OIKOS

-

Economical and environmental scientific journal series of the faculty Sustainable Economy, University of Sustainable Development Eberswalde (Germany)

Volume 26 - Journal No. 1 / December 2021

ISSN 1617-5360

Life Cycle Inventory Analysis (LCI) for reusable cups made of liquid wood for the project PotsPRESSO in Potsdam (Brandenburg, Germany)

-

Thoralf Buller

Professor for Business Management, bbw University Berlin

Visiting lecturer for Environmental Management, HNE Eberswalde

Prashant Mahendrakar

M.Sc. International Technology Transfer Management, bbw University Berlin

Abstract

Eco-Balances are powerful tools of operational environmental protection. The main goal is to show the eco-impacts of services and products all along the whole life cycle. In the end there should be the possibility to compare to other services and products and to improve any activity in the process from cradle to end-of-life. The Life Cycle Inventory Analysis (LCI) is based on goal and scope and presents the collected data. PotsPRESSO is part of the NGO Bürgerstiftung Potsdam in the state Brandenburg in Germany. PotsPRESSO is willing to change consumer habits regarding taking away (hot) beverages in non-returnable cups by offering reusable cups made of liquid wood. Consumers have to pay a deposit of 2 € per cup, which they can return to all partners of PotsPRESSO like bakeries, cafés or canteens. This is the first part of the study, evaluating the resusable cups made of liquid wood. It describes the processes to collect the data between cradle and end-to-life and transport. The assessment of the given data show, that the cup itself contributes the highest share regarding CO_2-emissions and energy consumption, while the packaging material contributes the highest share regarding water consumption.

JEL-Klassifikation: Q2-Q5
Schlagwörter: Eco-Balance, Life Cycle Assessment, Life Cycle Inventory Analysis

1. Initial position

1.1. Motivation and background

In Germany consumers use 2.8 billion disposable cups per year for hot beverages, an equivalent of 23 cups per person. Disposable cups are a waste of resources and pollute our environment. Reusable cups could be a good choice. 60 percent of all disposable cups are plastic-coated, and the remaining 40 percent are all-plastic.
To reduce environmental impacts and to come from ethical approaches of responsibility and fairness, people should always encourage reuse and recycling of the products at their end of life to reduce the overall impact, and align with the mission to reduce plastic wastage.
Environmental impacts can be measured in a standardized way through Life Cycle Assessments (LCA) throughout the entire life cycle. LCA is essential because it can be a key to cost reduction, especially regarding the input of resources, or to reduction of emissions in the area of its use, but the impacts overall are more significant. Several manufacturers and system operators point to their systems' ecological benefits. LCA can identify environmental hot spots in products and services and can be regarded as the standard for assessing changes. The LCI is part of the LCA and followed by the Life Cycle Impact Assessment (LCIA) and the Life Cycle Interpretation (both expected to be published in 2021).

1.2. Research questions

This analysis targets the processes of identifying, understanding and improving the factors and parameters of the product and the services like materials, transport, manufacturing, consumption etc., which have influence on any kind of output.

