Life cycle assessment of the Thermal KeepCup

EDGE

Final report - amended
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Delivered by: Joana Almeida
Reviewed by: Jonas Bengtsson, Joana Almeida

In a nutshell

This Thermal LCA is an extension of the original peer-reviewed LCA Edge Environment conducted for KeepCup in 2018. The original LCA is available here and includes a detailed methodology and all datasets that are not specific to the Thermal KeepCup.

What

- Assessing the environmental impact of the new Thermal KeepCup.
- Understanding the Thermal's hotspots.
- Generating sustainability metrics that KeepCup can use to communicate with customers and other stakeholders, such as the carbon breakeven point.

Why

- KeepCup is committed to the continuous improvement of its products' environmental performance.
- KeepCup wants robust sustainability metrics to communicate about their products and engage customers in their changemaking ethos.

How

- KeepCup collected data on the production of the Thermal KeepCup.
- Edge used this data, as well as some data from the previous LCA published by KeepCup to model the life cycle impacts of the Thermal KeepCup.
- The findings were plotted alongside the results obtained in the previous LCA for other KeepCups and benchmarks.

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Key findings

The carbon intensity of stainless steel is higher than that of polypropylene or tempered glass used in other KeepCups.

At the hub gate, Thermal has double of the carbon footprint and energy use of the other KeepCups. *This is due to the production of stainless steel.*

From cradle to grave, repeatedly ***washing the cup after each use is the main driver of the Thermal's environmental impacts, as seen with all other reusable cups analysed.***

Raw materials

Manufacture of parts

Transport to hub

Assembly

Distribution

Use, wash and reuse

End of life

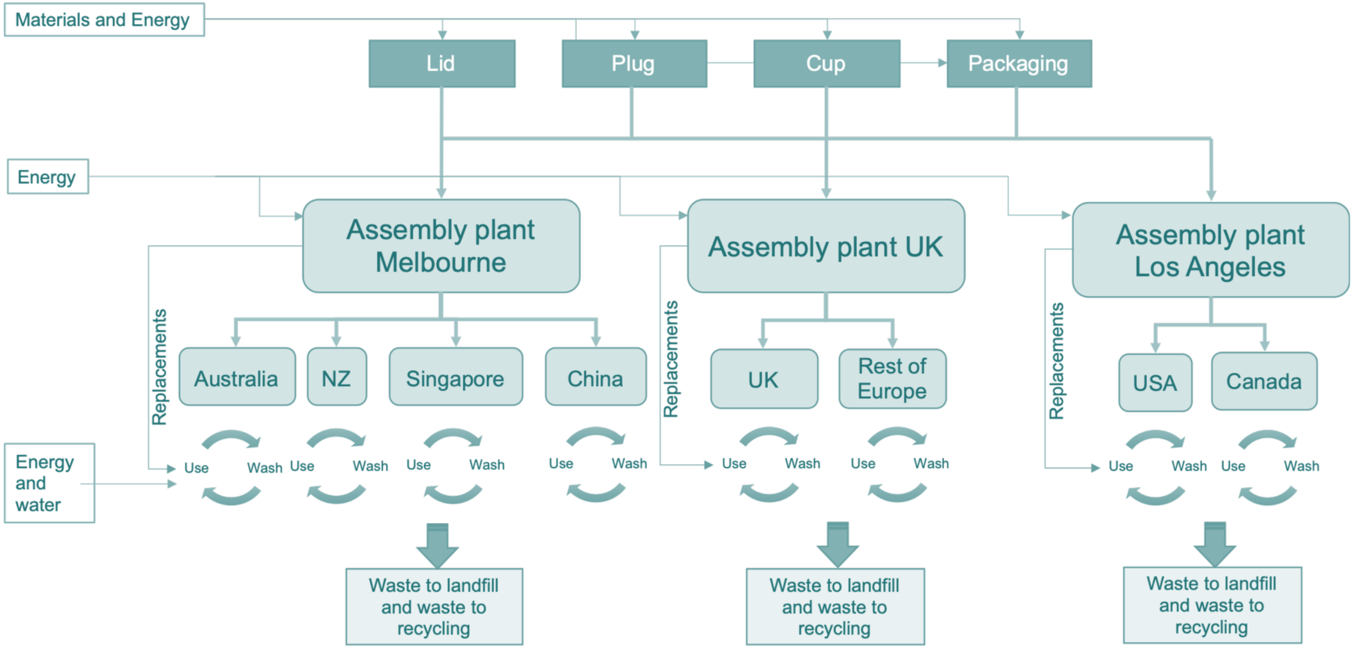
The raw materials and the manufacturing of the cup parts, namely ***the stainless steel cup, is the main source of impacts up to the point where the cup is sold.*** *This is common to the Thermal, the Original and The Brews.*

Using a Thermal KeepCup ***has a lower footprint than using a single-use paper cup after 8 uses and than using a compostable cup after 4 uses.*** *After one year of light usage (once every weekday), using a Thermal KeepCup has a 77-87% lower footprint than using disposable cups.*

Scope, data and methodology

Scope

- The LCA has a cradle to grave scope: it includes all life cycle stages from the extraction of raw materials for the manufacture of cup parts to the disposal of retired cups at their end of life.
- This scope was used in the published LCA study covering The Original, The Brew and The Brew Cork.



