable options with similar or the same functional units and with the same system boundaries, the Cupler products have a better environmental performance after a few uses.

The present study represents a comparative life cycle assessment of different alternatives for takeaway beverage and food packaging by fully considering *Article 4* of the *Proposal for the Green Claims Directive*[1]. Overall, the results show that Cup Revolution Kft., recognizing the generation of single-use waste in catering establishments, is addressing the problem with its reusable products. Despite some discrepancies and difficulties in volume matching that are thoroughly disclosed in this assessment, the present study provides valuable insights into the comparative environmental performance of Cup Revolution's reusable products and benchmark values for disposable alternatives. These findings can inform decision-making processes and promote sustainable choices in the food and beverage industry in order to comply with EU-level regulations, such as the *Directive on the reduction of the impact of certain plastic products on the environment (SUP Directive)*[2], and to prepare for laws similar to Germany's *Packaging Act*[3] – mandatory offering of reusable packaging by catering businesses.

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[1] Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A0166%3AFIN

[2] Source: https://eur-lex.europa.eu/eli/dir/2019/904/oj

[3] Source: https://verpackungsgesetz-info.de/en/

2. General Information

Commissioner of the study

CUP Revolution Kft.

Postal address and location: 1037 Budapest, Törökkő utca 1.

Contact: info@cuprevolution.hu

Manufacturing plants:

1. Pécs, Hungary
2. Érd, Hungary
3. Budapest, Hungary (the washing of the products takes place here)

The declaration is prepared by

Csongor Bajnóczki, denkstatt Hungary Kft.

Csaba Fűzfa, denkstatt Hungary Kft.

Report date

2023.06.

Declared product / Declared unit

1. RevoCup products:
    a. 1 piece of 300 ml reusable RevoCup
    b. 1 piece of 400 ml reusable RevoCup
    c. 1 piece of 500 ml reusable RevoCup
2. RevoBox products:
    a. 1 piece of 500 ml reusable RevoBox food container (container and lid)
    b. 1 piece of 1000 ml reusable RevoBox food container (container and lid)
3. Cupler products:
    a. 1 piece of 250 ml reusable Cupler coffee cup (gray colored coffee cup and gray colored lid)
    b. 1 piece of 400 ml reusable Cupler coffee cup (translucent coffee cup and translucent lid)
    c. 1 piece of 400 ml reusable Cupler coffee cup (gray colored coffee cup and gray colored lid)
4. Cup Revolution token:
    a. 1 piece of Cup Revolution token

3. Goal of the Study

The purpose of this research is to assess the potential environmental impacts of the reusable cup, food container, and coffee cup products of CUP Revolution Kft. (Cup Revolution) through LCA. The results of the LCA will be used for external communication to both consumers and businesses through the elaboration of LCA background report for each product described below. The goal of the study is to find out how many uses the reusable cups, food containers, and coffee cups operated by Cup Revolution require to reach the breakeven point with the disposable options, as well as the reusable glass cups, if the reusable products break even at all. Thereby, benchmark values have been researched for disposable options; this information is elaborated in Chapter 7.

4. Scope of the Study

This document contains requirements on the project report for LCA creation as EN ISO 14025.

The requirements on the project report include:

- Requirements from EN ISO 14025
- Requirements from EN ISO 14040/14044

The study has been conducted according to the requirements of EN ISO 14025 and EN ISO 14040/14044.

4.1. Declared unit

This LCA is concerned with the production, use (collection and washing), and recycling of nine products that have been categorized into four product groups due to identical technical characteristics:

- RevoCup products:
  - 1 piece of 300 ml reusable RevoCup
  - 1 piece of 400 ml reusable RevoCup
  - 1 piece of 500 ml reusable RevoCup
- RevoBox products:
  - 1 piece of 500 ml reusable RevoBox food container (container and lid)
  - 1 piece of 1000 ml reusable RevoBox food container (container and lid)
- Cupler products:
  - 1 piece of 250 ml reusable Cupler coffee cup (gray colored coffee cup and gray colored lid)
  - 1 piece of 400 ml reusable Cupler coffee cup (translucent coffee cup and translucent lid)
  - 1 piece of 400 ml reusable Cupler coffee cup (gray colored coffee cup and gray colored lid)
- Cup Revolution token:
  - 1 piece of Cup Revolution token

The functional unit of study for RevoCup products is:

pouring liquid beverage into a 300-, 400- or 500-ml cup.

The functional unit of the study for RevoBox products is:

food storage for takeaway/transportation in a food container with the capacity of 500 or 1000 ml.

The functional unit of study for Cupler products is:

pouring hot beverage liquid into a 240- or 400-ml cup.

These functional units are in line with the objectives of the study, which are to evaluate and compare the environmental impact of different reusable and disposable cup and food container options.

4.2. Declaration of Product Classes

The declared units refer to four main product groups with the same substances applied in different quantities. Product manufacturing is located at two plants in Pécs, Hungary and Érd, Hungary and refers to different technologies. Data used in calculations represents site-specific production volumes for 2022 January - 2022 December (12-month period). There are no by-products formed from the production lines subject to this study. The production figures for the production period could be summarized as shown below:

Product	Amount (pieces)
250 ml reusable Cupler coffee cup (gray colored)	59 496
400 ml reusable Cupler coffee cup (translucent)	25 200
400 ml reusable Cupler coffee cup (gray colored)	25 200
Cupler lid (gray colored)	106 614
Cupler lid (translucent)	25 600
300 ml reusable RevoCup	474 279
400 ml reusable RevoCup	408 853
500 ml reusable RevoCup	2 060 732
Cup Revolution token	487 969

Table 1 Product volumes of the products included in the assessment between 2022 January - 2022 December

Production of the RevoBox in zero batch started in 2023. In order to gather data to conduct the life cycle assessment for the RevoBox products, the subcontractor offered to measure all the information that is relevant for the life cycle assessment (electricity and other energy consumption, material use, waste management, water use, transportation of inputs and outputs, and supporting and other processes) during a time when the manufacture of other products was stopped. Thereby, the consumption of the machines and other processes were measured separately when nothing else was running at the manufacturing site.

4.3. Description of the Products

Field of application

The RevoCup, RevoBox, and Cupler products are reusable products primarily (at least 97%) made of polypropylene for durable and long-lasting applications.

RevoCup

RevoCup operates on a nationally interoperable, open- and closed-system. The reusable cups are available in a wide range of locations and provide an alternative solution to replace disposable cups. The network has been growing dynamically day by day, thus customers are not required to buy a new cup at every location or use a token that is only valid at a specific location.

Picture 1 Various RevoCup products

RevoBox

The reusable RevoBox food containers will arrive soon in the national catering sector. With a uniquely advantageous design, a full service tailored to guests and restaurateurs, and reusable equipment, RevoBox aims to revolutionize takeaway food packaging.

Picture 2 The 1000 ml RevoBox

Cupler

Cupler is a nationally redeemable cup holder system for hot beverages to go or consumed on site. Customers can redeem their Cupler cup for a token after use not only at the same place where it is bought, but also at many other cafés, bakeries, cafeterias and soon gas stations nationwide due to the traversable system operated by CUP Revolution Kft.

Picture 3 The 240 ml and 400 ml Cupler product with a sleeve

Technical and Functional Specifications

The three product groups are produced in accordance with the following specifications:

Product structure / composition / raw material	Material	Quantity (%)	Usability			Origin of the raw materials
			Renewable	Non-renewable	Recycled	
Plastic	Polypropylene	100%[4]		X		EU

Table 2 Raw-materials and composition of RevoCup products

Product structure / composition / raw material	Material	Quantity (%)	Usability			Origin of the raw materials
			Renewable	Non-renewable	Recycled	
Plastic	Polypropylene	97%		X		EU
Plastic, coloring additive	Polyethylene	3%		X		EU

Table 3 Raw-materials and composition of Cupler products

Product structure / composition / raw material	Material	Quantity (%)	Usability			Origin of the raw materials
			Renewable	Non-renewable	Recycled	
Plastic	Polypropylene	100%		X		EU

Table 4 Raw-materials and composition of RevoBox products

[4] 95% of the cups are made of polypropylene granules, while the remaining 5% is polypropylene-based label. The label is added onto the cups with in-mold labeling (IML) technology.

Product structure / composition / raw material	Material	Quantity (%)	Usability			Origin of the raw materials
			Renewable	Non-renewable	Recycled	
Plastic	Polypropylene	97%			X	EU
Plastic, coloring additive	Polyethylene	3%		X		EU

Table 5 Raw-materials and composition of Cup Revolution token

Technical specifications	3 dl RevoCup	4 dl RevoCup	5 dl RevoCup
Volume (ml)	300	400	500
Weight (g/piece)	35,5	47,1	49,2
Material	Polypropylene		

Table 6 Technical characteristics of the RevoCup products

Technical specifications	250 ml reusable Cupler coffee cup (gray colored with gray Cupler lid)	400 ml reusable Cupler coffee cup (translucent with translucent Cupler lid)	400 ml reusable Cupler coffee cup (gray colored with gray colored Cupler lid)
Volume (ml)	250	400	400
Weight (g/piece)	35	47	47
Material	Polypropylene and polyethylene		

Table 7 Technical characteristics of the Cupler products

Technical specifications	5 dl RevoBox with lid	1 l RevoBox with lid
Volume (ml)	500	1000
Weight (g/piece)	78,7	152
Material	Polypropylene	

Table 8 Technical characteristics of the RevoBox products

Technical specifications	Cup Revolution token
Weight (g/piece)	2
Material	Polypropylene and polyethylene

Table 9 Technical characteristics of the Cup Revolution token

Environmental/hazardous properties

The products do not contain substances listed in the Candidate List of Substances of Very High Concern for authorization under the REACH Regulation.

The final products are not expected to produce significant adverse health effects when the recommended instruction for use is followed.

4.4. System Boundaries

Following the goal of the study, this LCA study represents a 'cradle-to-grave' analysis for an average product, focusing on the following product manufacture stages:

- Extraction and processing of virgin raw materials;
- Generation of secondary energy carriers (e.g., electricity);
- Manufacturing of packaging;
- All relevant transport to the manufacturing facilities gate and within the manufacturing sites; transport of manufacturing waste to the respective recycling facilities; transport of the products to the recycling facility at the end of their life cycles;
- Production process;
- Lighting and heating at the production line;
- Waste generated as outputs from the production phase;
- End-of-life treatment of the products.

The following scheme represents the system boundary of the LCA for the Cup Revolution products under study:

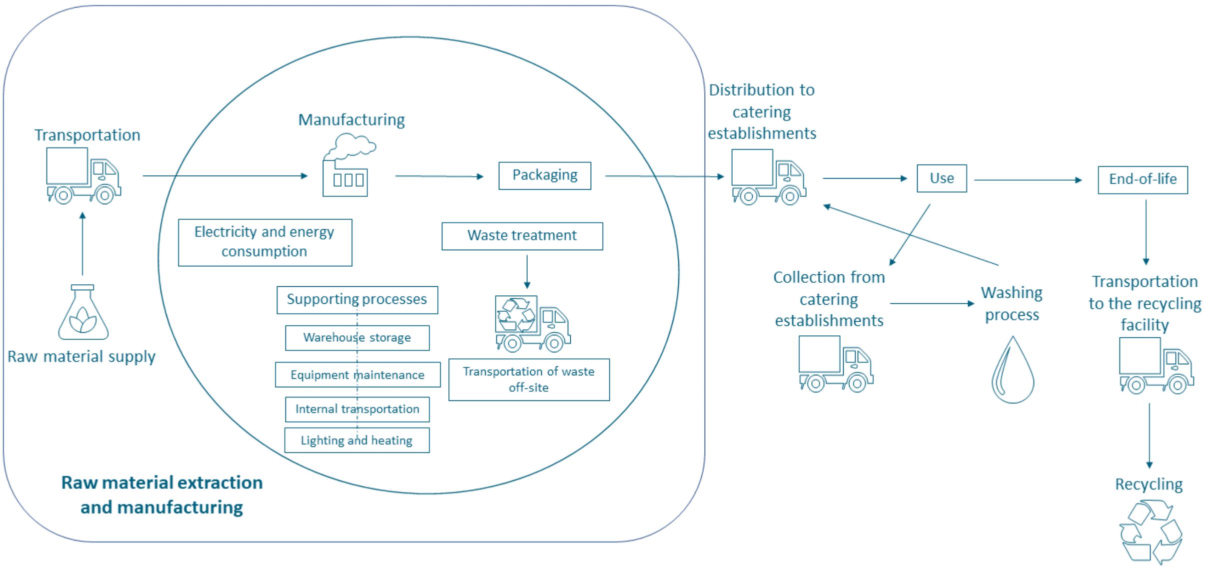


Figure 1 System boundaries

The foreground system comprises of the production specific process, where site specific information is obtained. These processes are particular for the manufacturer's plants and the operation mode is directly affected by the manufacturer's decisions. Such processes are related to electricity and energy production, raw materials processing, transport of some inputs/outputs, product manufacture at plant, waste treatment at plant, supporting processes at the manufacturing plants, packaging, and transport related to the core processes. In addition, other life cycle stages, such as distribution and collection of products to and from the catering establishments, washing procedure, transport of discarded products, and end-of-life treatment, are also under control thus part of the foreground system.

In contrast, the background system includes those processes that are averaged across suppliers and operated as part of the system but not under direct influence of the manufacturer. These are connected to the extraction and production of raw materials, waste management for the waste generated during manufacturing and packaging of raw materials, and the transport of some inputs/outputs.

The analysed products are produced at two manufacturing sites: the RevoCup and RevoBox products in Pécs, Hungary, while the Cupler products and Cup Revolution token in Érd, Hungary. Washing takes place at the headquarters of Cup Revolution in Budapest, Hungary.

Inputs to the production process are transported from various locations; the components of the products are primarily sourced from Hungary besides some ingredients coming from Germany and Croatia.

End-of life stage is modelled based on primary data: discarded products are collected by Cup Revolution and transported to Pécs, where the subcontractor of Cup Revolution recycles the discarded products.

Data sets for the study have been collected for the year before commissioning of the LCA study. No CO_2 certificates are considered in this study.

4.5. Criteria for the Exclusion of Inputs and Outputs (Cut-off)

According to the EN ISO 14044, "the cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly described. The effect on the outcome of the study of the cut-off criteria selected shall also be assessed and described in the final report" Data has been provided for all inputs and outputs to the manufacturing, use, and end-of-life processes, and one cut-off criterion has been applied.

During injection molding, the manufacturing sites use water-operated tempering equipment, with which they can ensure the optimal temperature of production. The water used for cooling at the manufacturing sites has been cut off, because the water is circulated in both systems; cooling water does not evaporate, all of it circulates. Essentially, this means that directly there is no amount of water used and lost during the manufacturing processes, because the same (amount of) water has been and will be circulated in the systems for years. In addition, the amount of water in the systems is relatively minimal, 20 m^3 and 400 liters, respectively. Since the manufacturing sites produce other products other than the ones under the scope of the study, the respective amount of water is relevant for the whole place of production. Nevertheless, the energy demand for water circulation is included in the energy consumption of each injection molding machine.

Where site-specific data was missing, it was modelled with generic datasets from the Ecoinvent 3.9.1 database.

Construction of buildings, machines and other equipment or infrastructure and consumption related to offices are not included as they do not have a direct relation to the production process.