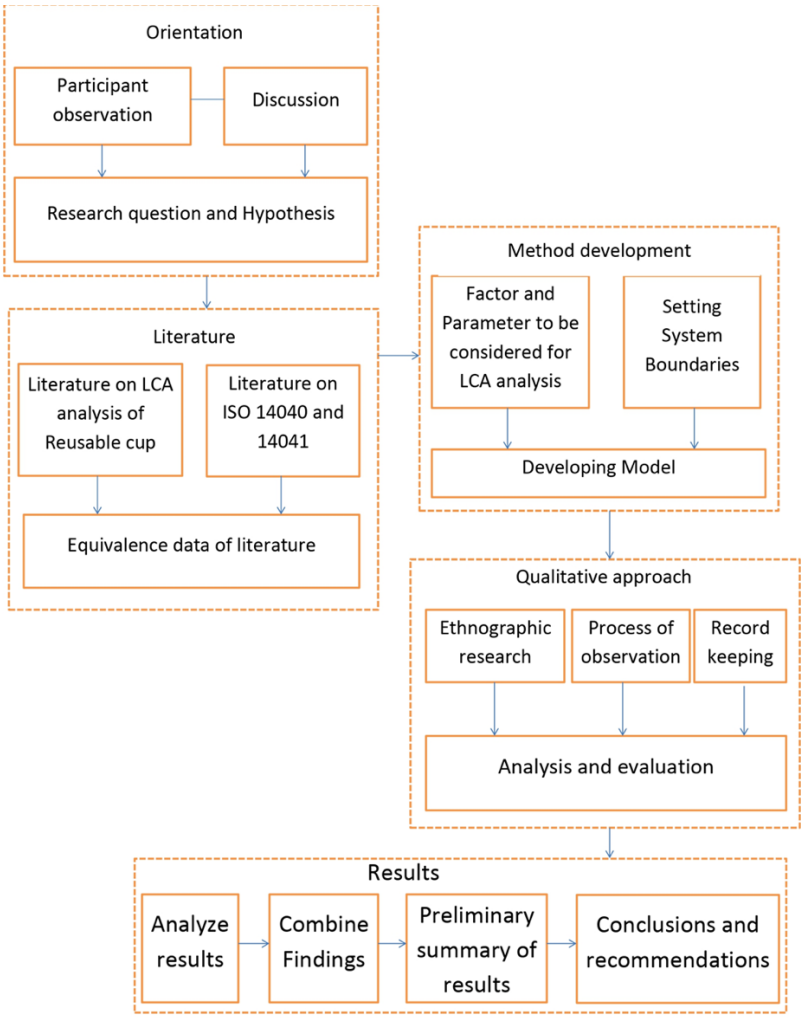
- What are the used methods to improve the environmental performance at various points in the life cycle?
- What are the factors to be considered in this LCI?
- How can input and output be measured?
- What are the limits of the observation?
- Which parameters affect the analysis of input and output?

1.3. Research methods

The framework used in this research study is shown in the figure. It describes the methods used to obtain the demanded results. The research framework can be divided into four sections:

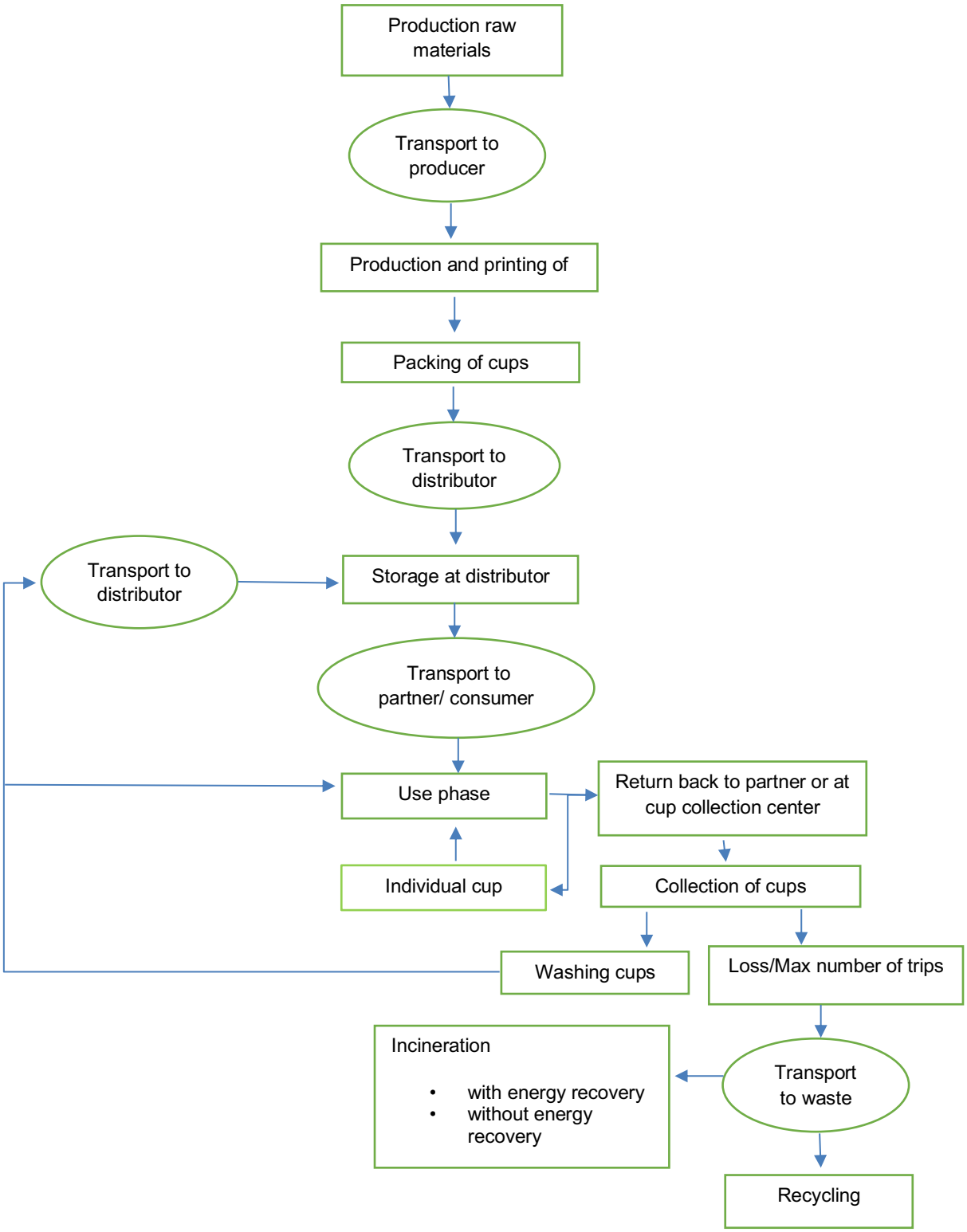
- the orientation and literature review part in which the topic of the research is described,
- the method development process part,
- the qualitative approach in which the research, the process of observation and the record keeping is conducted, and
- the analysis of the results, the findings and the conclusions which can be deduced from the work.