Data sources and assumptions

Life cycle stage/material	Primary data and source	Assumptions	Secondary data source
Raw materials and manufacturing of cup parts	• Part material composition and weights from KeepCup • Retail packaging composition and weights from KeepCup • Stainless steel: recycled content and provenance from material manufacturer. • Cup fabrication processes from KeepCup and literature. • Part manufacturing country from KeepCup	The industry average stainless steel process in ecoinvent 3.5 was adapted to model a material with 35% recycled content made in South Korea with the following changes: • The average electricity mix was replaced with South Korean electricity. • The technology mix was changed to 75% basic oxygen furnace using pig iron and 35% electric acr furnace which uses scrap and produced steel with recycled content.	LCA databases: ecoinvent 3.5 and Australian datasets (AusLCI, Australasian LCI database)
Assembly	Energy input and sources for assembly sites from KeepCup.	Assumed assembly data from The Brew as published in the LCA of 2018. Assumed the contribution of PV to the electricity use is 50% in UK and Australia, based on electricity usage reductions in the Melbourne facility since PV panels were installed.	
Distribution	Sold units to different markets from KeepCup	Distribution distances are based on the three KeepCups analysed in the LCA published in 2018.	
Use	• Washing methods from KeepCup (customer survey) • Replacements from KeepCup (customer survey) • Lifespan from KeepCup	Washing methods and replacement part data is an average of that used for The Brew Cork in the LCA published in 2018, as both cups are not dishwasher friendly. As such it was assumed that the Thermal is mostly handwashed (74%) or quick rinsed (21%). Lifespan was assumed to be 8 years, twice as long as other KeepCups due to the material longevity of steel compared to plastic and glass.	
Disposal	Resource recovery rates from literature.	Used Australia, UK and US resource recovery rates for its regional markets.	

Key data: production of cup components

The table below shows the life cycle inventory (LCI) of the 12oz Thermal KeepCup for the first stage of the life cycle, which is the materials used and the fabrication of the cup parts and its packaging.

Part/component	Material	Weight (g)	Manufacture location for Australian Hub	Manufacture location for UK hub	Manufacture location for US hub
Cup	South Korean-made 18/8 Stainless steel with 35% recycled content	180	China	China	China
Lid	PP	30	Australia	Australia	Australia
Overmould	TPE	9	With lid	With lid	With lid
Plug	LDPE	5	Australia	UK	Australia
Box	FSC cardboard	25	Australia	UK	Australia
Secondary packaging	Recycled cardboard	21	Australia	UK	Australia

- The production of the cup includes a series of steps, for which primary data couldn't be collected and proxy data was not available. Primary data couldn't be collected because the Thermal KeepCup is a very small part of the overall factory output and the manufacturer could not isolate the energy and water use for this product.
- Similarly to the approach taken in the LCA published in 2018 for three other KeepCups, the scope was limited to the main fabrication processes. For example, for the Original cup that was injection molding of the polypropylene.
- The table to the right shows the operations that were included in the analysis.

Included operations	Input	Unit
Pipe making*	90	g
Stretching	90	g
Welding mouth**	26.5	cm
Hydroforming***	0.02	kWh

**Assumed the outer and inner layer of the cup each have 50% of the total cup weight.*

***Mouth rim measured by Edge on a 12oz Original cup.*

**** Electricity derived from literature.*

Key data: assembly, distribution and end of life

- The table to the right shows the key data used to model the life cycle steps from transporting the finished cup parts to the assembly hubs, assembling the cups and delivering them to customers.

Life cycle stage	Input	Australian hub	UK hub	US hub
Transport of parts to hub	Transport of parts by truck (kgkm)	25	25	25
	Transport of parts by ship (kgkm)	1887	4448	2918
Assembly of cups	Assembly electricity - PV (kWh)	0.0005	0.0025	
	Assembly electricity - grid (kWh)	0.0005	0.0025	0.10
Delivery to customers	Delivery by truck (kgkm)	31	35	105
	Delivery by airplane (kgkm)	110	26	83
	Delivery by ship (kgkm)	133	20	

Waste stream	Australian market	Other markets**
Plastic to WTE	NA	28%
Plastic to recycling	37%	10%
Plastic to landfill	63%	61%
Stainless steel to recycling*	50%	50%
Stainless steel to landfill	50%	50%
Paper/cardboard to recycling	87%	72%
Paper/cardboard to landfill	13%	28%

- The table to the left shows the landfill and resource recovery rates used to model the end of life stage of the Thermal Cup. To model waste disposal, the product needs to be broken down into its materials: plastic (lid and plug), stainless steel (cup) and paper and carboard (box).
- The rates were retrieved from literature and are the same as used in the published LCA. The exception is stainless steel, which wasn't modelled in the previous report. A proxy rate of 50% was assumed across all markets, based on Australian statistics.

*This is a conservative estimate based on Norgate T. (2013) Metal recycling: The need for a life cycle approach. EP135565, CSIRO, Australia.