4.6. Data Selection

The data used in this study includes information provided by the manufacturers that is representative for 2022 January – 2022 December (12-month period). Input materials and processes with less than 1% contributions are also included. Where the information was not precise, generic datasets from the Ecoinvent database are used with the appropriate geographic, temporal, and technological coverage as best as possible. The database was updated less than 1 year ago, so it is considered with good time representativeness.

The input production flows for the products by Cup Revolution are listed below:

Inputs	%
RevoCup products	
Polypropylene	100%
Subtotal:	*100%*

Table 10 Mass inputs for the RevoCup products

Inputs	%
RevoBox products	
Polypropylene	100%
Subtotal:	*100%*

Table 11 Mass inputs for the RevoBox products

Inputs	%
Cupler products	
Polypropylene	97%
Polyethylene	3%
Subtotal:	*100%*

Table 12 Mass inputs for the Cupler products

Inputs	%
Cup Revolution token	
Polypropylene	97%
Polyethylene	3%
Subtotal:	*100%*

Table 13 Mass inputs for the Cup Revolution token product

Packaging materials	Weight, kg (per functional unit)
300 ml RevoCup	
Cup Revolution packaging crate	0,0086
400 ml RevoCup	
Cup Revolution packaging crate	0,0108
500 ml RevoCup	
Cup Revolution packaging crate	0,0128

Table 14 Mass inputs for the packaging materials for the RevoCup products

Packaging materials	Weight, kg (per functional unit)
500 ml RevoBox	
Cup Revolution packaging crate	0,0128
1000 ml RevoBox	
Cup Revolution packaging crate	0,0256

Table 15 Mass inputs for the packaging materials for the RevoBox products

Packaging materials	Weight, kg (per functional unit)
250 ml reusable Cupler coffee cup (gray colored with gray Cupler lid)	
Cup Revolution packaging crate	0,0078
400 ml reusable Cupler coffee cup (translucent with translucent Cupler lid)	
Cup Revolution packaging crate	0,0108
400 ml reusable Cupler coffee cup (gray colored with gray colored Cupler lid)	
Cup Revolution packaging crate	0,0108

Table 16 Mass inputs for the packaging materials for the Cupler products

Packaging materials	Weight, kg (per functional unit)
Cup Revolution token	
Polyethylene bag	0,00001784

Table 17 Mass inputs for the packaging materials for the Cup Revolution token product

The electricity consumption for the manufacturing of 1 t of the products is the following:

Product	Manufacturing site	Electricity consumption per 1 t of product
300 ml RevoCup	Pécs, Hungary	2287,32 kWh
400 ml RevoCup	Pécs, Hungary	1959,66 kWh
500 ml RevoCup	Pécs, Hungary	1953,24 kWh
Container for the 500 ml RevoBox	Pécs, Hungary	3253,45 kWh
Lid for the 500 ml RevoBox	Pécs, Hungary	9115,94 kWh
Container for the 1000 ml RevoBox	Pécs, Hungary	2168,97 kWh
Lid for the 1000 ml RevoBox	Pécs, Hungary	2903,08 kWh
250 ml Cupler coffee cup (gray colored)	Érd, Hungary	902,58 kWh
400 ml Cupler coffee cup (translucent)	Érd, Hungary	677,08 kWh
400 ml Cupler coffee cup (gray colored)	Érd, Hungary	677,08 kWh
Cupler lid (gray colored)	Érd, Hungary	926,08 kWh
Cupler lid (translucent)	Érd, Hungary	927,08 kWh
Cup Revolution token	Érd, Hungary	2777,84 kWh

Table 18 Electricity consumption for the manufacturing of 1 t of products

For the manufacturing processes in Pécs, the subcontractor of Cup Revolution is connected to the Hungarian electricity grid. For this electricity consumption, the particular characterization factor was selected from Ecoinvent 3.9.1 during the LCA calculation.

For the manufacturing processes in Érd, the subcontractor of Cup Revolution is connected to the Hungarian electricity grid, and primarily receives its electricity from the national grid. Besides this, the subcontractor has a 40-kW solar power system, which can produce roughly one month's worth of electricity per year. The particular characterization factors were selected from Ecoinvent 3.9.1 during the LCA calculation, which were weighed and normalized according to the appropriate ratio.

4.7. Data Quality and Completeness

EN ISO 14044 was applied in terms of data collection and quality requirements. This LCA report is based on site-specific data from the manufacturers and is representative for the production for 2022 January - 2022 December[5] (12-month period). The manufacturing locations are in Pécs, Hungary and Érd, Hungary. However, since the ingredients of the products are produced and delivered by external suppliers, their production processes are modelled using data from the Ecoinvent 3.9.1 database. The following table summarizes the data quality per processes.

[5] Except for the production of RevoBox that has started in 2023.

Process	Data type	Assigned data quality	Reliability
Raw materials acquisition and pre-products	Specific	Very good/ good	Measured
Energy supply (electricity)	Specific	Very good	Measured
Production process	Specific	Very good	Measured
Transport of materials	Specific	Very good/ good	Quantity transported – measured Distance travelled – calculated Vehicle type and technology – good
Washing procedure	Specific	Very good	Measured
End-of-life treatment	Specific	Very good	Measured

Table 19 Data quality overview

Data quality level and criteria based on the UN Environment Global Guidance on LCA database development:

Process	Parameter	Geographical representativeness	Technological representativeness	Temporal representativeness
Production process	Electricity	Very good	Very good	Very good
	Water use	Good	Very good	Poor
	Treatment of wastewater	Good	Very good	Poor

Process	Parameter	Geographical representativeness	Technological representativeness	Temporal representativeness
	Energy (natural gas)	Good	Good	Fair
Inputs	Polypropylene granulates	Good	Very good	Poor
	Polyethylene granulates	Good	Very good	Poor
	Dishwashing liquid	Poor	Good	Fair
	Rinse	Poor	Good	Fair
	Antifoam	Poor	Good	Fair
	Lubricating oil	Good	Very good	Very poor
Outputs	Plastic waste	Very good	Very good	Good
	Municipal solid waste	Very good	Very good	Good
	Wastewater	Good	Very good	Poor
Transport of materials	Input materials	Good	Very good	Poor
	Collection and transport of products from catering establishments	Good	Good	Poor
	Transport of discarded products to the recycling facility	Good	Good	Poor
	Output materials	Good	Very good	Poor

Table 20 Data quality level and criteria based on the UN Environment Global Guidance on LCA database development

4.8. Estimates and assumptions

This assessment is based mostly on data from the manufacturer, so it is representative for the technology, geography, and time period (2022 January - 2022 December (12-month period)).

LCA module	Assumptions
Raw materials supply	Production of components for the RevoCup, Cupler, RevoBox, and Cup Revolution token products are modelled using referent generic datasets, based on the provided info from manufacturer. The "polypropylene production, granulate, RER" characterization factor was selected, which adequately covers the geographical and technological representativeness. Besides 97% polypropylene content, another component of the Cupler and Cup Revolution token products is the coloring additive made of polyethylene. Other raw materials have to do with the washing of the products during the use phase. For the direct washing procedure, these materials are dishwashing liquid, antifoam, and rinse. For the overall maintenance of the washing machines, filter bag and salt tablet are needed. Last but not least, lubricating oil is required for the maintenance of the machines that manufacture the products under the scope of the study.
Transport of raw materials to factory	Modelled with data from the manufacturers. Some routes are not clearly defined, so these are averaged. Origin and data on truck capacity are known in all cases. EURO class of the vehicles is known in all cases.
Production	Even though the subcontractors of Cup Revolution manufacture other products other than the ones under the scope of the study, impacts do not need to be allocated based on production volume, because the specific electricity consumption of the machines are measured. Internal transport and factory waste handling are modelled with data from the manufacturer. Other supporting processes, such as lighting and heating at the production line, are modelled with data from the manufacturer and the impacts are allocated based on production volume.

Transport of products to the catering establishments	The final products are transported to the various catering establishments from Pécs or Érd. Since Cup Revolution uses its own vehicles for transport, this stage is modelled with primary data from Cup Revolution.
Use	The use phase includes the collection of the products, the washing of the products, and the transport of the products to the catering establishments. Since Cup Revolution uses its own vehicles for transport and its own machines for washing, this stage is modelled with primary data from Cup Revolution.
End-of-life treatment	This stage includes the transport of the discarded products to the recycling facility and the recycling process. Cup Revolution uses its own vehicles to transport the products to the recycling facility thus the transport is modelled with primary data from Cup Revolution, while the subcontractor of Cup Revolution shared primary data for the modelling of the recycling process.

Table 21 Assumptions in the LCA model

5. Life Cycle Inventory Analysis

5.1. Data collection and calculation procedures

Primary data representative for the specific production processes is provided by the subcontractors of Cup Revolution and Cup Revolution. Data collected refers to all inputs and outputs included in the system boundary and represents the technological advances for 2022 January - 2022 December (12-month period). Data was collected over several phases to ensure as far as possible completeness, precision, consistency, reproducibility, and coverage (geographical, time-related, and technological).

Calculations were performed using Excel-based model, where inputs and outputs are listed. The LCA impacts were calculated using an Excel model and the characterization factors from Ecoinvent 3.9.1. For each impact category the appropriate impact factor was multiplied by the respective quantity of inputs/outputs. In the case of energy used, inputs in natural units are converted to the corresponding energy units using country-specific or generic net calorific values. Impact from electricity consumption is assessed applying the country specific factor reflecting the corresponding purchased electricity: electricity, low voltage, residual mix for the manufacturing site in Pécs and the headquarters of Cup Revolution Budapest where the washing takes place, while electricity, low voltage, residual mix, and electricity production, photovoltaic for the manufacturing site in Érd.

5.2. Allocation

EN ISO 14040 defines the allocation as “partitioning the input or output flow of a unit process to the product system under study”.

Even though the subcontractors of Cup Revolution manufacture other products other than the ones under the scope of the study, most of the impacts do not need to be allocated. Nevertheless, some supporting processes are modelled with data from the manufacturers and the impacts are allocated based on production volume. These processes include lighting, heating, and support and storage processes (e.g., forklift use).

Allocation was done to identify the associated quantity of flows that are common for the factories: electricity and heat for general factory needs, transportation of the common ingredients between the products, and support and storage processes. Allocation is based on product volume, mass (kg), because there is a linear correlation between energy demand and weight mass of materials (product volume) and the inputs and outputs were provided in mass (kg).

In addition, allocation was also conducted to get the average length in km of a typical collection route during which Cup Revolution usually picks up final products from the manufacturing sites and ingredients for the washing procedure, distributes clean products, collects dirty products, and drops off discarded products at the recycling facility. In order to gather the length (km) of a typical route, Cup Revolution shared all the routes of their three vehicles taken during one of the busiest months of the year, 2022 July. The EURO classification is EURO 6 in all cases. One of the vehicles is typically used for transport within Budapest, while the other two often takes trips outside of Budapest. Nevertheless, the amount of km and the number of routes taken by all three vehicles are known, thus an average round taken by the vehicles is 100 km.

5.3. Unit Processes for the RevoCup and RevoBox products

Raw Materials and pre-products supply

The RevoCup and RevoBox products are made of food-grade clear, translucent polypropylene granulates. The required raw material is subject to ISO 9001 incoming material control; the raw material is not added or modified in any way, it is used directly. In case of the RevoCup products, they are supplied with polypropylene-based IML (in-mould labelling) printed film, subject to the same incoming material control as the polypropylene granulates. Each IML printed film is 50 microns thick, contains of 5 layers in total, rolled together, which gives it its durability, and to be tempered between 20-25 Celsius degrees. The materials are stored according to TDS storage conditions.

Raw materials for the RevoCup and RevoBox products are pre-produced ingredients which are delivered by external suppliers and mixed at the factory. The mixing process is performed in Pécs. In Pécs, the respective electricity production, Hungarian residual mix, is applied for the manufacturing process' electricity consumption. Electricity use also includes on-site transport by electric forklift. According to the EN ISO 14040/44, manufacturing of packaging is also included. Lubricating oil is used for the general maintenance of the injection moulding machines.

Process	Parameter
Energy	Electricity
Raw material supply	Polypropylene granulates
	Laminated, carrier PP film
	Lubricating oil
Pre-manufactured packaging	Polypropylene-based packaging boxes
	High-density polyethylene bags

Table 22 Inventory for the modelling of raw materials and pre-manufactured products supply modules of the RevoCup and RevoBox products

Transportation

Transportation of all input materials is fully included. Data was provided by the manufacturer, and allocation was applied for the delivery kilometers of the common ingredients.

According to EN ISO 14044, normalization is the calculation of the magnitude of the category indicator results relative to some reference information. The aim of the normalization is to understand better the relative magnitude for each indicator result of the product system under study. It is an optional element that may be helpful in, for example, preparing for additional procedures, such as grouping, weighting or life cycle interpretation. According to EN ISO 14044, weighting is the process of converting indicator results of different impact categories by using numerical factors based on value-choices. It may include aggregation of the weighted indicator results. In order to provide an overall aggregate and averaged picture about the polypropylene granulates supply, normalization and weighting are conducted in accordance with the relevant information and impacts associated with the polypropylene supply coming from various locations.

Normalization and weighing were necessary in order to adequately model the incoming supply of polypropylene granulates from two suppliers: one of them is in Hungary, while the other is in Germany. Around 80% of the incoming supply is from Hungary and the remaining 20% is from Germany, thereby the ratio is 8:2. The impacts associated with the transport of polypropylene granules have been averaged in accordance with the ratio of 8:2.

Process	Parameter
Transport of raw materials	Polypropylene granulates from Hungarian and German suppliers
	Laminated, carrier PP film from Croatia
	Lubricating oil from Hungary
Transport of pre-manufactured packaging	Polypropylene-based packaging boxes from Germany
	High-density polyethylene bags of the raw materials coming from various suppliers
Transport of final products	RevoCup products transported to the various catering establishments

Table 23 Inventory for the modelling of transportation modules of the RevoCup and RevoBox products

The impacts related to the collection of products from the various catering establishments are under the use stage of the life cycle of the products, while the impacts related to the transport of discarded products to the recycling facility are under the end-of-life stage of the life cycle of the products.

Manufacturing process

The RevoCup products are manufactured by plastic injection moulding, using a special moulding tool developed for IML technology, with a special IML label dispensing robot. The production is highly automated, with the robot being responsible for inserting the IML printed film into the label dispensing-manufacturing mould and at the same time removing the finished product from the mould core. IML printed films are not applied onto the RevoBox products.

The main steps of the production process are as follows:

1. insertion of raw materials, finished product rolls into the production cell;
2. start of production, heating, manual loading of labels into label holders for the robot;
3. setting product production in automatic mode - batch production;
4. checking the finished product, placing in a collection box (reusable, washable roll); and
5. production administration.

During production, around 2-3% of the IML printed films end up being wasted. The robot picks up each IML printed film with a suction cup and puts it on the cup-based spike with butterfly-like skill, then zaps and vacuums it through the system. In some cases, the suction of the robot is not strong enough, thus the IML printed films are scattered over the production lines. Since these become contaminated, they are thrown away. In addition to the IML printed films, around 1% additional waste is generated during production due to machine configuration.

The loading/unloading and supply of materials to the production system as well as packaging of the ready products are included in the total electricity consumption.