The data were collected between May and September 2020.



Research framework

1.4. Process of the Life Cycle Analysis



2. Data and results

2.1. Manufacturing

Liquid wood cups are manufactured in three different volumes of 400, 300 and 250 ml.

400 ml

300 ml

250 ml

Weight of the product (g)	Large (400ml)	Medium (300ml)	Small (250ml)
Body	0.095kg	0.093kg	0.043kg
Lid	0.045kg	0.045kg	0.045kg
Cup (body + lid)	0.14kg	0.138kg	0.088kg

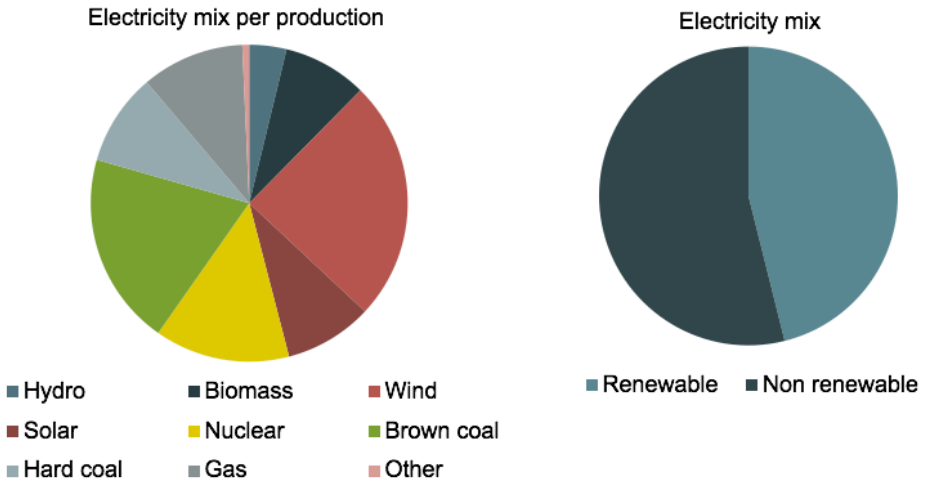
Weight of cups

Manufacturing produces minor greenhouse gas emissions in the liquid wood cups` life cycle, approximately a consumption of 9 % of energy and 1 % of water. The gross electricity consumption utilized over a full year of production (2019) to manufacture bodies and ends. The maximum electric mix of all contributing associates (weighted by country production) is described by the countries' energy sources as shown in the figure.

Source	TWh
Hydro	19.23
Biomass	44.42
Wind	127.22
Solar	46.54
Nuclear	71.09
Brown coal	102.18
Hard coal	48.69
Gas	54.05
Other	-
Total	515.56