** Combined due to data gaps. When data for North America and Europe was available, an average was used. All data sources except for stainless steel are documented in the 2018 LCA.

Impact calculation method

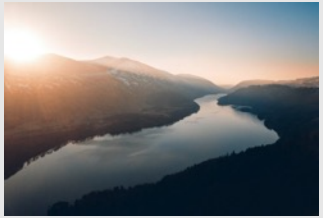
- Using the life cycle inventory data, the Thermal's life cycle was modelled with the LCA software SimaPro.
- As mentioned previously, this made use of LCA databases such as ecoinvent 3.5, for processes happening overseas, and AusLCI for processes happening in Australia.
- 3 impact indicators are reported on, shown in the boxes to the right.
- To assess the carbon footprint and water use, Edge used the method ReCiPe 2016. Energy use was assessed with the Cumulative Energy Demand method.

Carbon footprint

- Also known as Global Warming Potential.
- Translates a contribution to climate change.
- Measured in mass of greenhouse gases emitted – kg CO_2 eq.

Water use

- Shows the cumulative volume of water extracted from ecosystems into life cycle processes.
- Measured in cubic meters – m^3.



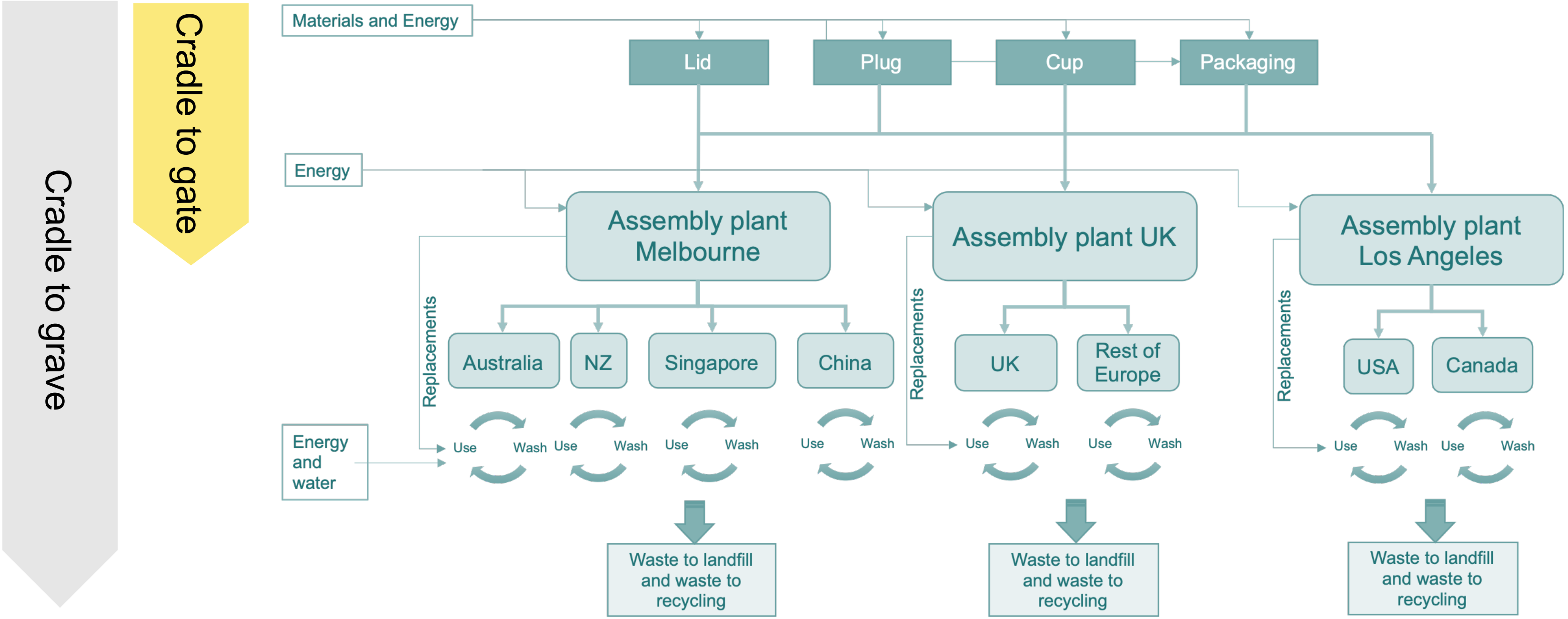
Energy use

- Shows the total non-renewable and renewable energy used by the processes and materials used along the life cycle.
- Measured in Megajoules – MJ.