Cooling water is directly connected to the production line. Water is circulated throughout, cooling all the equipment, with a unit for each line. There are different cooling needs during winter than during summer. The complete system holds around 20 m^3 of water. The water is supplied from the utility system and softened by the manufacturer's own system. Cooling water does not evaporate, all the water circulates. Occasionally, a few liters of water may spill during installation, but it is not common to have to add water. While water consumption has been cut-off due to the reasons mentioned in chapter 3.5, the impacts associated with the energy consumption of the water-cooling system is considered, because the manufacturer was able to include the energy demand in the energy consumption of each injection moulding machine when providing data.

In terms of waste management, the local waste treatment facility treats the 2-3% of the total IML printed films that are scattered during production and the packaging of the raw materials. For these impacts, the selected market dataset models the disposal mix for waste plastic, mixture in Hungary using country-specific data. The 1% scrap generated during production are handled internally by the manufacturer; the scrap material is mechanically shredded, and the secondary plastic shreds are used to produce plastic paving elements. Associated impacts are considered in all cases.

Process	Parameter
Energy	Electricity consumption during manufacturing (including the energy consumption associated with the water-cooling system)
	General lighting at the production line
	Charging the electric forklifts
Waste management	Market for plastic waste mixture
	Mechanical shredding of plastic scrap

Table 24 Inventory for the modelling of manufacturing process module of the RevoCup and RevoBox products

Use stage

The use phase of the products includes the collection and transport of the products from the various catering establishments to the washing facility of Cup Revolution in Budapest, the washing procedure and supporting processes, and the distribution of the products to the catering establishments. Since Cup Revolution uses its own vehicles for the collection, transport, and distribution of the products and has its own washing facility for the procedure, primary data has been used to model this phase.

According to EN ISO 14044, normalization is the calculation of the magnitude of the category indicator results relative to some reference information. The aim of the normalization is to understand better the relative magnitude for each indicator result of the product system under study. It is an optional element that may be helpful in, for example, preparing for additional procedures, such as grouping, weighting or life cycle interpretation. According to EN ISO 14044, weighting is the process of converting indicator results of different impact categories by using numerical factors based on value-choices. It may include aggregation of the weighted indicator results. In order to provide an overall aggregate and averaged picture about the collection and transport of the products, normalization and weighting are conducted in accordance with the relevant information and impacts associated with the transport of products between the various locations.

For the collection and transport of the products, Cup Revolution shared all the routes taken during one of the busiest months of the year, 2022 July. This is needed in order to illustrate the number of kilometers travelled between the various catering establishments, the headquarters of Cup Revolution, manufacturing sites, and the recycling facility. This data is averaged in order to obtain the typical amount of kilometer taken under one route.

In 2022, three vehicles were used for transport. The delivery of clean products to the catering establishments and the collection of dirty ones is done in one round, practically in a collection round, because Cup Revolution can make several deliveries to different partners in one round.

For the washing procedure, Cup Revolution shared primary data for all the process impacts associated with this phase. For the cleaning of the products, HOBART FUX (7-S-A-B-PF-TBR2-TBR2-DSK-N-DSK-DSK-9) industrial dishwasher with conveyor belt is used. On average, it can wash up to 10 000 products, while consuming 300 liters per hour. After the washing procedure is over, the water can be discharged as wastewater. The dishwasher's electricity consumption is 115 kWh, while the water softening equipment's electricity consumption that is required prior to the washing procedure is 2.2 kWh. For one cycle (one hour), the following detergents are used: dishwashing liquid (650 ml/h), rinse aid (150 ml/h), and antifoam (50ml/h).

Picture 4 The industrial dishwasher used for cleaning the products at the headquarter of Cup Revolution

The warehouse where the washing machine is located consumes natural gas for heating. In the warehouse and the washing areas, there are 59 W LED bulbs: 18 pieces in the warehouse and 24 pieces in the washing area. The associated impacts are considered as well.

For the general maintenance, dishwasher and water softener servicing is carried out by external technicians, and when parts need to be replaced, they order them and bring them with them when they are repaired. The impacts associated with the production of these parts are not under the scope of the study. In addition, filter bags (for the 3 liquid filter tanks of the dishwasher) and a salt tablet for water softening are used. The impacts associated with the production of these materials are under the scope of the study.

Forklift is used during the washing procedure as a supporting process to lift and move the products within the warehouse and washing areas. The forklift truck is gas powered so it does not consume electricity. Nevertheless, the associated impacts are under the scope of the study.

Regarding waste management, the local waste treatment facility treats the packaging material of the incoming materials. For these impacts, the selected market dataset models the disposal mix for waste plastic, mixture in Hungary using country-specific data.

Process	Parameter
Energy	Electricity
	Liquefied petroleum gas
	Natural gas
Raw material supply	Dishwashing liquid
	Rinse aid
	Antifoam
	Filter bag
	Salt tablet
	Packaging of raw materials
Transport	Products collected from the various catering establishments and transported to the washing facility
	Products transported to the various catering establishments from the washing facility
	Transport of raw materials and associated packaging

Process	Parameter
	Transport of waste packaging materials to waste treatment facility

Table 25 Inventory for the modelling of the processes during the use stage of the RevoCup and RevoBox products

End-of-life stage

The end-of-life treatment phase of the products includes the transport of the discarded products from the headquarters of Cup Revolution to the recycling facility. Since Cup Revolution uses its own vehicles for the transport of the products and the subcontractor handles the recycling of the discarded products, primary data has been used to model this phase.

The products wear out and become damaged over time, thus after repeated use by consumers at the catering establishments, when they are no longer suitable for the delivery of the beverage from a safety (e.g.: disfigured mouth part), hygiene or aesthetic point of view, Cup Revolution discards and collects these products.

The discarded products, cleaned of contamination, are transported by Cup Revolution to its subcontractor in Pécs, where they were originally produced. The subcontractor processes the high quality secondary raw material base by mechanical shredding using its own technological equipment.

The shredded products are used directly by the subcontractor for the manufacture of technical plastic products, which are used to make plastic paving elements at its headquarters and are ideal for fixed paving solutions or as temporary paving, particularly for events and festivals. The valuable plastic recovered from the shredding of the Cup Revolution products can also be used to make a wide range of other technical plastic products (such as gardening tools: raised beds, composting containers, etc.). In summary, used, recovered products do not become waste at the end of their life cycle and are fully recycled into other products that are also useful in the long term. Nevertheless, the impacts associated with the manufacture of the secondary plastic products from the shredded products are not under the scope of the present study.

Process	Parameter
Energy	Electricity
Transport	Products collected from the various catering establishments and transported to the washing facility
	Discarded products transported to the recycling facility

Table 26 Inventory for the modelling of the processes during the end-of-life stage of the RevoCup and RevoBox products

5.4. Unit processes for the Cupler products

Raw Materials and pre-products supply

The Cupler products are made of food-grade clear, translucent polypropylene granulates. The required raw material is subject to ISO 9001 incoming material control; the raw material is not added or modified in any way, it is used directly. The materials are stored according to TDS storage conditions.

Raw materials for the Cupler products are pre-produced ingredients which are delivered by external suppliers and mixed at the factory. The mixing process is performed in Érd. Electricity use also includes on-site transport by electrical forklift. According to the EN ISO 14040/44, manufacturing of packaging is also included. Lubricating oil is used for the general maintenance of the injection moulding machines.

Process	Parameter
Energy	Electricity
Raw material supply	Polypropylene granulates
	Polyethylene coloring additives
	Lubricating oil
Pre-manufactured packaging	Polypropylene-based packaging boxes
	High-density polyethylene bags

Table 27 Inventory for the modelling of raw materials and pre-manufactured products supply modules of the Cupler products

Transportation

Transportation of all input materials is fully included. Data was provided by the manufacturer, and allocation was applied for the delivery kilometers of the common ingredients.

Process	Parameter
Transport of raw materials	Polypropylene granulates from the Hungarian supplier
	Polyethylene coloring additives from the Hungarian supplier
	Lubricating oil from Hungary
Transport of pre-manufactured packaging	Polypropylene-based packaging boxes from Germany
	High-density polyethylene bags of the raw materials coming from various suppliers

Process	Parameter
Transport of final products	Cupler products transported to the various catering establishments

Table 28 Inventory for the modelling of transportation modules of the Cupler products

The impacts related to the collection of products from the various catering establishments are under the use stage of the life cycle of the products, while the impacts related to the transport of discarded products to the recycling facility are under the end-of-life stage of the life cycle of the products.

Manufacturing process

For the manufacturing processes in Érd, the subcontractor of Cup Revolution is connected to the Hungarian electricity grid, and primarily receives its electricity from the national grid. Besides this, the subcontractor has a 40-kW solar power system, which can produce roughly one month's worth of electricity per year. The particular characterization factors were selected from Ecoinvent 3.9.1 during the LCA calculation, which were weighed and normalized according to the appropriate ratio.

For the manufacturing process, the manufacturing plant in Érd produces the Cupler products from the incoming polypropylene and polyethylene granulates and the Cup Revolution tokens from the incoming shredded RevoCup plastic and polyethylene granulates. The main manufacturing step in the injection moulding process from the incoming ingredients. After heating and shaping in the machine, the final product is placed in Cup Revolution's reusable plastic storage boxes stored. The emissions related to this process are also included in the manufacturing stage. Once the products are produced at the site, other incoming goods are checked, labelled, and then placed in the warehouse. From the warehouse, it is loaded onto the transport vehicle.

Cooling water is directly connected to the production line. Water is circulated throughout, cooling all the equipment, with a unit for each line. There are different cooling needs during winter than during summer. The complete system holds around 400 l of water. The water is supplied from the utility system and softened by the manufacturer's own system. Cooling water does not evaporate, all the water circulates. Occasionally, a few liters of water may spill during installation, but it is not common to have to add water. While water consumption has been cut-off due to the reasons mentioned in chapter 3.5, the impacts associated with the energy consumption of the water-cooling system is considered, because the manufacturer was able to include the energy demand in the energy consumption of each injection moulding machine when providing data.

The loading/unloading and supply of materials to the production system as well as packaging of the ready products are included in the total electricity consumption.

In terms of waste management, the local waste treatment facility treats the 1-2% scrap material generated during the production of the Cupler products and the packaging of the raw materials. For these impacts, the selected market datasets model the disposal mix for municipal solid waste and the disposal mix for waste plastic, mixture in Hungary using country-specific data. The 1% scrap generated during the production of Cup

Revolution tokens are handled internally by the manufacturer; the scrap material is mechanically shredded, and the secondary plastic shreds can be circled back into production of new Cup Revolution tokens. Associated impacts are considered in all cases.

Use stage

The use phase of the Cupler products includes the collection and transport of the products from the various catering establishments to the washing facility of Cup Revolution in Budapest, the washing procedure and supporting processes, and the distribution of the products to the catering establishments. Since Cup Revolution uses its own vehicles for the collection, transport, and distribution of the products and has its own washing facility for the procedure, primary data has been used to model this phase.

According to EN ISO 14044, normalization is the calculation of the magnitude of the category indicator results relative to some reference information. The aim of the normalization is to understand better the relative magnitude for each indicator result of the product system under study. It is an optional element that may be helpful in, for example, preparing for additional procedures, such as grouping, weighting or life cycle interpretation. According to EN ISO 14044, weighting is the process of converting indicator results of different impact categories by using numerical factors based on value-choices. It may include aggregation of the weighted indicator results. In order to provide an overall aggregate and averaged picture about the collection and transport of the products, normalization and weighting are conducted in accordance with the relevant information and impacts associated with the transport of products between the various locations.

For the collection and transport of the products, Cup Revolution shared all the routes taken during one of the busiest months of the year, 2022 July. This is needed in order to illustrate the number of kilometers travelled between the various catering establishments, the headquarters of Cup Revolution, manufacturing sites, and the recycling facility. This data is averaged in order to obtain the typical amount of kilometer taken under one route.

In 2022, three vehicles were used for transport. The delivery of clean products to the catering establishments and the collection of dirty ones is done in one round, practically in a collection round, because Cup Revolution can make several deliveries to different partners in one round.

For the washing procedure, Cup Revolution shared primary data for all the process impacts associated with this phase. For the cleaning of the products, HOBART FUX (7-S-A-B-PF-TBR2-TBR2-DSK-N-DSK-DSK-9) industrial dishwasher with conveyor belt is used. On average, it can wash up to 10 000 products, while consuming 300 liters per hour. After the washing procedure is over, the water can be discharged as wastewater. The dishwasher's electricity consumption is 115 kWh, while the water softening equipment's electricity consumption that is required prior to the washing procedure is 2.2 kWh. For one cycle (one hour), the following detergents are used: dishwashing liquid (650 ml/h), rinse aid (150 ml/h), and antifoam (50ml/h).

Picture 5 Loading the industrial dishwasher with dirty cups

The warehouse where the washing machine is located also consumes natural gas for heating. In the warehouse and the washing areas, there are 59 W led bulbs: 18 pieces in the warehouse and 24 pieces in the washing area. The associated impacts are considered as well.

For the general maintenance, dishwasher and water softener servicing is carried out by external technicians, and when parts need to be replaced, they order them and bring them with them when they are repaired. The impacts associated with the production of these parts are not under the scope of the study. In addition, filter bags (for the 3 liquid filter tanks of the dishwasher) and a salt tablet for water softening are used. The impacts associated with the production of these materials are under the scope of the study.

A forklift is used during the washing procedure as a supporting process to lift and move the products within the warehouse and washing areas. The forklift truck is gas powered so it does not consume electricity. Nevertheless, the associated impacts are under the scope of the study.

Regarding waste management, the local waste treatment facility treats the packaging material of the incoming materials. For these impacts, the selected market dataset models the disposal mix for waste plastic, mixture in Hungary using country-specific data.

Process	Parameter
Energy	Electricity
	Liquefied petroleum gas
	Natural gas
Raw material supply	Dishwashing liquid
	Rinse aid
	Antifoam
	Filter bag
	Salt tablet
	Packaging of raw materials
Transport	Products collected from the various catering establishments and transported to the washing facility
	Products transported to the various catering establishments from the washing facility
	Transport of raw materials and associated packaging
	Transport of waste packaging materials to waste treatment facility

Table 29 Inventory for the modelling of manufacturing process module of the Cupler products

The possible impacts of the Cup Revolution tokens are not considered under the use stage, because consumers are expected to hold onto them and redeem it for a RevoCup or Cupler product at a catering establishment. Thereby, the tokens are also circulated between consumers and catering establishments, but they do not need to be collected, transported[6], and washed between uses.

[6] Technically, the tokens need to be transported, because they are assumed to be in the wallet of the customers while they move between catering establishments. Nevertheless, the impact of this is beyond the control and scope of Cup Revolution, there is no reliable information for modelling the impacts, and the possible impacts are deemed to be negligible.

End-of-life stage

The end-of-life treatment phase of the products includes the transport of the discarded products from the headquarters of Cup Revolution to the recycling facility. Since Cup Revolution uses its own vehicles for the transport of the products and the subcontractor handles the recycling of the discarded products, primary data has been used to model this phase.

The products wear out and become damaged over time, thus after repeated use by consumers at the catering establishments, when they are no longer suitable for the delivery of the beverage from a safety (e.g.: disfigured mouth part), hygiene or aesthetic point of view, Cup Revolution discards and collects these products.