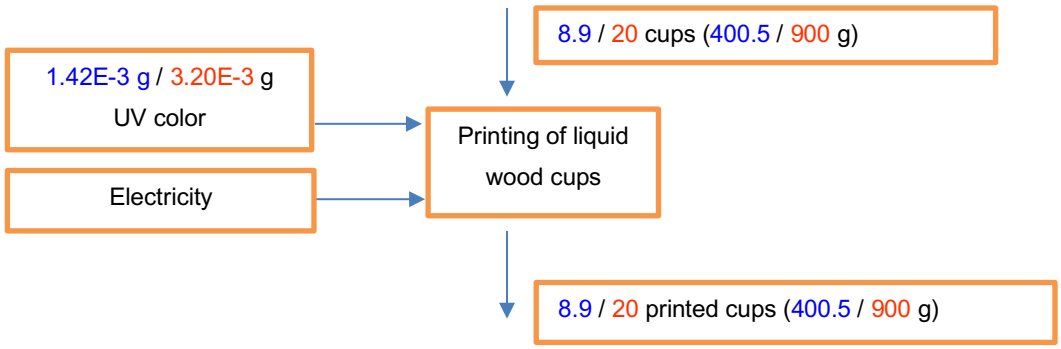
	TWh
Renewable	237.41
Non-Renewable	278.15

Energy mix and sources



2.2. Printing

The input/output diagram below relates to the actual quantity of liquid wood cups. The electricity needed for printing is not defined in this process step but is included in the electricity consumption for the cup production. The company measured a negligible VOC emission to the air for this printing, which is below the standard emissions.



I/O diagram (printing)

2.3. Transport

The key transports take part in the following stages of the life cycle:

- raw materials to manufacturing site
- produced cups from the manufacturing plant to the distributor

- cups from distributor center to partners of PotsPRESSO
- collection of damaged cups
- damaged cups to the recycler at the end-of-life process

Transport (in km)			Truck	Car	Bike
Raw materials delivery	Liquid wood granules	Distance	600	-	-
	Printing	Distance	100	-	-
	Adhesive materials	Distance	100	-	-
	Packaging materials	Distance	200	-	-
Primary and secondary packaging	From manufacturer to distributor		550	-	-
Delivery	From distribution to destination		-	60	20
Transport at end-of-life	Waste collection		100	-	-
	Transport to recycler		80	-	-

Transport and distances

2.4. Packaging

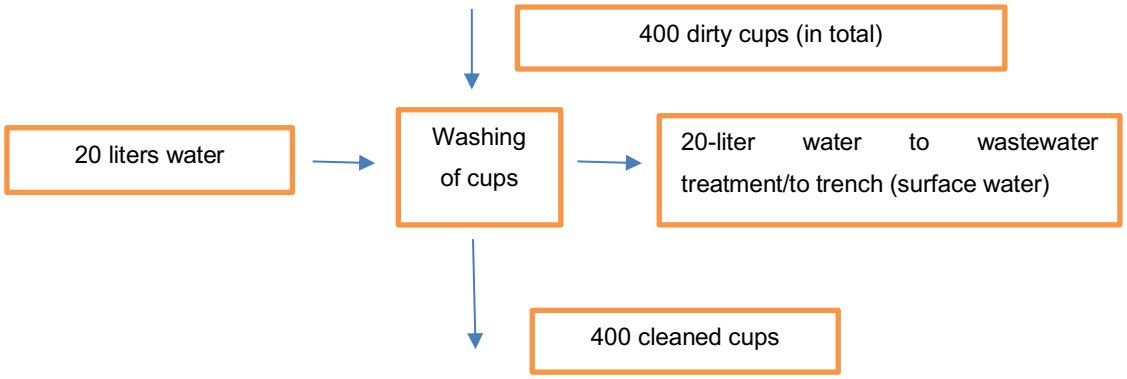
The inventory revealed that the packing materials were the same for all three cups, but the packed cups' weight and quantity varied. The cups are packed and transported in cardboard boxes (140 cups per box, one box weight 10 kg) to the distributor. Cup groups are packed together and the sets are bundled in single cartons (10 kg for 140 cups). These data are based on specific company data. No plastic material is used to wrap cups.

2.5. Storage at distribution center

The cups are supplied to the distributor by the Nowaste Company in different quantities in cardboard boxes and stored on normal wooden pallets (average wooden pallets can be reused at least 15 times). Special storing equipment requiring maintenance of storage place is not included in the study.

2.6. Cleaning of cups

In a sensitivity analysis, it is assumed that every cleaning process uses 0.1 liters of water and 0.4 g of detergent. In this case, the wastewater goes into the wastewater treatment system of the municipal wastewater treatment plant.