Results

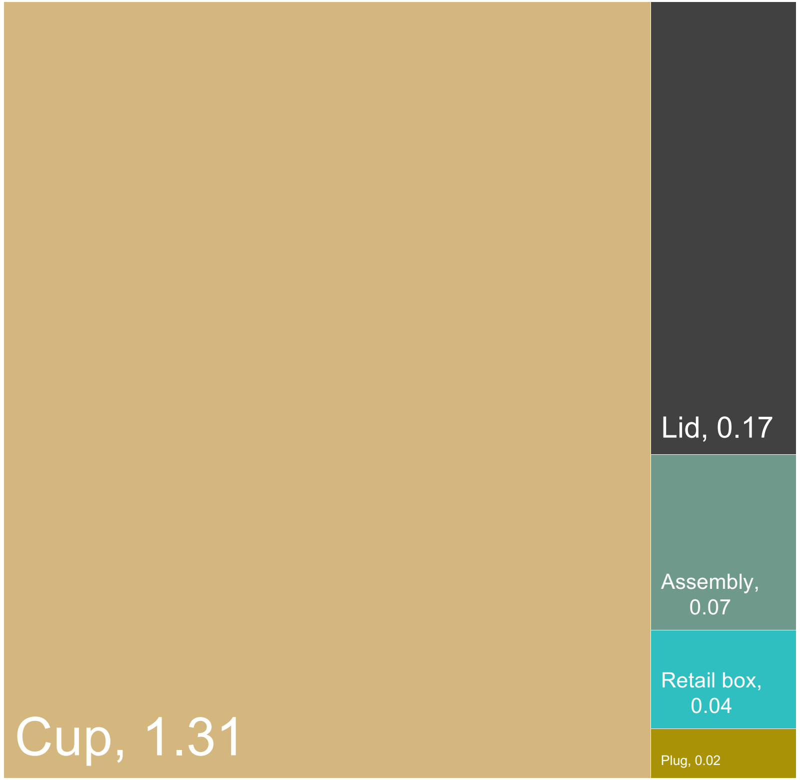
In the following slides, the LCA results are shown for the following scopes:

- Cradle to gate: from raw materials to the point when the cup is assembled at the KeepCup warehouse, before it's sold.
- Cradle to grave: from extraction of raw materials to the end of life of the cup and its materials, including all stages in between.



What drives greenhouse gas emissions and energy use from cradle to gate?

Cradle to gate

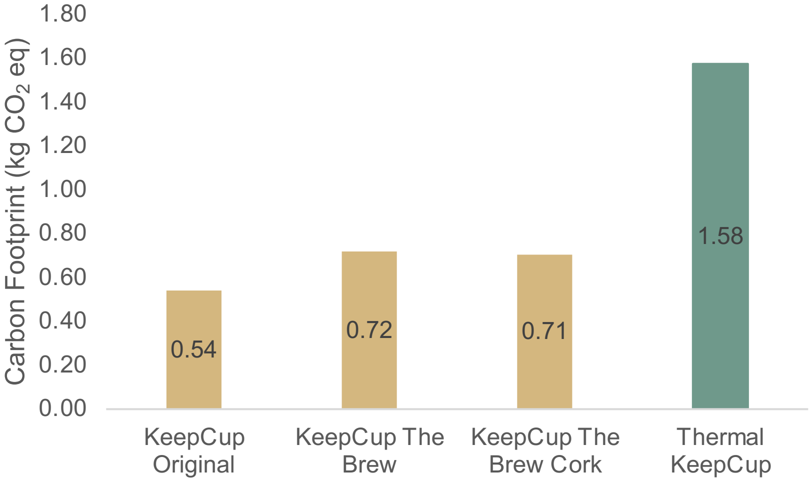


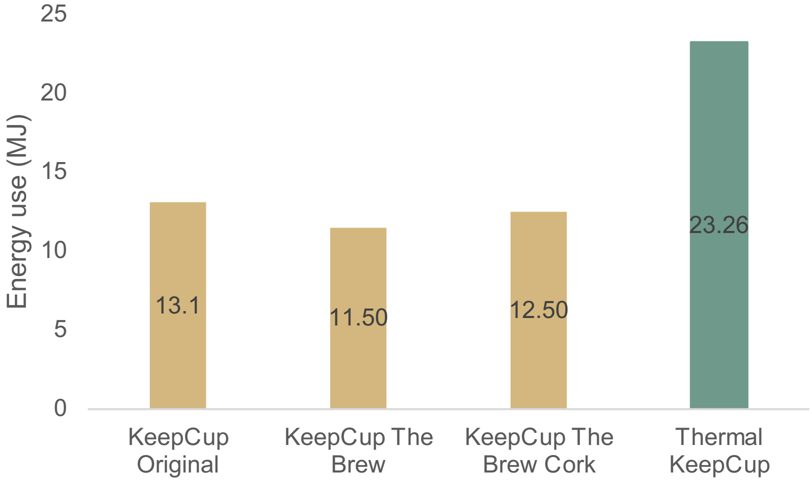
- This image shows the greenhouse gas contribution of the different processes up to the point where the cup is assembled and packaged and before it's sold.
- At the hub gate, the Thermal KeepCup has a carbon footprint of 1.6 kg CO_2 eq and consumed 24.3 MJ.
- The chart to the left shows the contribution of the cup parts, the assembly process and the retail box to the carbon footprint of the Thermal KeepCup. The assembly includes transport from supplier, packaging and assembly energy and waste. These figures are averages across KeepCup's three hubs.
- The energy use follows the same trend, so it's not discussed separately.
- The main source of emissions is the cup itself, namely the production of the stainless steel. This follows the pattern of the other cups and it's to be expected, since the cup is the largest component of the final product.