The discarded products, cleaned of contamination, are transported by Cup Revolution to its subcontractor in Pécs. The subcontractor processes the high quality secondary raw material base by mechanical shredding using its own technological equipment.

Cup Revolution has little experience over the end-of-life stage of the Cupler products at the moment. So far, there is only one place where they deliver Cupler products back and forth on a weekly basis. At the end of their life cycle, the Cupler products can be recycled and used in the manufacture of plastic products (the difference between recycling Cupler products and RevoCup products is that the granulate made from Cupler products can even be used for food products, because it does not contain any dyes).

In summary, used, recovered products do not become wasted at the end of their life cycle and are fully recycled into other products that are also useful in the long term. Nevertheless, the impacts associated with the manufacture of the secondary plastic products from the shredded products are not under the scope of the present study.

Process	Parameter
Energy	Electricity
Transport	Products collected from the various catering establishments and transported to the washing facility
	Discarded products transported to the recycling facility

Table 30 Inventory for the modelling of the processes during the end-of-life stage of the Cupler products

6. Life cycle impact assessment

Statement that the estimated impact results are only relative statements which do not indicate the end points of the impact categories, exceeding threshold values, safety margins or risks.

Considering the quality of the LCI data and results, it is deemed suitable to conduct the LCIA in accordance with the study goal and scope definition. Additionally, the system boundary and data cut-off decisions have been sufficiently reviewed to ensure the availability of LCI results necessary to calculate indicator results for the LCIA. Last but not least, the environmental relevance of the LCIA results is not decreased due to the LCI functional unit calculation, system wide averaging, aggregation and allocation. Overall, the assignment of LCI results to the selected impact categories (classification) has been done accordingly.

6.1. Selected impact assessment indicators

Characterization factors for the impact assessment calculations are derived from Ecoinvent 3.9.1 database. The preferred system model is ‘Allocation, cut-off by classification’.

The calculation and categorization of life cycle emissions has been carried out in accordance with the EN ISO 14040/44 principles. The impact assessment is prepared for the following mid-point impact categories and regarded as relevant for the goal of the study:

Category	Indicator	Unit
Climate change-total	Global warming potential-total (GWP-total)	kg CO_2-eq.
Climate change-fossil	Global warming potential-fossil (GWP-fossil)	kg CO_2-eq.
Climate change-biogenic	Global warming potential-biogenic (GWP-biogenic)	kg CO_2-eq.
Climate change-land use and land use change	Global warming potential-luluc (GWP-luluc)	kg CO_2-eq.
Eutrophication-aquatic freshwater	Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg P-eq.
Eutrophication-terrestrial	Eutrophication potential, accumulated exceedance (EP-terrestrial)	mol N-eq.
Photochemical ozone formation	Formation potential of tropospheric ozone (POCP)	kg NMVOC-eq.
Depletion of abiotic resources minerals and metals[1]	Abiotic depletion potential for non-fossil resources (ADPminerals&metals)	kg Sb-eq.
Depletion of abiotic resources fossil fuels[1]	Abiotic depletion for fossil resources potential (ADP-fossil)	MJ, net calorific value
Water use[1]	Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	m^3 world-eq. deprived
Particulate Matter emissions	Potential incidence of disease due to PM emissions (PM)	Disease incidence

Land use related impacts/ Soil quality[1]	Potential soil quality index (SQP)	dimensionless

Table 31 Core environmental indicators assessed

[1] Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

Characterization factors for the impact assessment calculations are derived from Ecoinvent 3.9.1 database. In this LCA study, the EF v3.1 characterization method is applied.

6.2. Environmental profile of the products under the scope of the study

The assessment results, summarized in the tables below, show the estimated potential impacts from the life cycle of the products with a scope of cradle-to-grave.

6.2.1. RevoCup products

Potential environmental impact of the 3 dl RevoCup

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Tot. A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	1,32E-01	6,85E-03	1,06E-04	1,39E-01	7,44E-03	4,15E-03	1,38E-02	1,64E-01
GWP-biogenic	kg CO_2 eq.	1,52E-04	2,31E-06	7,10E-08	1,54E-04	1,09E-05	1,52E-06	1,34E-05	1,80E-04
GWP-luluc	kg CO_2 eq.	4,98E-05	3,75E-06	2,00E-08	5,35E-05	2,94E-05	2,43E-06	3,76E-06	8,92E-05
GWP-total	kg CO_2 eq.	1,32E-01	6,86E-03	1,06E-04	1,39E-01	7,48E-03	4,15E-03	1,38E-02	1,64E-01
EP-freshwater	kg P eq.	2,70E-05	5,42E-07	2,06E-08	2,76E-05	1,66E-06	3,51E-07	3,96E-06	3,36E-05
EP-terrestrial	mol N eq.	1,06E-03	6,64E-05	7,65E-07	1,12E-03	6,28E-05	2,07E-05	1,31E-04	1,34E-03
POCP	kg NMVOC eq.	4,30E-04	2,94E-05	2,62E-07	4,60E-04	2,47E-05	1,30E-05	4,51E-05	5,43E-04
ADP-minerals& metals	kg Sb eq.	9,95E-07	2,75E-08	8,53E-10	1,02E-06	6,93E-08	1,86E-08	1,64E-07	1,28E-06
ADP-fossil	MJ	3,80E+00	9,77E-02	1,96E-03	3,90E+00	1,69E-01	5,87E-02	3,75E-01	4,51E+00
WDP	m^3	4,73E-02	5,25E-04	2,06E-05	4,79E-02	2,48E-03	3,34E-04	3,76E-03	5,45E-02
PM	Disease incidence	4,28E-09	4,42E-10	4,44E-12	4,73E-09	2,35E-10	2,20E-10	2,92E-10	5,48E-09
SQP	dimensionless	3,47E-01	4,72E-02	4,88E-04	3,95E-01	5,24E-02	2,42E-02	9,03E-02	5,62E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

Potential environmental impact of the 4 dl RevoCup

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	1,67E-01	9,10E-03	1,38E-04	1,76E-01	8,08E-03	5,50E-03	1,83E-02	2,08E-01
GWP-biogenic	kg CO_2 eq.	1,94E-04	3,06E-06	9,43E-08	1,97E-04	1,12E-05	2,02E-06	1,77E-05	2,28E-04
GWP-luluc	kg CO_2 eq.	6,28E-05	4,98E-06	2,66E-08	6,78E-05	2,98E-05	3,22E-06	4,99E-06	1,06E-04
GWP-total	kg CO_2 eq.	1,67E-01	9,11E-03	1,38E-04	1,76E-01	8,12E-03	5,51E-03	1,83E-02	2,08E-01
EP-freshwater	kg P eq.	3,34E-05	7,19E-07	2,74E-08	3,42E-05	1,72E-06	4,66E-07	5,25E-06	4,16E-05
EP-terrestrial	mol N eq.	1,32E-03	8,81E-05	1,01E-06	1,41E-03	6,60E-05	2,75E-05	1,74E-04	1,68E-03
POCP	kg NMVOC eq.	5,43E-04	3,91E-05	3,46E-07	5,83E-04	2,68E-05	1,73E-05	5,98E-05	6,87E-04
ADP-minerals& metals	kg Sb eq.	1,22E-06	3,65E-08	1,14E-09	1,26E-06	7,22E-08	2,46E-08	2,18E-07	1,58E-06
ADP-fossil	MJ	4,86E+00	1,30E-01	2,60E-03	4,99E+00	1,78E-01	7,79E-02	4,98E-01	5,74E+00
WDP	m^3	6,03E-02	6,97E-04	2,73E-05	6,10E-02	2,54E-03	4,43E-04	4,99E-03	6,90E-02
PM	Disease incidence	5,48E-09	5,87E-10	5,69E-12	6,08E-09	2,70E-10	2,92E-10	3,87E-10	7,02E-09
SQP	dimensionless	4,14E-01	6,27E-02	6,48E-04	4,78E-01	5,62E-02	3,21E-02	1,20E-01	6,86E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

Potential environmental impact of the 5 dl RevoCup

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	1,77E-01	9,50E-03	1,48E-04	1,87E-01	8,20E-03	5,75E-03	1,91E-02	2,20E-01
GWP-biogenic	kg CO_2 eq.	2,05E-04	3,20E-06	9,83E-08	2,08E-04	1,12E-05	2,11E-06	1,85E-05	2,40E-04
GWP-luluc	kg CO_2 eq.	6,80E-05	5,20E-06	2,77E-08	7,32E-05	2,99E-05	3,36E-06	5,21E-06	1,12E-04
GWP-total	kg CO_2 eq.	1,77E-01	9,51E-03	1,48E-04	1,87E-01	8,24E-03	5,75E-03	1,91E-02	2,20E-01
EP-freshwater	kg P eq.	3,59E-05	7,50E-07	2,85E-08	3,67E-05	1,73E-06	4,86E-07	5,48E-06	4,44E-05
EP-terrestrial	mol N eq.	1,41E-03	9,19E-05	1,06E-06	1,50E-03	6,66E-05	2,87E-05	1,82E-04	1,78E-03
POCP	kg NMVOC eq.	5,77E-04	4,08E-05	3,64E-07	6,18E-04	2,71E-05	1,80E-05	6,25E-05	7,25E-04
ADP-minerals& metals	kg Sb eq.	1,31E-06	3,82E-08	1,18E-09	1,35E-06	7,27E-08	2,57E-08	2,28E-07	1,68E-06
ADP-fossil	MJ	5,10E+00	1,35E-01	2,71E-03	5,23E+00	1,80E-01	8,14E-02	5,20E-01	6,02E+00
WDP	m^3	6,42E-02	7,27E-04	2,86E-05	6,50E-02	2,55E-03	4,63E-04	5,21E-03	7,32E-02
PM	Disease incidence	5,83E-09	6,13E-10	6,27E-12	6,45E-09	2,76E-10	3,05E-10	4,04E-10	7,43E-09
SQP	dimensionless	4,40E-01	6,54E-02	6,76E-04	5,06E-01	5,69E-02	3,36E-02	1,25E-01	7,22E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

6.2.2. RevoBox products

Potential environmental impact of the 500 ml RevoBox

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	2,96E-01	1,53E-02	1,66E-04	3,12E-01	9,89E-03	9,19E-03	3,05E-02	3,62E-01
GWP-biogenic	kg CO_2 eq.	3,45E-04	5,15E-06	1,61E-07	3,50E-04	1,18E-05	3,37E-06	2,96E-05	3,95E-04
GWP-luluc	kg CO_2 eq.	8,14E-05	8,37E-06	4,53E-08	8,99E-05	3,09E-05	5,38E-06	8,33E-06	1,34E-04
GWP-total	kg CO_2 eq.	2,97E-01	1,53E-02	1,66E-04	3,12E-01	9,93E-03	9,20E-03	3,05E-02	3,62E-01
EP-freshwater	kg P eq.	5,87E-05	1,21E-06	4,77E-08	5,99E-05	1,87E-06	7,78E-07	8,77E-06	7,13E-05
EP-terrestrial	mol N eq.	2,36E-03	1,49E-04	1,58E-06	2,51E-03	7,50E-05	4,60E-05	2,91E-04	2,92E-03
POCP	kg NMVOC eq.	9,70E-04	6,60E-05	5,44E-07	1,04E-03	3,24E-05	2,89E-05	1,00E-04	1,20E-03
ADP-minerals& metals	kg Sb eq.	2,36E-06	6,14E-08	1,98E-09	2,42E-06	8,03E-08	4,12E-08	3,64E-07	2,91E-06
ADP-fossil	MJ	9,74E+00	2,18E-01	4,53E-03	9,96E+00	2,04E-01	1,30E-01	8,32E-01	1,11E+01
WDP	m^3	9,94E-02	1,17E-03	4,54E-05	1,01E-01	2,68E-03	7,41E-04	8,34E-03	1,12E-01
PM	Disease incidence	8,91E-09	9,90E-10	3,54E-12	9,90E-09	3,65E-10	4,88E-10	6,47E-10	1,14E-08
SQP	dimensionless	1,06E+00	1,06E-01	1,09E-03	1,16E+00	6,67E-02	5,37E-02	2,00E-01	1,48E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

Potential environmental impact of the 1000 ml RevoBox

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	4,87E-01	2,75E-02	3,21E-04	5,14E-01	1,40E-02	1,78E-02	3,73E-02	5,84E-01
GWP-biogenic	kg CO_2 eq.	5,82E-04	9,33E-06	3,12E-07	5,91E-04	1,34E-05	6,52E-06	3,32E-05	6,44E-04
GWP-luluc	kg CO_2 eq.	1,34E-04	1,51E-05	8,75E-08	1,49E-04	3,33E-05	1,04E-05	9,52E-06	2,02E-04
GWP-total	kg CO_2 eq.	4,87E-01	2,75E-02	3,21E-04	5,15E-01	1,41E-02	1,78E-02	3,73E-02	5,84E-01
EP-freshwater	kg P eq.	8,86E-05	2,19E-06	9,22E-08	9,09E-05	2,22E-06	1,50E-06	9,76E-06	1,04E-04
EP-terrestrial	mol N eq.	3,73E-03	2,52E-04	3,06E-06	3,99E-03	9,56E-05	8,88E-05	3,32E-04	4,50E-03
POCP	kg NMVOC eq.	1,59E-03	1,15E-04	1,05E-06	1,71E-03	4,53E-05	5,57E-05	1,17E-04	1,92E-03
ADP-minerals& metals	kg Sb eq.	3,53E-06	1,12E-07	3,83E-09	3,65E-06	9,87E-08	7,95E-08	4,04E-07	4,23E-06
ADP-fossil	MJ	1,65E+01	3,91E-01	8,75E-03	1,69E+01	2,62E-01	2,52E-01	9,75E-01	1,83E+01
WDP	m^3	1,69E-01	2,11E-03	8,76E-05	1,71E-01	3,01E-03	1,43E-03	9,35E-03	1,85E-01
PM	Disease incidence	2,17E-01	1,05E-02	1,37E-04	2,27E-01	5,84E-10	7,60E-03	3,59E-03	2,39E-01
SQP	dimensionless	1,48E+00	1,86E-01	2,10E-03	1,67E+00	9,08E-02	1,04E-01	2,22E-01	2,08E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

6.2.3. Cupler products

Potential environmental impact of the 250 ml gray Cupler product

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	9,42E-02	4,78E-03	1,22E-04	9,91E-02	7,41E-03	4,22E-03	1,36E-02	1,24E-01
GWP-biogenic	kg CO_2 eq.	1,20E-04	1,75E-06	4,65E-04	5,86E-04	1,09E-05	1,55E-06	1,32E-05	6,12E-04
GWP-luluc	kg CO_2 eq.	2,76E-05	2,80E-06	8,32E-09	3,04E-05	2,94E-05	2,47E-06	3,70E-06	6,60E-05
GWP-total	kg CO_2 eq.	9,43E-02	4,79E-03	5,87E-04	9,97E-02	7,45E-03	4,23E-03	1,36E-02	1,25E-01
EP-freshwater	kg P eq.	1,54E-05	4,05E-07	3,61E-08	1,59E-05	1,66E-06	3,57E-07	3,90E-06	2,18E-05
EP-terrestrial	mol N eq.	6,88E-04	2,39E-05	7,67E-07	7,13E-04	6,26E-05	2,11E-05	1,29E-04	9,26E-04
POCP	kg NMVOC eq.	3,24E-04	1,50E-05	4,36E-07	3,40E-04	2,46E-05	1,33E-05	4,45E-05	4,22E-04
ADP-minerals& metals	kg Sb eq.	6,18E-07	2,14E-08	4,38E-11	6,39E-07	6,92E-08	1,89E-08	1,62E-07	8,89E-07
ADP-fossil	MJ	3,31E+00	6,77E-02	2,11E-04	3,38E+00	1,68E-01	5,99E-02	3,70E-01	3,98E+00
WDP	m^3	3,49E-02	3,85E-04	1,17E-05	3,53E-02	2,48E-03	3,40E-04	3,71E-03	4,18E-02
PM	Disease incidence	3,21E-09	2,54E-10	1,51E-11	3,48E-09	2,34E-10	2,24E-10	2,88E-10	4,22E-09
SQP	dimensionless	2,16E-01	2,79E-02	2,88E-04	2,44E-01	5,23E-02	2,47E-02	8,91E-02	4,10E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