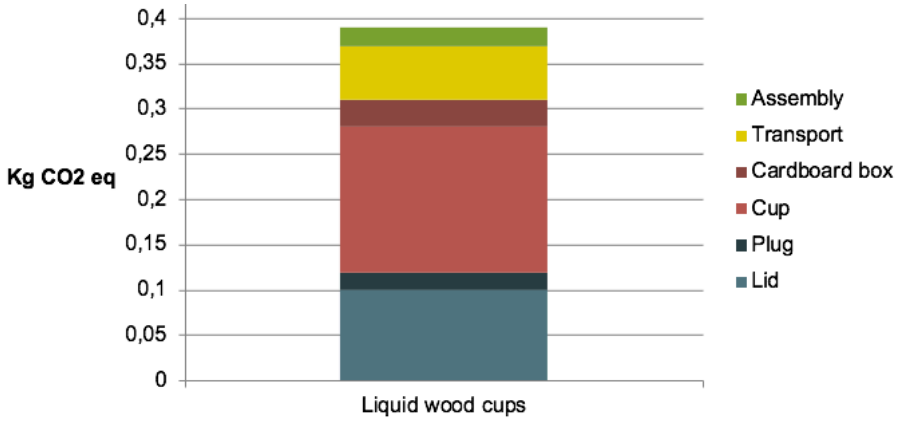
I/O diagram (cleaning of cups)

For one cup	Wash by hand	Machine wash
Energy	0.22 MJ	0.04 MJ (Washing) 0.01 MJ (Drying)
Water consumption	0.05 liters	0.176 liters
Detergent	0.4 g	0.4 g

Water and electricity consumption (cleaning of cups)

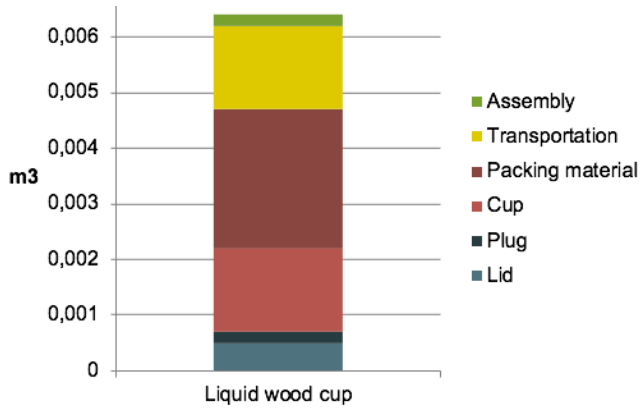
3. Conclusion and discussion

The assessment of the given data shows, that the cup itself contributes the highest share regarding CO_2-emissions and energy consumption, while the packaging material contributes the highest share regarding water consumption.
The choice of liquid wood as raw material puts the question, if there are other producers with better results and/or substitutes for liquid wood. As well the assessment poses the fundamental question regarding the inventory turnover ratio of the cups. Due to Corona pandemic, there is a strong influence on consumer habits and the sales figures for the PotsPRESSO reusable cups are on the decrease.

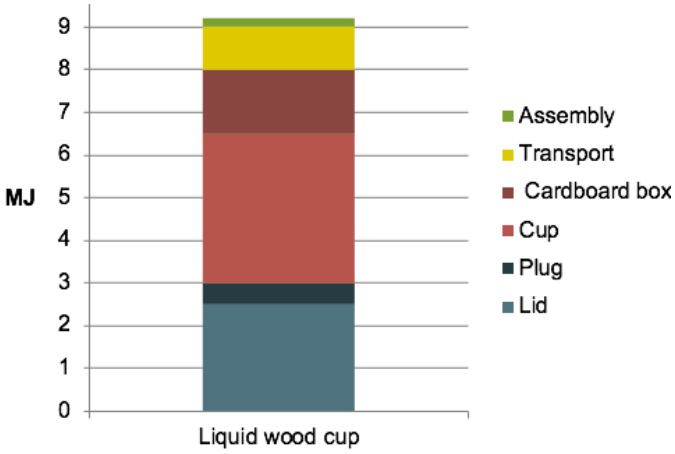


CO_2-emissions

The cleaning of the cups is not centralized and will be cleaned with normal gastronomy dishwashers or washed by hand. There also are consumers who keep cups as souvenirs. Probably these cups won´t be returned. Regrettably, this could disimprove the results. The more a cup is used, the greater is the impact on the inventory analysis and its data and the environmental impact as well.



Water consumption



Energy consumption

Regarding the water and energy consumption the consumption of packaging material should be optimized concerning a zero-waste approach. Regarding the transport there should be a clean fleet approach.