Cradle to gate

The Thermal compared to other KeepCup products

- The other KeepCups shown below are The Original (polypropylene cup with silicone band), The Brew (glass cup with silicone band) and The Brew Cork (glass cup with cork band).
- At the warehouse gate, the Thermal's carbon footprint is 66% higher than The Original's and 55 - 56% higher than either of The Brew model. This is due to the impact of stainless steel production, as explained in the following slide.
- The energy results closely correlate with the carbon footprint results: the energy used to make one Thermal KeepCup is 46 - 53% higher than the energy used to make other KeepCups.
- These figures are averages across KeepCup's three hubs.





Cradle to gate

The Thermal compared to other KeepCup products

- The key driver of the difference between the different KeepCups so far scrutinised is the material that makes up the cup, both the amount used and their embodied carbon:
  - At 180g, the stainless steel cup of the Thermal is heavier than PP cup of the The Original (about 50g) and lighter than the glass cup of the Brews (220g).
  - The embodied carbon of a material is all the greenhouse gas emissions that happen from the extraction of raw materials from nature to their processing into a usable form or product.
  - The manufacturing of 1 kg of stainless steel and forming it into KeepCups emits 7.2 kg CO_2 eq. This is 6 times more than glass and twice as much as plastic.
- As a result of weight and embodied carbon, the emissions of making the stainless steel cup are about 1.5 times higher than making the PP cup and about 4 times higher than making the glass cup.

Properties of the cup piece	The Original	The Brew/Cork	Thermal
LCA results in	2018 LCA	2018 LCA	This study
Volume (oz)	12	12	12
Weight (g)	49.4	219.5	180
Material	Polypropylene, injection molded	Tempered glass, blown molded	Stainless steel, hydroforming
Embodied carbon of the cup material (kg CO_2 eq/kg material)	**3.5**	**1.2**	**7.2**
Emissions of the cup only* (kg CO_2 eq/cup)	**0.8**	**0.3**	**1.3**

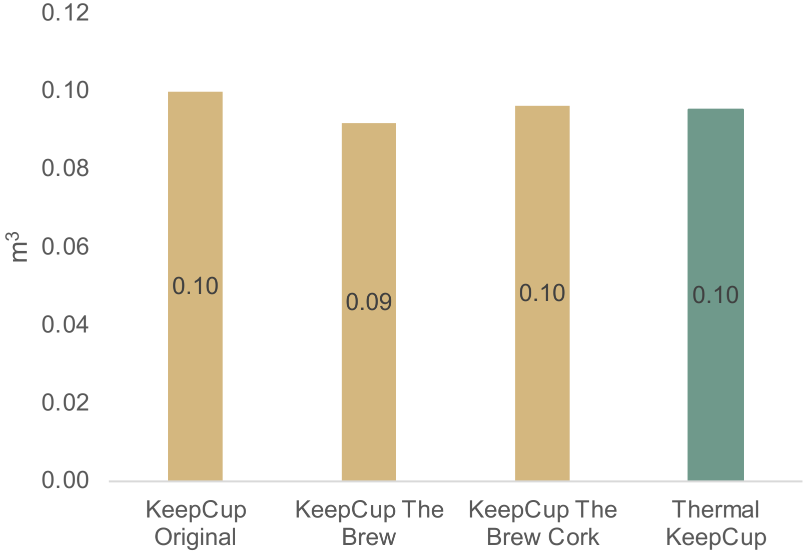
*Excluding lid and band, when applicable.

Cradle to gate

The Thermal KeepCup's water use from cradle to gate

- Water requirements of producing raw materials, manufacturing cup parts and assembling them do not vary greatly between all KeepCups. At the warehouse gate, the Thermal's water use is 5% lower than the Original, 1% higher than the Brew and 4% lower than the Brew Cork.

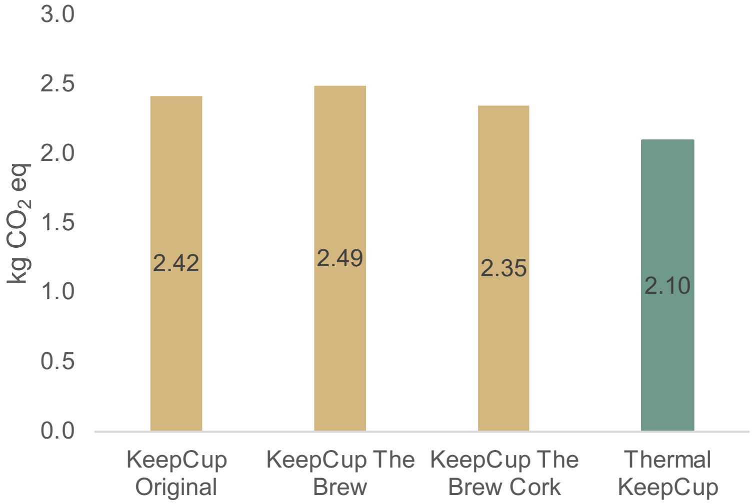
- Similar to carbon and energy, the production of stainless steel and the different processes involved in the production of the cup are the main drivers of water use. The retail box is the second main driver of water use, followed by the lid.