Potential environmental impact of the 400 ml translucent Cupler product

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	1,22E-01	6,57E-03	1,63E-04	1,28E-01	8,08E-03	5,67E-03	1,82E-02	1,60E-01
GWP-biogenic	kg CO_2 eq.	1,55E-04	2,41E-06	6,24E-04	7,82E-04	1,12E-05	2,08E-06	1,77E-05	8,13E-04
GWP-luluc	kg CO_2 eq.	3,54E-05	3,84E-06	1,12E-08	3,93E-05	2,98E-05	3,32E-06	4,97E-06	7,74E-05
GWP-total	kg CO_2 eq.	1,22E-01	6,57E-03	7,88E-04	1,29E-01	8,12E-03	5,68E-03	1,82E-02	1,61E-01
EP-freshwater	kg P eq.	1,90E-05	5,56E-07	4,85E-08	1,96E-05	1,72E-06	4,80E-07	5,24E-06	2,70E-05
EP-terrestrial	mol N eq.	8,75E-04	3,28E-05	1,03E-06	9,09E-04	6,60E-05	2,84E-05	1,74E-04	1,18E-03
POCP	kg NMVOC eq.	4,39E-04	2,06E-05	5,85E-07	4,61E-04	2,67E-05	1,78E-05	5,97E-05	5,65E-04
ADP-minerals& metals	kg Sb eq.	7,62E-07	2,94E-08	5,88E-11	7,91E-07	7,22E-08	2,54E-08	2,17E-07	1,11E-06
ADP-fossil	MJ	4,34E+00	9,31E-02	2,83E-04	4,44E+00	1,78E-01	8,04E-02	4,97E-01	5,19E+00
WDP	m^3	4,49E-02	5,29E-04	1,57E-05	4,54E-02	2,54E-03	4,57E-04	4,98E-03	5,34E-02
PM	Disease incidence	4,24E-09	3,49E-10	2,03E-11	4,60E-09	2,69E-10	3,01E-10	3,86E-10	5,56E-09
SQP	dimensionless	2,54E-01	3,84E-02	3,87E-04	2,93E-01	5,62E-02	3,31E-02	1,20E-01	1,50E+00
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

Potential environmental impact of the 400 ml gray Cupler product

Results per functional or declared unit									
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**Use (B)**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	1,21E-01	6,42E-03	1,63E-04	1,27E-01	8,08E-03	5,67E-03	1,82E-02	1,59E-01
GWP-biogenic	kg CO_2 eq.	1,55E-04	2,36E-06	6,24E-04	7,82E-04	1,12E-05	2,08E-06	1,77E-05	8,13E-04
GWP-luluc	kg CO_2 eq.	3,55E-05	3,76E-06	1,12E-08	3,92E-05	2,98E-05	3,32E-06	4,97E-06	7,74E-05
GWP-total	kg CO_2 eq.	1,21E-01	6,43E-03	7,88E-04	1,28E-01	8,12E-03	5,68E-03	1,82E-02	1,60E-01
EP-freshwater	kg P eq.	1,90E-05	5,43E-07	4,85E-08	1,96E-05	1,72E-06	4,80E-07	5,24E-06	2,71E-05
EP-terrestrial	mol N eq.	8,69E-04	3,21E-05	1,03E-06	9,03E-04	6,60E-05	2,84E-05	1,74E-04	1,17E-03
POCP	kg NMVOC eq.	4,24E-04	2,02E-05	5,85E-07	4,45E-04	2,67E-05	1,78E-05	5,97E-05	5,49E-04
ADP-minerals& metals	kg Sb eq.	7,54E-07	2,88E-08	5,88E-11	7,83E-07	7,22E-08	2,54E-08	2,17E-07	1,10E-06
ADP-fossil	MJ	4,30E+00	9,10E-02	2,83E-04	4,39E+00	1,78E-01	8,04E-02	4,97E-01	5,15E+00
WDP	m^3	4,52E-02	5,17E-04	1,57E-05	4,57E-02	2,54E-03	4,57E-04	4,98E-03	5,37E-02
PM	Disease incidence	4,19E-09	3,41E-10	2,03E-11	4,55E-09	2,69E-10	3,01E-10	3,86E-10	5,51E-09
SQP	dimensionless	2,52E-01	3,75E-02	3,87E-04	2,90E-01	5,62E-02	3,31E-02	1,20E-01	4,98E-01
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality								

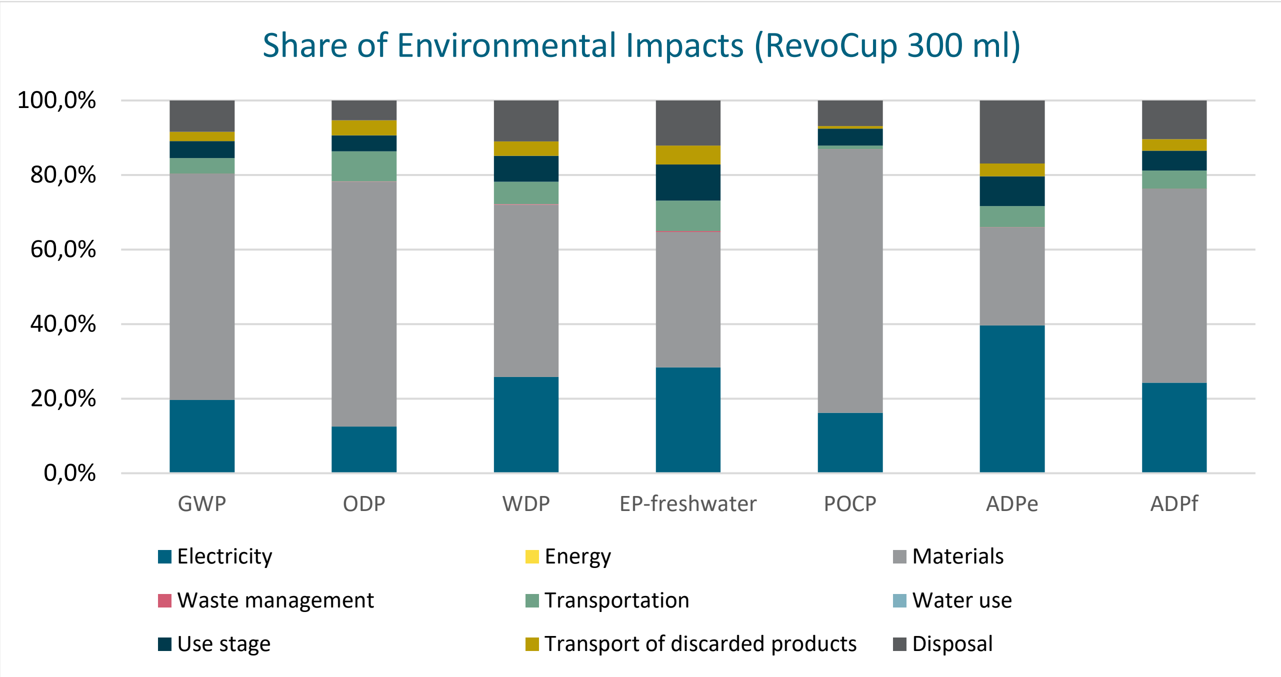
6.2.4. Cup Revolution token product

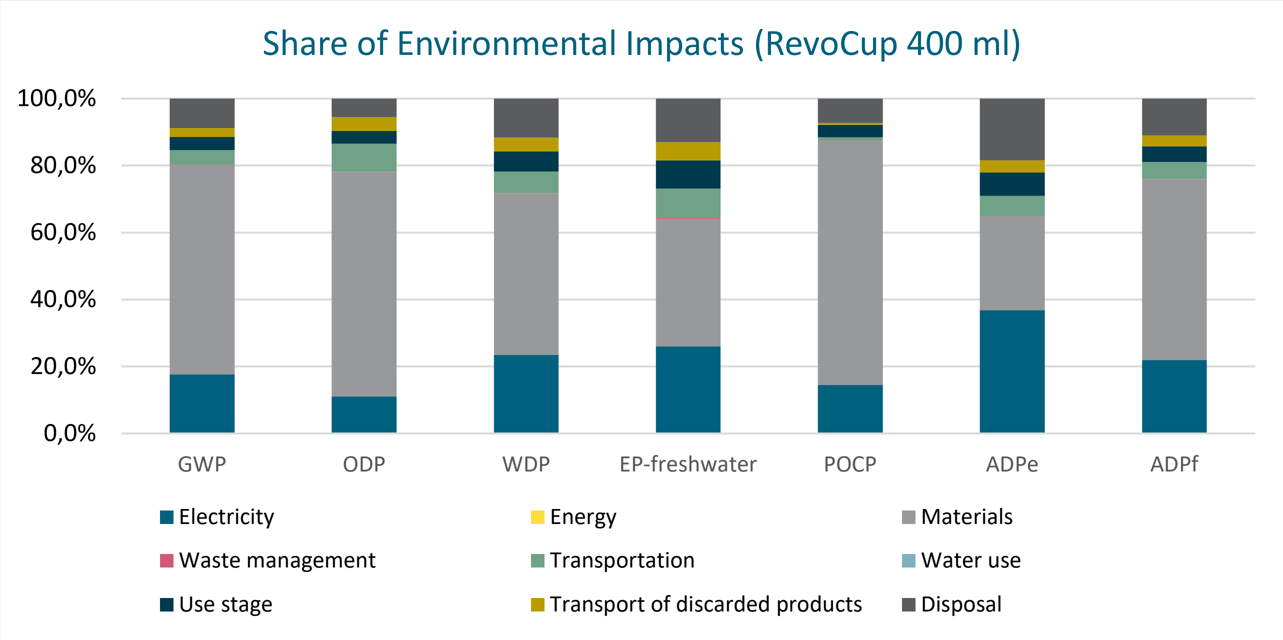
Potential environmental impact of the Cup Revolution token product

Results per functional or declared unit								
Indicator	**Unit**	**Raw material (A1)**	**Transport (A2)**	**Production (A3)**	**Total A1-A3**	**End-of-life transport (C2)**	**End-of-life disposal (C4)**	**Total A1-C**
GWP-fossil	kg CO_2 eq.	6,97E-03	4,00E-05	1,45E-06	7,02E-03	2,41E-04	7,75E-04	8,03E-03
GWP-biogenic	kg CO_2 eq.	7,39E-06	1,47E-08	1,49E-09	7,41E-06	8,86E-08	7,53E-07	8,25E-06
GWP-luluc	kg CO_2 eq.	2,32E-06	2,34E-08	4,50E-10	2,34E-06	1,41E-07	2,12E-07	2,69E-06
GWP-total	kg CO_2 eq.	6,98E-03	4,00E-05	1,46E-06	7,03E-03	2,42E-04	7,76E-04	8,04E-03
EP-freshwater	kg P eq.	2,03E-06	3,39E-09	4,29E-10	2,03E-06	2,04E-08	2,23E-07	2,27E-06
EP-terrestrial	mol N eq.	6,59E-05	2,00E-07	1,39E-08	6,61E-05	1,21E-06	7,39E-06	7,47E-05
POCP	kg NMVOC eq.	2,42E-05	1,26E-07	4,80E-09	2,43E-05	7,58E-07	2,54E-06	2,76E-05
ADP-minerals& metals	kg Sb eq.	8,81E-08	1,79E-10	1,90E-11	8,83E-08	1,08E-09	9,25E-09	9,86E-08
ADP-fossil	MJ	1,89E-01	5,67E-04	3,92E-05	1,89E-01	3,42E-03	2,11E-02	2,14E-01
WDP	m^3	2,11E-03	3,22E-06	4,26E-07	2,11E-03	1,94E-05	2,12E-04	2,34E-03
PM	Disease incidence	1,60E-10	2,13E-12	3,24E-14	1,62E-10	1,28E-11	1,64E-11	1,91E-10
SQP	dimensionless	4,39E-02	2,34E-04	9,46E-06	4,41E-02	1,41E-03	5,09E-03	5,06E-02
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption; PM = Particulate Matter emissions; SQP = Land use related impacts/Soil quality							

7. Interpretation

Relative contributions from the assessed RevoCup's life cycle stages are presented below on. For the RevoCup products, regardless of their capacity, the largest share of emissions on all indicators is observed during the stage of the production of raw materials/ingredients, with the exception of abiotic depletion potential for non-fossil resources. Electricity usage is also relevant, since it is responsible for the second largest share of emissions during the life cycle, with the exception of abiotic depletion potential for non-fossil resources, where it is the largest. Disposal is also relevant as it contributes more than 10% of impacts in several categories. The other life cycle stages have minimal (less than 10%) of the total impact on each indicator.





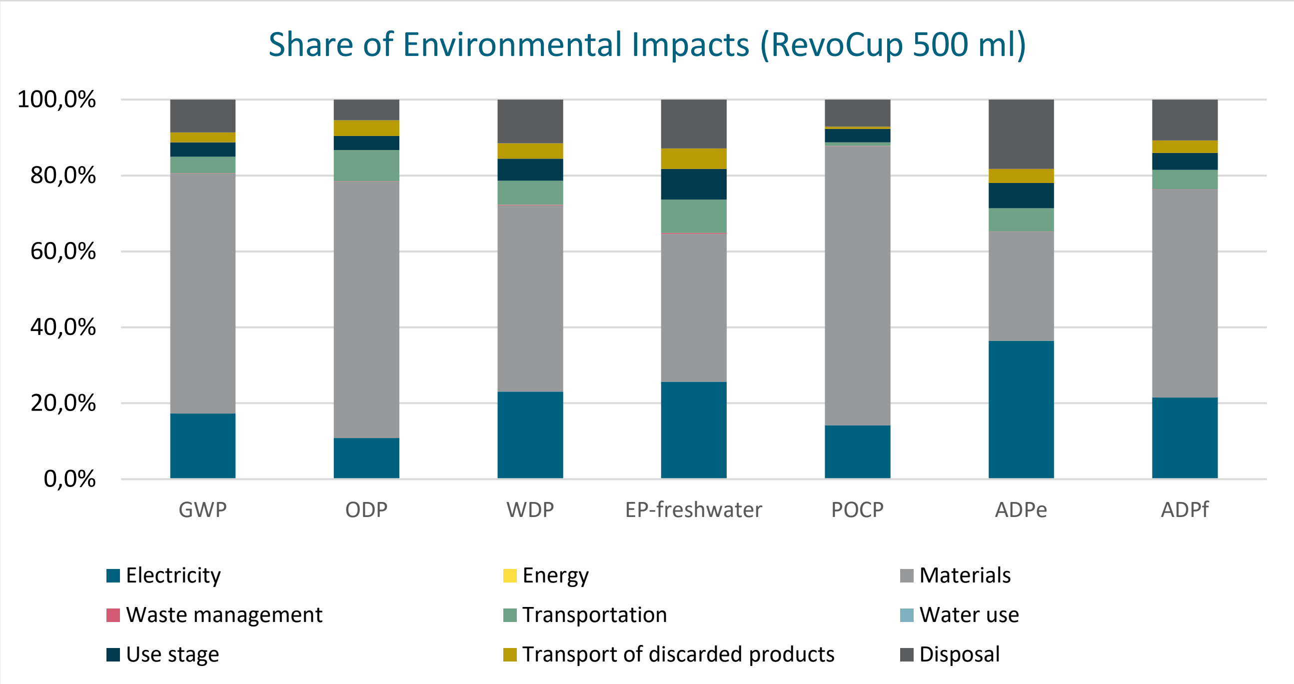
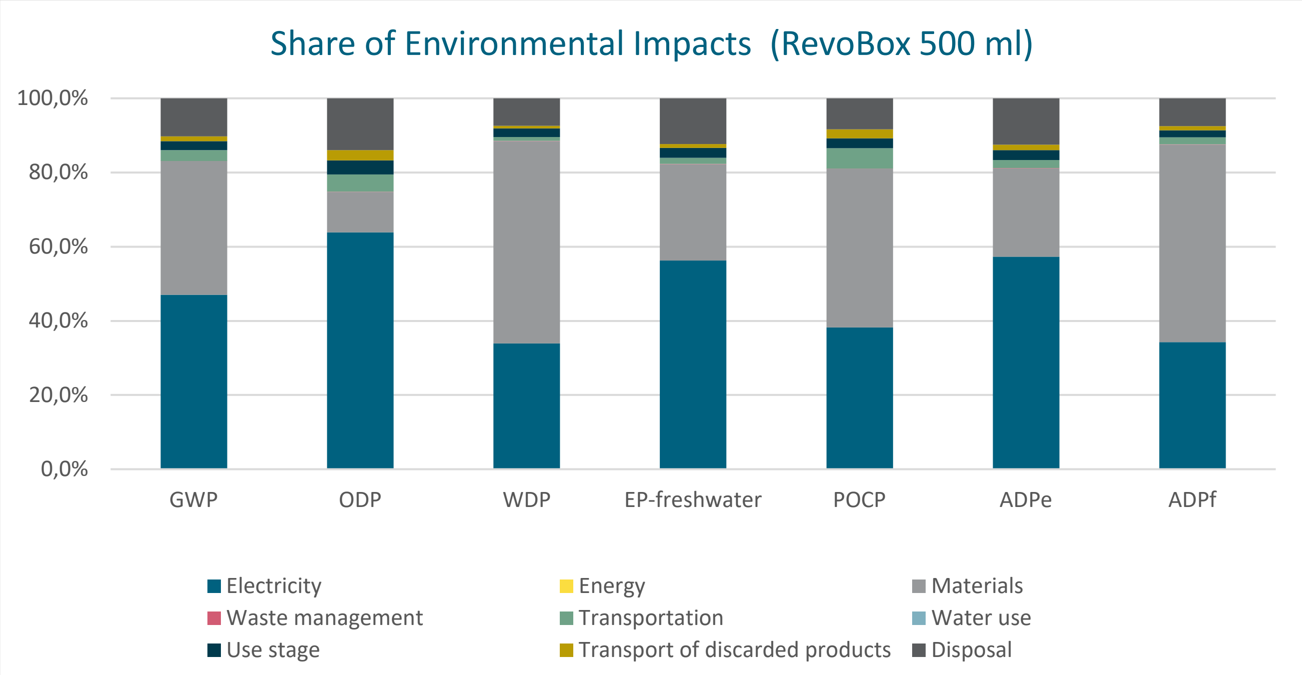


Table 32 Share of Environmental Impacts - RevoCup products

Relative contributions from the assessed RevoBox products' life cycle stages are presented below on. For the RevoBox products, regardless of their capacity, the largest share of emissions on all indicators is observed during the stage of the production of raw materials/ingredients and the production of used electricity. The two stages contribute more than 70% of the emissions and impacts on each indicator. Disposal is also relevant as on some indicators it contributes just below or over 10% of the impacts.



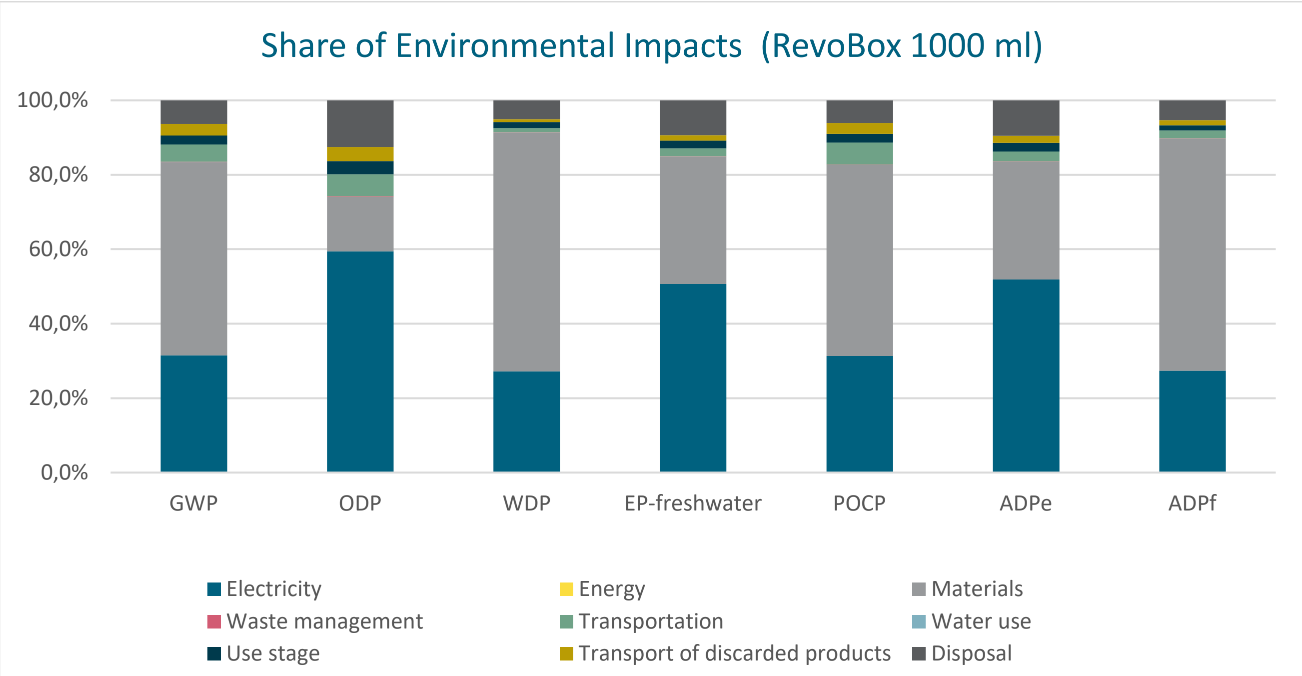
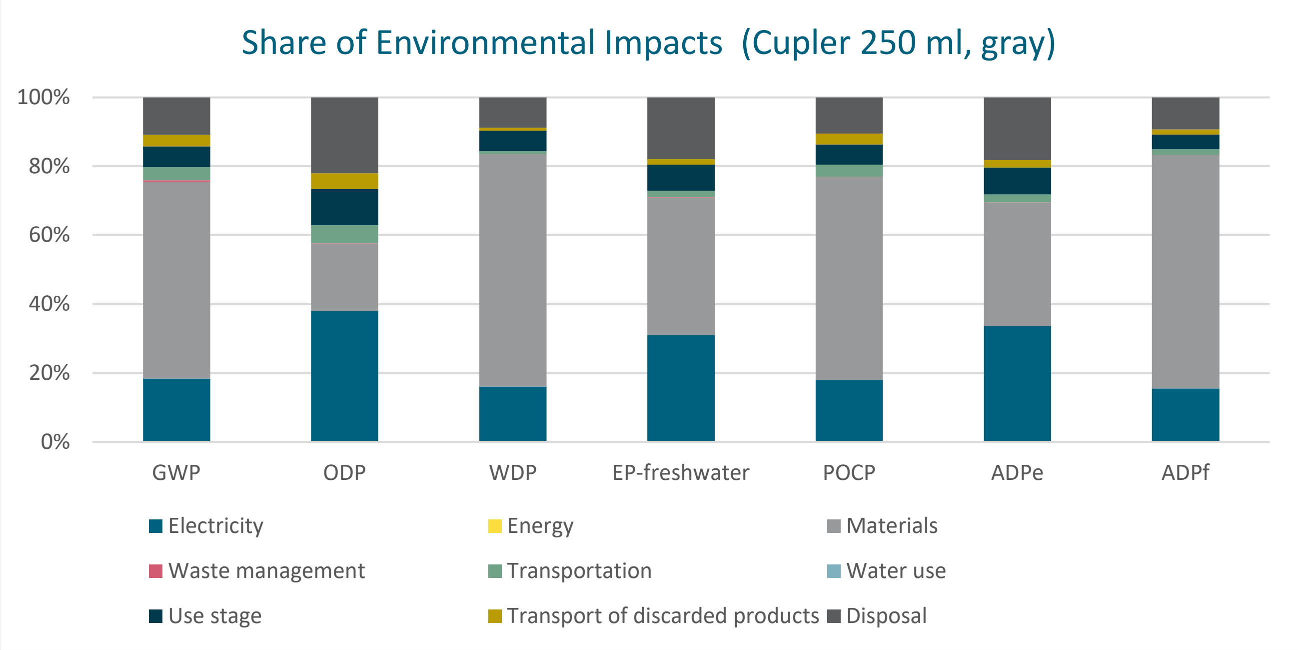
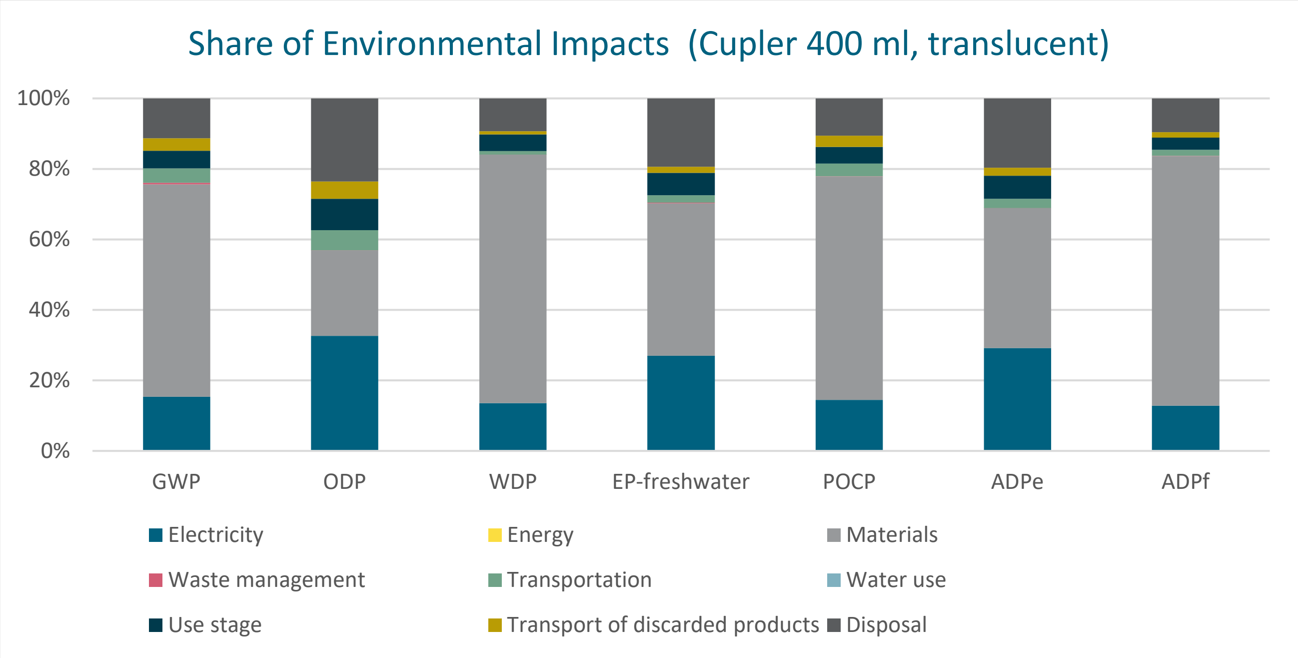


Table 33 Share of Environmental Impacts - RevoBox products

Relative contributions from the assessed Cupler products' life cycle stages are presented below on. For the Cupler products, regardless of their capacity, the largest share of emissions on all but one indicator is observed during the stage of the production of raw materials/ingredients. In the case of ozone depletion potential, the production of the electricity used during the manufacturing process is the biggest contributor. Disposal is also relevant as on most of the indicators it contributes just over 10% of the impacts in the case of all three products.


Share of Environmental Impacts (Cupler 250 ml, gray)
100%
80%
60%
40%
20%
0%
GWP
ODP
WDP
EP-freshwater
POCP
ADPe
ADPf
Electricity
Energy
Materials
Waste management
Transportation
Water use
Use stage
Transport of discarded products
Disposal


Share of Environmental Impacts (Cupler 400 ml, translucent)
100%
80%
60%
40%
20%
0%
GWP
ODP
WDP
EP-freshwater
POCP
ADPe
ADPf
Electricity
Energy
Materials
Waste management
Transportation
Water use
Use stage
Transport of discarded products
Disposal

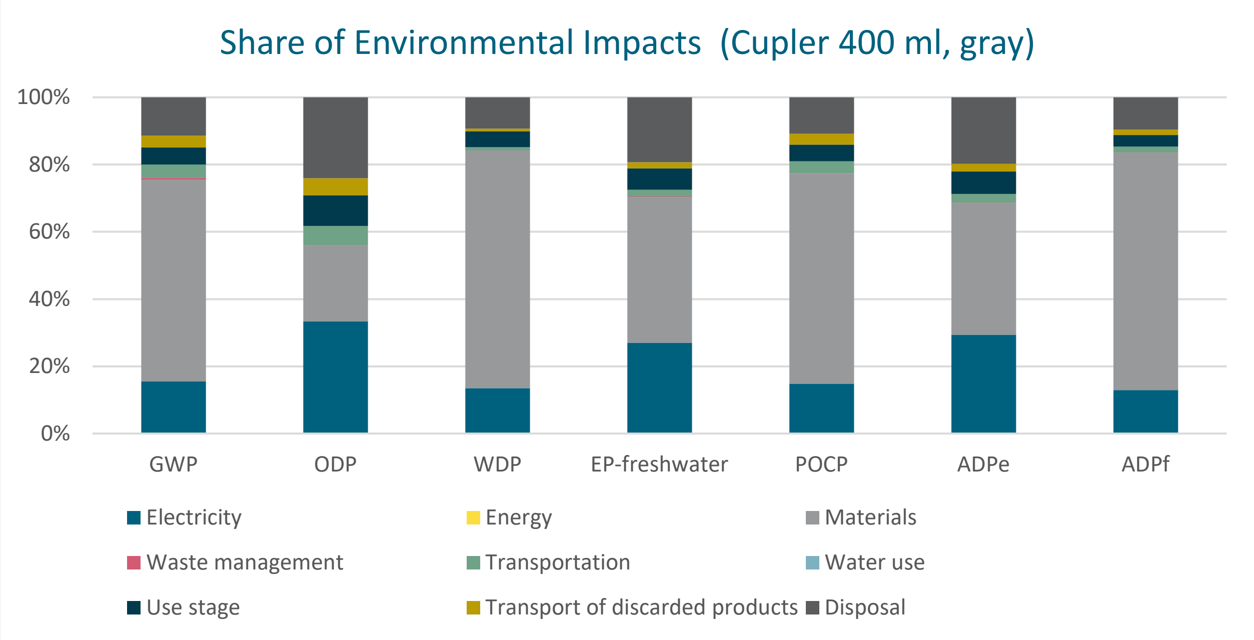


Table 34 Share of Environmental Impacts - Cupler products

The tables in chapter 3.7. Data Quality and Completeness demonstrate that the data quality ranges from 'very poor' to 'very good' in terms of geographical, temporal, and technological representativeness. Annual energy, support and storage processes, and water consumption are precise, as well as the distance of transport of inputs and outputs. The amount of input is considered either 'very good' or 'fair' in terms of data reliability, because some of the information was based on expected average consumption level per process and expert judgement. Nevertheless, the mass balance of inputs and outputs made these assumptions more reliable, thus the data for the amount of inputs are deemed reliable at the end. Representative characterization factors were ordered to the inputs. Overall, the LCA results are deemed to be strongly plausible.