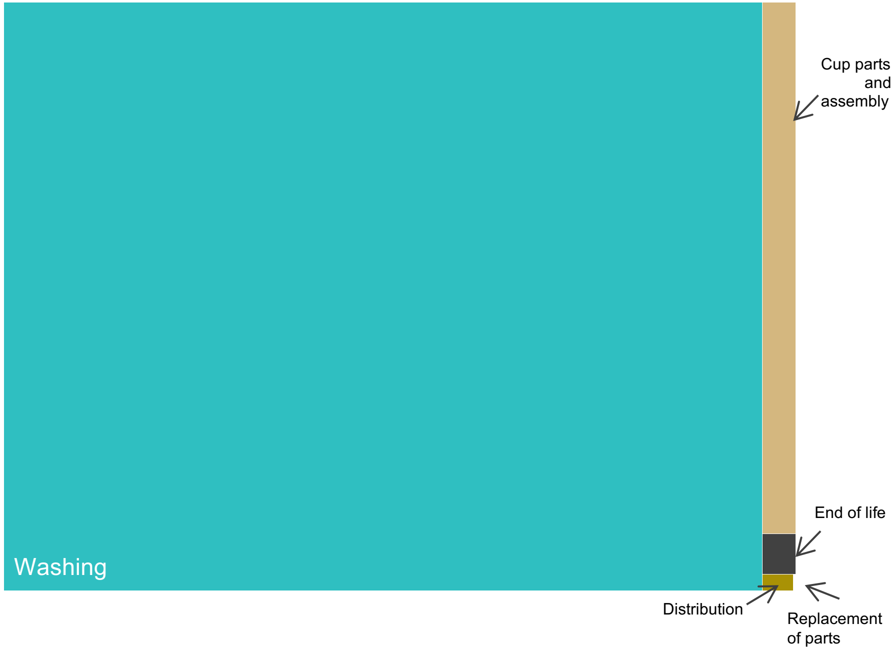
Cradle to grave

Using KeepCup for one year

- When looking from the perspective of one year of use, the difference between the cups decreases.
- The differences between the cups are largely due to:
  - The longer lifespan of the Thermal;
  - The different washing practices of KeepCup users: quick rinse, hand washing and machine washing.

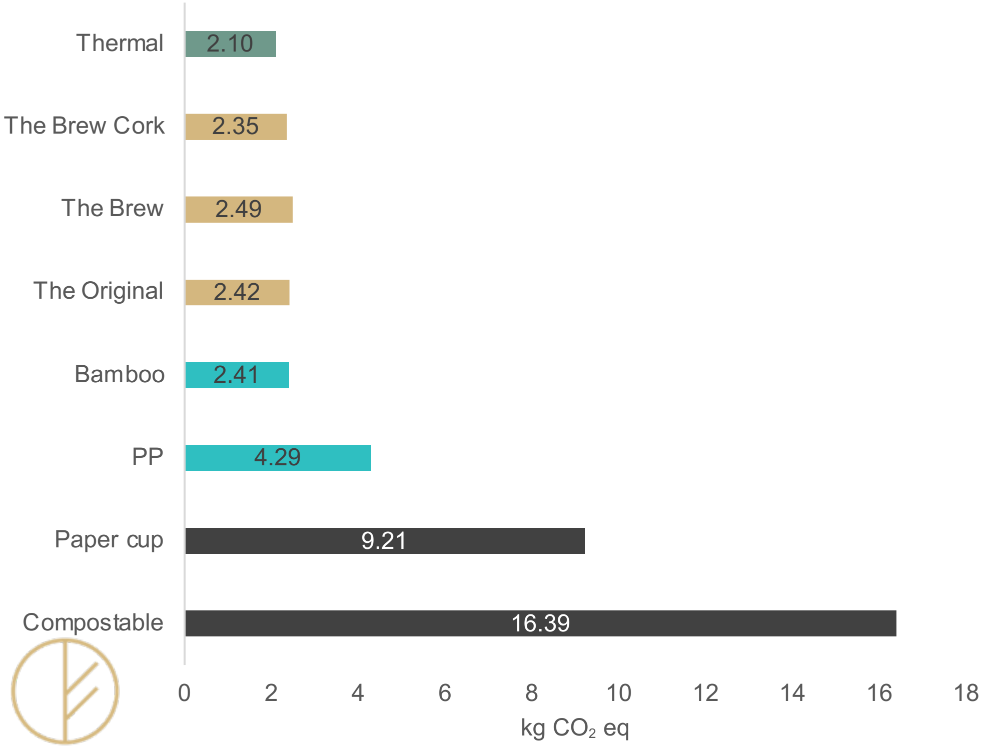


- From a cradle to grave perspective, the main source of impacts is washing, with handwashing with hot water leading to higher emissions than dishwashing or just doing a quick rinse.



Everyday use for a year compared to other cups

Cradle to grave



Compared to other KeepCups

The emissions of using a Thermal are 11% to 16% lower than using other KeepCups.

Compared to other reusables

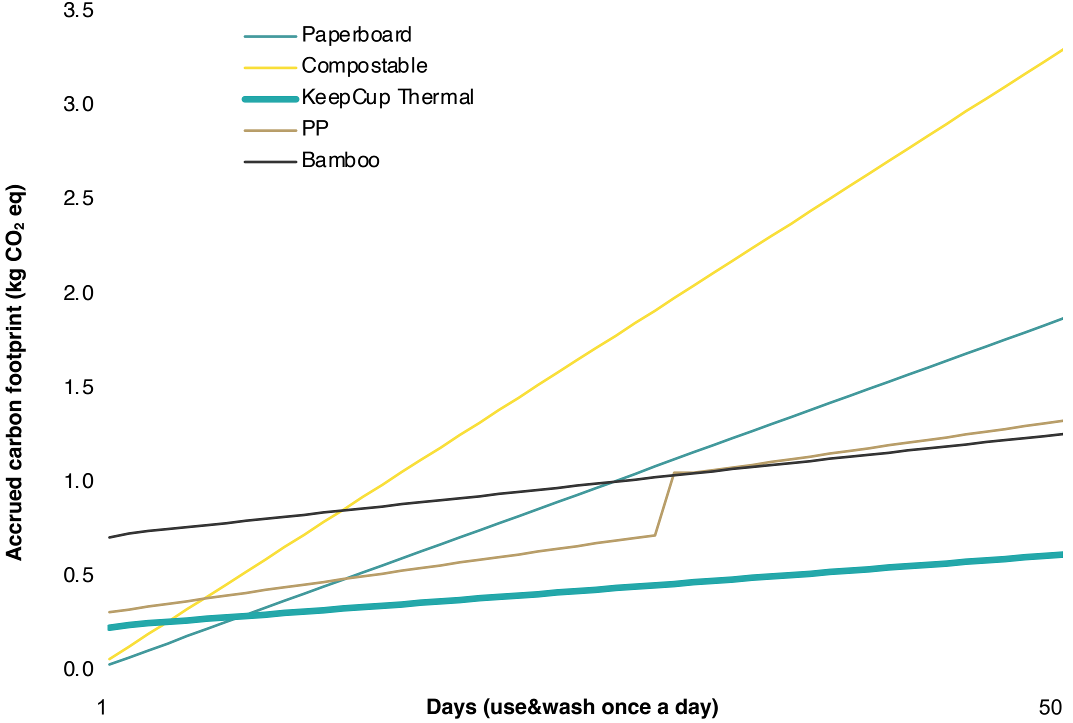
After one year of usage, the carbon footprint of the Thermal is 51% lower than the reusable PP cup and 13% lower than the bamboo cup.

Compared to single-use cups

After one year of usage, the carbon footprint of using the Thermal KeepCup is 87% lower than using compostable single-use cup and 77% lower than using paperboard single-use cups.

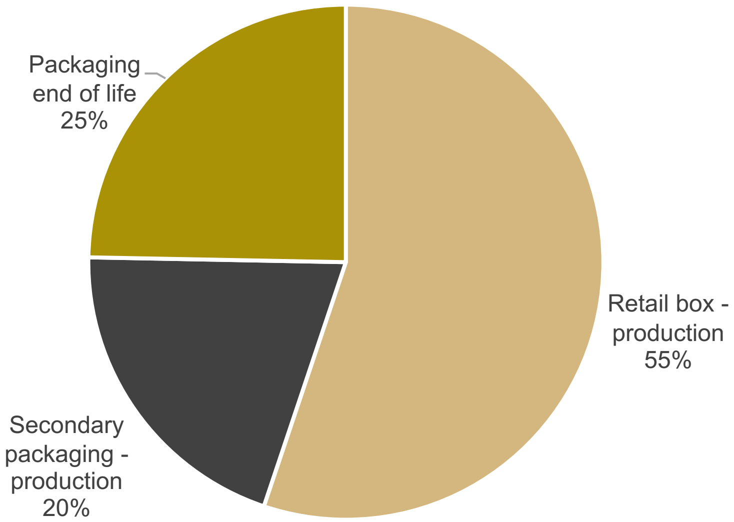
Break even point compared to other cups

- The break even point is calculated by apportioning the emissions of each cup to 1 use and accruing the emissions of each use in time. The break even is achieved when using a KeepCup starts accruing less emissions than using another cup.
- The chart shows where the breakeven points occur with competing cups assuming 250 uses in a year (following the 2018 LCA):
    - Using a Thermal KeepCup has a lower footprint than using a single-use compostable cup after 4 uses and than using a single-use paper cup after 8 uses. This is a shorter period compared with the other KeepCups due to the Thermal having longer longevity (8 years vs 4 years, based on conservative lifespan modelling).
    - Using a Thermal KeepCup always has a lower footprint than using a bamboo or a PP cup.*