8. Benchmark values

Since the goal of the study is to find out how many uses the reusable cups, food containers, and coffee cups operated by Cup Revolution require to reach the breakeven point with the disposable options, if the reusable products break even at all, benchmark values for disposable products have been researched.

When searching for benchmarks of disposable products, it was important to keep in mind the functional units of the reusable products by Cup Revolution. ISO 14040 states that "the functional unit defines the quantification of the identified functions (performance characteristics) of the product. The primary purpose of a functional unit is to provide a reference to which the inputs and outputs are related. This reference is necessary to ensure comparability of LCA results. Comparability of LCA results is particularly critical when different systems are being assessed, to ensure that such comparisons are made on a common basis."

Besides the identical functional units between the products under study, it is crucial that the life cycle stages and the scope of the products to be compared must also be identical. As a reminder, the life cycle stage and the scope of the Cup Revolution products are cradle-to-grave, thus it is desirable that the publicly available life cycle assessments of the disposable products have the same life cycle stages and scope.

8.1. Disposable and reusable glass beverage cup benchmark values

In the function of drinking a beverage from a cup, the disposable cups and the reusable glass cups need to be studied besides the reusable RevoCups. The selected functional unit is expressed in terms of the identical amount of beverage to be drunk for both systems. Due to technical feature, it is not possible to determine the reference flow, e.g., the average mass of plastic/paper/etc. required for being able to drink the identical amount of beverage for each system, because the present report only studies the reference flows and inventory of inputs and outputs of the reusable RevoCups. Thus, since extensive information has only been acquired for the reusable cup system operated by Cup Revolution in order to conduct the life cycle assessment, publicly available life cycle assessments for disposable cups were researched to be able to compare the systems. The publicly available life cycle assessments for disposable cups and reusable glass cups are displayed in the below table.

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one cup	Source
Glass	N/A	Cradle-to-gate	0,480	https://www.academia.edu/44464441/Assessment_of_the_environmental_break_even_point_for_deposit_return_systems_through_an_LCA_analysis_of_single_use_and_reusable_cups
Glass	355	Cradle-to-gate	0,92	https://css.umich.edu/sites/default/files/css_doc/CSS09-11.pdf
Polylactic acid (PLA)	400	Cradle-to-grave	0,0342	https://www.sciencedirect.com/science/article/pii/S2212827122000038
PLA	473,18	Cradle-to-grave	0,0509784	www.athenasmi.org/wp-content/uploads/2

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one cup	Source
				012/01/Plastic_Products_LCA_Technical_Rpt.pdf
High-impact polystyrene (HIPS)	473,18	Cradle-to-grave	0,0576218	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Polypropylene (PP)	473,18	Cradle-to-grave	0,0345187	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Polyethylene terephthalate (PET)	473,18	Cradle-to-grave	0,0718847	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Paper cup with polyethylene (PE) coating	340	Cradle-to-grave	0,02985	https://sci-hub.se/10.1016/j.jclepro.2020.120294

Table 35 Benchmark values of LCAs for disposable beverage cups

As mentioned above, it is deemed important to have identical functional units between the various products under the scope of the study for a valid and legitimate comparison. None of the RevoCups' volumes (3 dl, 4 dl, and 5 dl) match exactly the volume of the disposable and glass cups for which publicly available life cycle assessments were found. On the other hand, each publicly available life cycle assessment for disposable cups covers the same life cycle stages and scope. The publicly available life-cycle assessments for glass cups do not cover the same life-cycle stages, as the results are understood from cradle-to-gate, and the volume is not known in one case. In order to fulfill the goal of the study and to get a sense about the comparative environmental performances of the various products, the publicly available life cycle assessments for the disposable cups and glass cups are compared with the life cycle assessments of the RevoCups. For the comparison of the products, the global warming potential (kg CO_2-eq.) was chosen.

8.2. Disposable food container benchmark values

In the function of eating from a food container, the disposable food container needs to be studied besides the reusable RevoBoxes. The selected functional unit is expressed in terms of the identical amount of food to be eaten for both systems. Due to technical feature, it is not possible to determine the reference flow, e.g., the average mass of plastic/paper/etc. required for being able to eat the identical amount of food for both systems, because the present report studies the reference flows and inventory of inputs and outputs of the reusable RevoBoxes. Thus, since extensive information has only been acquired for the reusable box system operated by Cup Revolution in order to conduct the life cycle assessment, publicly available life cycle assessments for disposable food containers were researched to be able to compare the two systems. The publicly available life cycle assessments for disposable food containers are displayed in the below table.

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one food container	Source
Polystyrene (PS)	N/A	Cradle-to-gate	0,0299241	https://ec.europa.eu/environment/enveco/circular_economy/pdf/studies/DG ENV Single Use Plastics LCA 181213.pdf
Paperboard with wax coating	N/A	Cradle-to-gate	0,0418229	https://ec.europa.eu/environment/enveco/circular_economy/pdf/studies/DG ENV Single Use Plastics LCA 181213.pdf
Polylactic acid (PLA)	473,18	Cradle-to-grave	0,0589243	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
General-purpose polystyrene (GPPS)	473,18	Cradle-to-grave	0,0683718	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Polyethylene terephthalate (PET)	473,18	Cradle-to-grave	0,1170169	www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf

Table 36 Benchmark values of LCAs for disposable food containers

As mentioned above, it is deemed important to have identical functional units between the various products under the scope of the study for a valid and legitimate comparison. None of the RevoBox's volumes (500 ml and 1 000 ml) match exactly the volume of the disposable food containers for which publicly available life cycle assessments were found. In addition, two of the publicly available life cycle assessments for disposable food containers do not disclose the volume of those products. Besides, the scope and the assessed life cycle stages of these life cycle assessments are cradle-to-gate, while scope and assessed life cycle stages of the others are cradle-to-grave. In order to fulfill the goal of the study and to get a sense about the comparative environmental performances of the various products, the publicly available life cycle assessments for the disposable food containers are compared with the life cycle assessments of the RevoBoxes. For the comparison of the products, the global warming potential (kg CO_2-eq.) was chosen.

8.3. Disposable coffee cup benchmark values

In the function of drinking a beverage from a coffee cup, the disposable coffee cup needs to be studied besides the reusable Cupler products. The selected functional unit is expressed in terms of the identical amount of beverage to be drunk for both systems. Due to technical feature, it is not possible to determine the reference flow, e.g., the average mass of plastic/paper/etc. required for being able to drink the identical amount of beverage for both systems, because the present report only studies the reference flows and inventory of inputs and outputs of the reusable Cupler products. Thus, since extensive information has only been acquired for the reusable cup system operated by Cup Revolution in order to conduct the life cycle assessment, publicly available life cycle assessments for disposable coffee cups were researched to be able to compare the two systems. The publicly available life cycle assessments for disposable coffee cups are displayed in the below table.

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one coffee cup	Source
Paper cup with polyethylene (PE) coating and low-density polyethylene (LDPE) lid	N/A	Cradle-to-gate	0,048253	https://ec.europa.eu/environment/enveco/circular_economy/pdf/studies/DG ENV Single Use Plastics LCA 181213.pdf
Paper cup with PE coating and polystyrene (PS) lid	300 ml	Cradle-to-grave	0,052933333	https://www.openlca.org/wp-content/uploads/2018/09/comparative_assessment_ope

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one coffee cup	Source
				nLCA_coffee_mugs.pdf
Paper cup with PE coating	N/A	Cradle-to-grave	0,0103	https://www.huhtamaki.com/globalassets/global/highlights/responsibility/taking-a-closer-look-at-paper-cups-for-coffee.pdf
Paper cup with plant PE coating	N/A	Cradle-to-grave	0,0102	https://www.huhtamaki.com/globalassets/global/highlights/responsibility/taking-a-closer-look-at-paper-cups-for-coffee.pdf
Compostable paper cup	N/A	Cradle-to-grave	0,0132	https://www.huhtamaki.com/globalassets/global/highlights/responsibility/taking-a-closer-look-at-paper-cups-for-coffee.pdf
Polylactic acid (PLA)	473,18	Cradle-to-grave	0,0509784	http://www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
High-impact polystyrene (HIPS)	473,18	Cradle-to-grave	0,0576218	http://www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Polypropylene (PP)	473,18	Cradle-to-grave	0,0345187	http://www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one coffee cup	Source
Polyethylene terephthalate (PET)	473,18	Cradle-to-grave	0,0718847	http://www.athenasmi.org/wp-content/uploads/2012/01/Plastic_Products_LCA_Technical_Rpt.pdf
Paper cup with PE coating	340	Cradle-to-grave	0,02985	https://sci-hub.se/10.1016/j.jclepro.2020.120294
PLA with PLA lid	340	Cradle-to-grave (recycled at the end of the life cycle)	0,0604924	https://drive.google.com/file/d/1C5Qzx31HQnVPg-EyglzR3PRDteQH5SfK/view
PLA with PLA lid	340	Cradle-to-grave (composted at the end of the life cycle)	0,060689	https://drive.google.com/file/d/1C5Qzx31HQnVPg-EyglzR3PRDteQH5SfK/view
Extended polystyrene (EPS) cup with EPS lid	340	Cradle-to-grave (50% landfilled, 50% incinerated at the end of the life cycle)	0,044765	https://drive.google.com/file/d/1C5Qzx31HQnVPg-EyglzR3PRDteQH5SfK/view
PET coffee cup with PET lid	473,18	Cradle-to-grave	0,093	https://www.natureworksllc.com/~/media/Files/NatureWorks/What-is-Ingeo/Why-it-Matters/LCA/PEA_Cup_Lid_LCA_FullReport_ReviewStatement_121209_pdf.pdf
Ingeo cup with Ingeo lid	473,18	Cradle-to-grave	0,037	https://www.natureworksllc.com/~/media/Files/NatureWorks/What-is-Ingeo/Why-it-Matters/LCA/PEA_Cup_Lid_LCA_FullReport_ReviewState

Material	Volume (ml)	Scope	Environmental performance – global warming potential (kg CO_2-eq.) / one coffee cup	Source
				ment_121209_pdf.pdf
PP cup with PP lid	473,18	Cradle-to-grave	0,053	https://www.natureworksllc.com/~/media/Files/NatureWorks/What-is-Ingeo/Why-it-Matters/LCA/PEA_Cup_Lid_LCA_FullReport_ReviewStatement_121209_pdf.pdf

Table 37 Benchmark values of LCAs for disposable coffee cups

As mentioned above, it is deemed important to have identical functional units between the various products under the scope of the study for a valid and legitimate comparison. None of the Cupler products' volume (240 ml and 400 ml) match exactly the volume of the disposable coffee cups for which publicly available life cycle assessments were found. In addition, four of the publicly available life cycle assessments for disposable coffee cups do not disclose the volume of those products. Besides, the scope and the assessed life cycle stages of one of these life cycle assessments is cradle-to-gate, while scope and assessed life cycle stages of the others are cradle-to-grave. In order to fulfill the goal of the study and to get a sense about the comparative environmental performances of the various products, the publicly available life cycle assessments for the disposable coffee cups are compared with the life cycle assessments of the Cupler products. For the comparison of the products, the global warming potential (kg CO_2-eq.) was chosen.

9. Comparison of reusable and disposable products

The main objective of the present LCA study is to compare the environmental performance of reusable products with disposable products. Prior to the study, it has been anticipated that the production of a Cup Revolution product has a higher environmental impact than the production of disposable options. On the other hand, the Cup Revolution products are washed and reused many times, whereas the disposable products cannot be reused after one use, thus new ones must be produced for each use. Thereby, if the environmental performance of the Cup Revolution products during the use phase (at its simplest level, collection of dirty products, washing process, and distribution of clean products) are lower than the production of new disposable products, then the reusable products would eventually have better environmental performances. For the comparison of the products and to measure their environmental performances, the global warming potential (kg CO_2-eq.) was chosen.

In order to compare reusable and disposable products, the concept of *'breakeven point'* is used. The breakeven point is the point at which a system starts to perform better than the system it is compared with, while a common variable is modified. In the present LCA study, the common variable is the number of uses after which the reusable products are collected, washed, and distributed, while a new production is performed each time disposable products are used. In other words, the variable in this study is the number of times the Cup Revolution products are reused – while considering the environmental impacts during their use phase (at its simplest level, collection of dirty products, washing process, and distribution of clean products) to offset the environmental impacts of disposable options. In the case of the RevoCup and Cupler products, the environmental impacts of one Cup Revolution token are also considered as it is needed for the proper use of the product/service.

9.1. The comparison of disposable beverage cups and glass cups with the RevoCup products

Since the production of each RevoCup product comes with the emission of 0,139 kg CO_2-eq. (3 dl RevoCup), 0,176 kg CO_2-eq. (4 dl RevoCup), and 0,187 kg CO_2-eq. (5 dl RevoCup), while according to publicly available life cycle assessments, the production of each glass cup comes with the emission of 0,48 kg CO_2-eq. and 0,92 kg of CO_2-eq., RevoCup products provide a better environmental performance compared to the compared glass cups even before the first use and perform even better after several uses in terms of CO_2-eq. emission.

The breakeven point of the 500 ml RevoCup against the 473,18 ml PP cup, which has a similar functional unit and has the lowest GWP impact amongst the benchmark products with a similar functional unit to the 500 ml RevoCup, the 500 ml RevoCup has smaller GWP impact after the 8th use. The breakeven point between the 500 ml RevoCup and the other disposable products with similar functional units is much earlier; the 500 ml RevoCup usually starts to have a better environmental performance in terms of GWP after five uses.