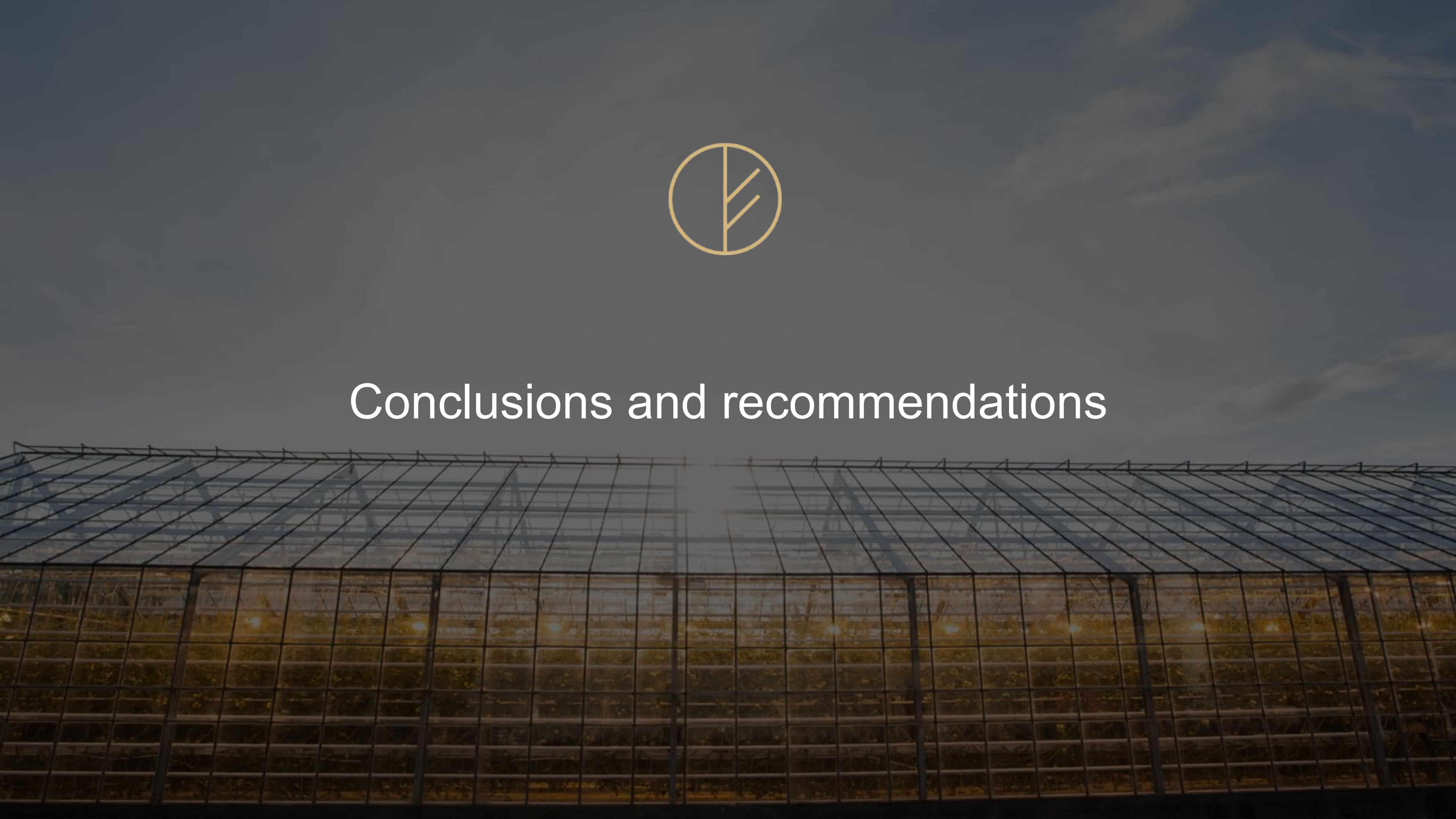


*The “jump” in the emissions of the PP cup is due to its disposal and replacement, which is assumed to happen after 30 uses.

Packaging in the Thermal’s life cycle



- The Thermal cup part is stacked in cardboard secondary packaging and is shipped to the hubs. In the assembly line, it is packaged individually in a retail box. In the 2018 LCA, a brochure was included in the retail box but KeepCup has discontinued it.
- The production and disposal of packaging account for 4% of GHG emissions of the cup and 1% of the emissions of the Thermal’s entire life cycle.
- 75% of packaging impacts are the production of the boxes, mainly the retail box, and 25% the end of life of the materials.



Conclusions and recommendations

Conclusions and future work

- Like the KeepCup series previously analysed, the main hotspot in terms of the Thermal's manufacture is the cup itself. Working with suppliers to source lower impact stainless steel is the biggest opportunity for KeepCup to mitigate impacts from sources it can influence.
- Looking at the whole life cycle, the findings for the Thermal follow the same trend as the other cups: washing the cup after each use is the key hotspot.
- This analysis was based on washing practices surveyed in 2016. Since then, KeepCup has targeted this life cycle hotspot with communications work and we recommend understanding if this has been effective in reducing the impact of using KeepCups by revisiting the washing survey. This would also help quantifying current downstream impacts and carbon mitigation opportunities for the upcoming Science-Based Target work.

References

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