The breakeven point of the 400 ml RevoCup against the 400 ml PLA cup is after the 7th use. When compared to the 473,18 ml PP cup, which has a similar functional unit and has the lowest GWP impact amongst the other benchmark products with a similar functional unit to the 400 ml RevoCup, the 400 ml RevoCup has smaller GWP impact after the 7th use. The breakeven point between the 400 ml RevoCup and the remaining disposable products is much earlier; the 400 ml RevoCup usually starts to have a better environmental performance in terms of GWP after four uses.

The breakeven point of the 300 ml RevoCup against the 340 ml paper cup with PE lining is after the 7th use. The breakeven point between the 300 ml RevoCup and the other disposable products is much earlier; the 300 ml RevoCup usually starts to have a better environmental performance in terms of GWP after three uses.

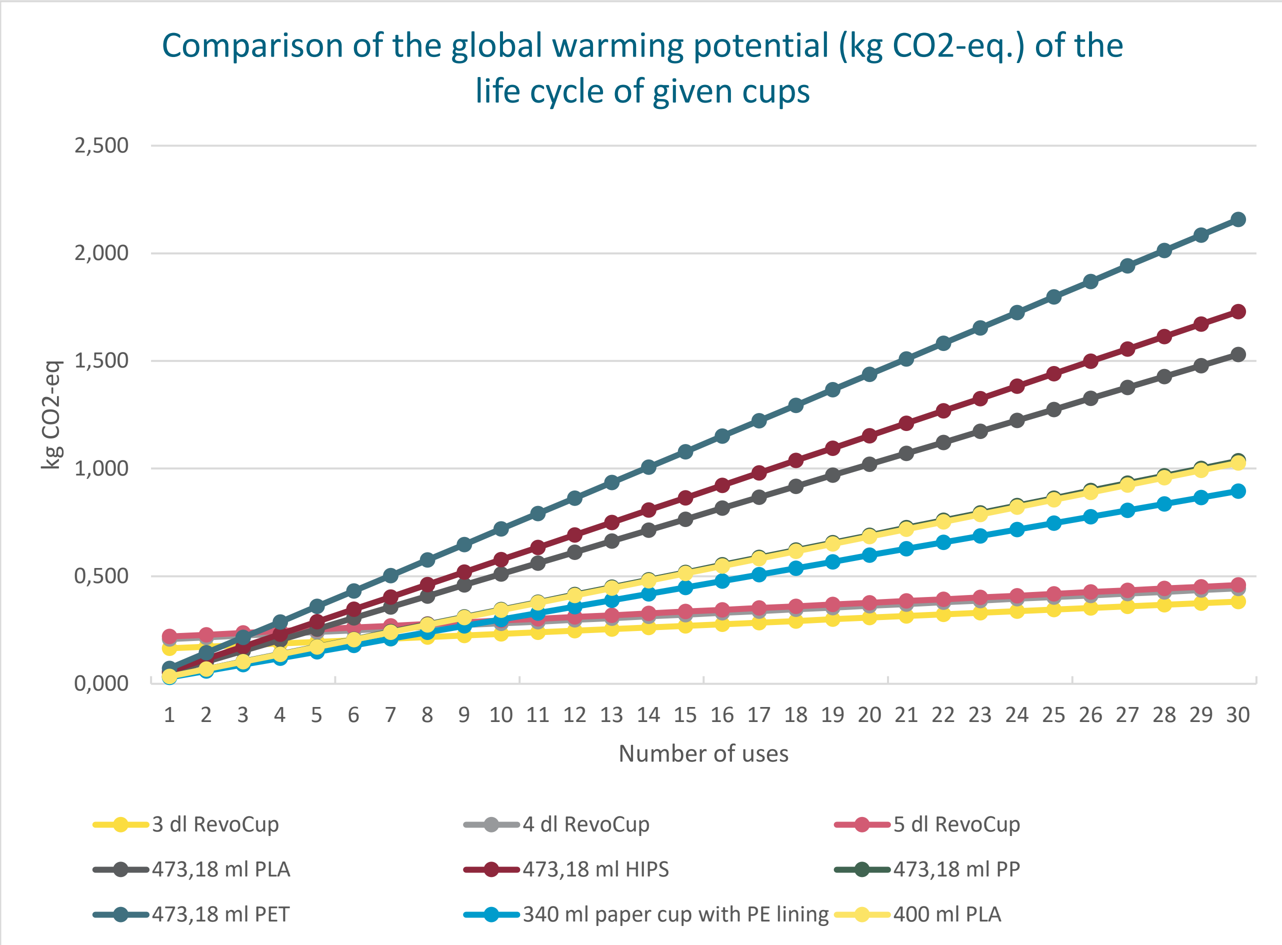


Figure 2 Comparison of RevoCup products with disposable cups

9.2. The comparison of disposable food containers with the RevoBox products

In the case of benchmark products for the RevoBox products polystyrene food container had the lowest GWP impact. The breakeven point of the 1000 ml RevoBox against the polystyrene food container is after the 36th use. However, as the functional unit is unknown in the case of the polystyrene food container, it is hard to compare them directly. In the cases of the single use food containers of which the functional unit is known, the breakeven point is between the 5th and the 10th use. Also, it must be mentioned, that all single use food containers with identifiable functional units are smaller than the smaller RevoBox (500 ml). Thus, it is more relevant to compare these food containers to the small RevoBox, which makes the breakeven points positioned between the 4th and the 8th uses. After the 6 uses, the PLA box has higher GWP impact than the 1000 ml RevoBox.

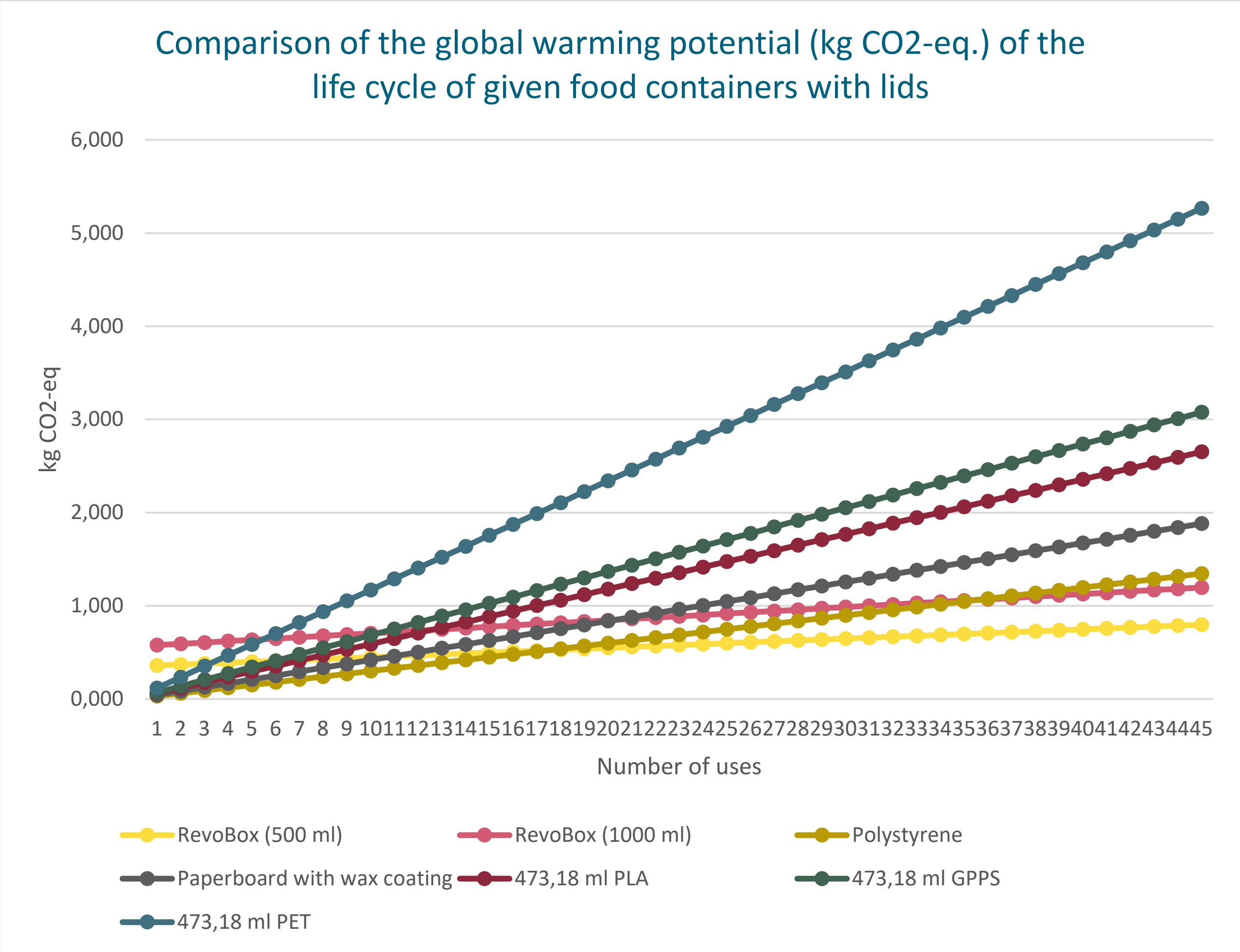


Figure 3 Comparison of RevoBox products with disposable food containers

9.3. The comparison of disposable coffee cups with the Cupler products

In the case of benchmark products for the Cupler products, paper cup with plant PE coating had the lowest GWP impact. The breakeven point of the 400 ml translucent and gray Cupler products against the paper cup with plant PE coating is after the 25th use, while the breakeven point of the 240 ml gray Cupler product against the paper cup with plant PE coating is after the 20th use However, as the functional unit is unknown in the case of the paper cup with plant PE coating, it is hard to compare them directly. In addition, a coffee cup made of paper and the Cupler plastic coffee cups have different attributes and technical characteristics should also be considered. It must be mentioned that after the 5th use, the Cupler products have a better environmental performance in terms of GWP than all the other benchmark coffee cup products.

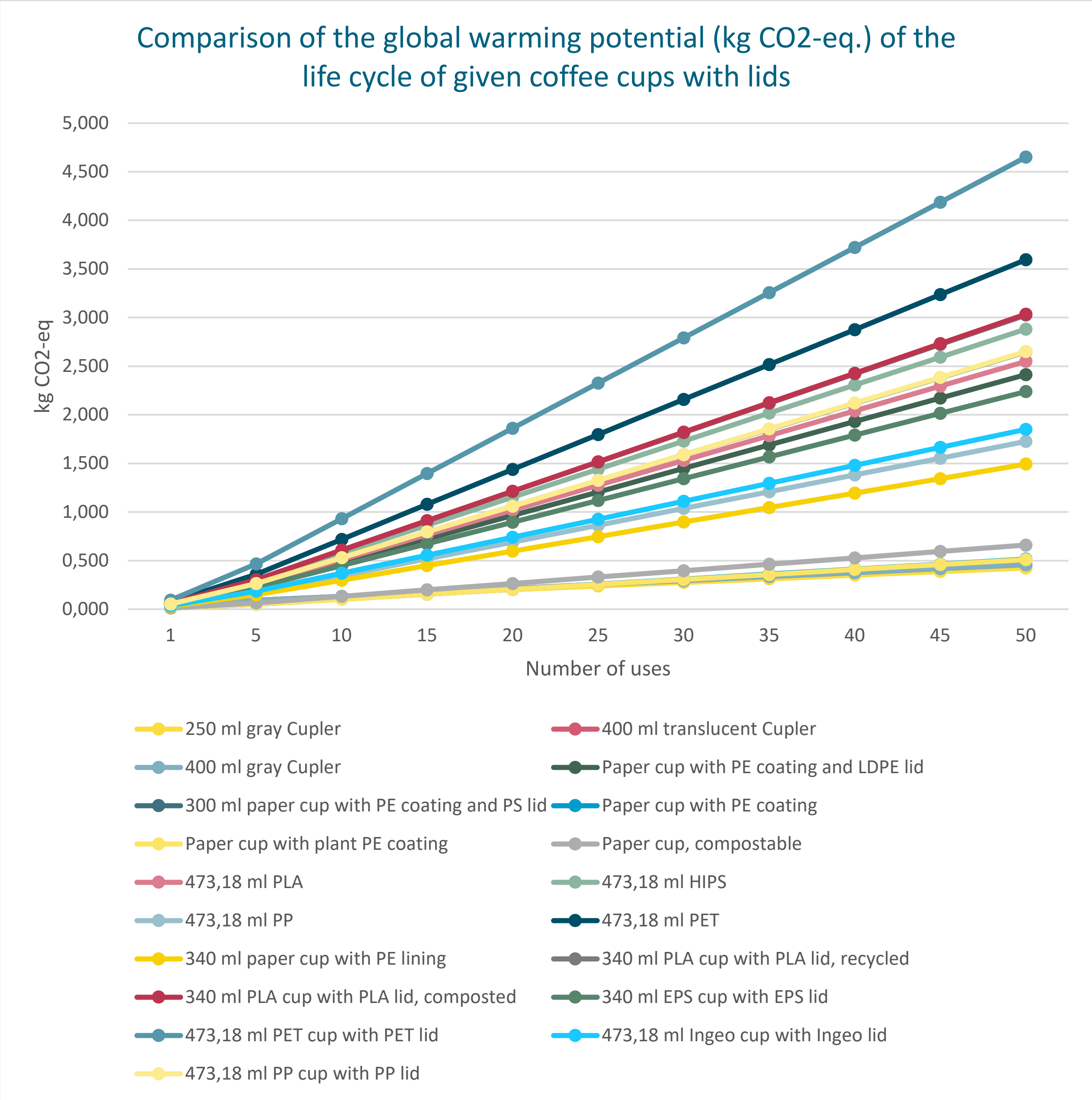


Figure 4 Comparison of Cupler products with disposable coffee cup

10. Limitations

Comparing products using life cycle assessment is a valuable tool for identifying hotspots and understanding the environmental impacts of different products throughout their life cycles. However, there are limitations to the comparisons that can be made, as was encountered during the present study.

One limitation is the difficulty in finding comparable products. For the comparison of the reusable RevoCup products against disposable beverage cups, none of the disposable products had the same exact volume as the RevoCup products. This can make it challenging to draw meaningful conclusions from the comparisons, because the identical functional units between products should ensure the comparability of the LCA results. For the comparison of the reusable RevoBox products against disposable food containers, the functional unit was not disclosed for two disposable products and these two were assessed only from cradle-to-gate. For the comparison of the Cupler products against disposable coffee cups, the functional unit was not disclosed for three for three disposable products, and the scope of one of these LCAs is only cradle-to-gate.

Another limitation is the use of different LCA methodologies and characterization factors by different practitioners. This can make it difficult to compare the results of different studies, even when the products being compared are similar. In the case of the comparisons presented in this study, the publicly available LCAs for the disposable products used different methodologies and older characterization factors, which may not accurately reflect the current environmental impact of those products.

Despite these limitations, conducting LCAs is still a valuable tool for identifying hotspots and understanding the environmental impacts of products and services. It is important to conduct independent LCAs for products and services, not just for comparisons, but also to identify areas where improvements can be made during the life cycle, which is essentially the main goal of an LCA. This will not only lead to more accurate comparisons between products but also contribute to the overall goal of reducing the environmental impact of products and services.

List of figures

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List of references

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