

GRIND

FUTUREPLUS



# LCA OF BIODEGRADABLE COFFEE PODS

LCA of Grind home-compostable coffee pods

## 1.1. Executive Summary

### 1.1.1. What is a LCA?

A Life Cycle Assessment (LCA) is a technique for evaluating the overall environmental and climate impact associated with a product from cradle to grave (in other words, over its life-cycle). The goal of a LCA is to compare the full range of effects assignable to that product and assess how these affect the environment. Grind's own objective in completing their LCA was to use this information to improve their processes, support policies, and provide a basis for informing decisions aimed at reducing their impact on the climate.

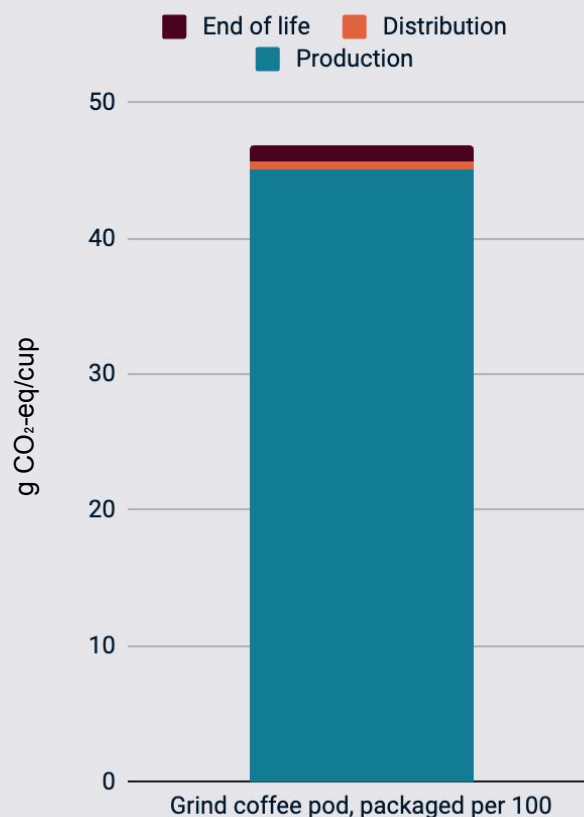
### 1.1.2. Background

The life cycle of Grind coffee pods start at the extraction of raw materials and the production of coffee beans. The coffee is then roasted, ground, and packaged. Next comes the distribution stage which is followed by consumer use. At the final stage, packaging is discarded and the coffee pods are disposed of. The use stage of the coffee pod is emitted from this analysis, as it is dependent on the machine used.

The Grind LCA was commissioned via the Sustainability Group and FuturePlus, the ESG and sustainability partner of Grind, who are partnered with Hedgehog Company, based in The Netherlands.

Grind completed LCAs for their home-compostable coffee pods, packaged by both 10 and by 100 pods, providing transparent data on the carbon footprint of both products.

### 1.1.3. Summary results



# LIFE CYCLE ASSESSMENT (LCA) OF GRIND HOME COMPOSTABLE COFFEE PODS

## 2.1. Background

This LCA study is carried out on behalf of Grind and is prepared by Rik Wessels, and internally reviewed by Zoë Tan of Hedgehog Company in partnership with The Sustainability Group and FuturePlus. The report is drawn up on 14-02-2023 and meets the requirements of ISO 14040 [1], ISO 14044[2], ISO 14025 [3] and the Product Environmental Footprint (PEF) method [4].

For the LCA calculations, Ecochain Mobius v0.9.222 is used, a LCA software developed by Ecochain Technologies [5]. The results of the LCA study and resulting Environmental Product Declarations (EPDs) are only comparable if they comply with the same calculation method as is used in this LCA.

## 2.2. Product description

The product under study in this LCA is that of filled coffee pods, ready for consumption. These coffee pods are filled with roasted ground coffee produced in Brazil. The coffee pods are made from a biopolymer pod with a paper ring.



*Figure 1: The Grind pods, packaged per 100 pods*

## 2.3. Goal and target group of the LCA study

This study aims to generate reliable and accurate quantitative environmental data of the Grind coffee pods, as produced by Grind. The outcomes of this study can be used for both business-to-business and business-to-consumer communication. The target group of this study consists of the internal organisation of Grind, their direct clients and other interested parties with whom Grind wishes to share the results.

### 3.1. Scope

The following sections describe the scope of this study. This includes, but is not limited to, the identification of the product function(s), functional unit, system boundaries, allocation method and cut-off criteria of this study.

### 3.2. Declared unit

The studied function in this LCA is providing coffee pods to be used to make a cup of coffee. This LCA calculates the environmental impact of the coffee pods, ready for sale. The coffee pods are sold in different quantities. This study compares two options: coffee pods packaged per 10 and per 100 pods.

### 3.3. System boundaries

In this study, all inputs and outputs - such as emissions, energy and material imports - are included in the calculation, in accordance with the PEF method. The production, transport and maintenance of capital goods at the production site are not taken into account, because the contribution to each impact category of these capital goods is estimated to be no more than 1%.

This study comprises a cradle to grave, with options, analysis of the coffee pod production. The use stage is excluded from this study as this is dependent on the type of machines that can be used to make coffee with these coffee pods.

The life cycle starts at the extraction of raw materials and the production of coffee beans, after which transport to the coffee pod assembler takes place. At the coffee pod assembler, the coffee is roasted and ground and the filled coffee pods are assembled and packaged per 10 or 100 pods. The final step of the production stage is distribution to Grind in London. From here, final distribution to the final consumer takes place. At the final consumer, the packaging is discarded and the coffee pods are composted after use.

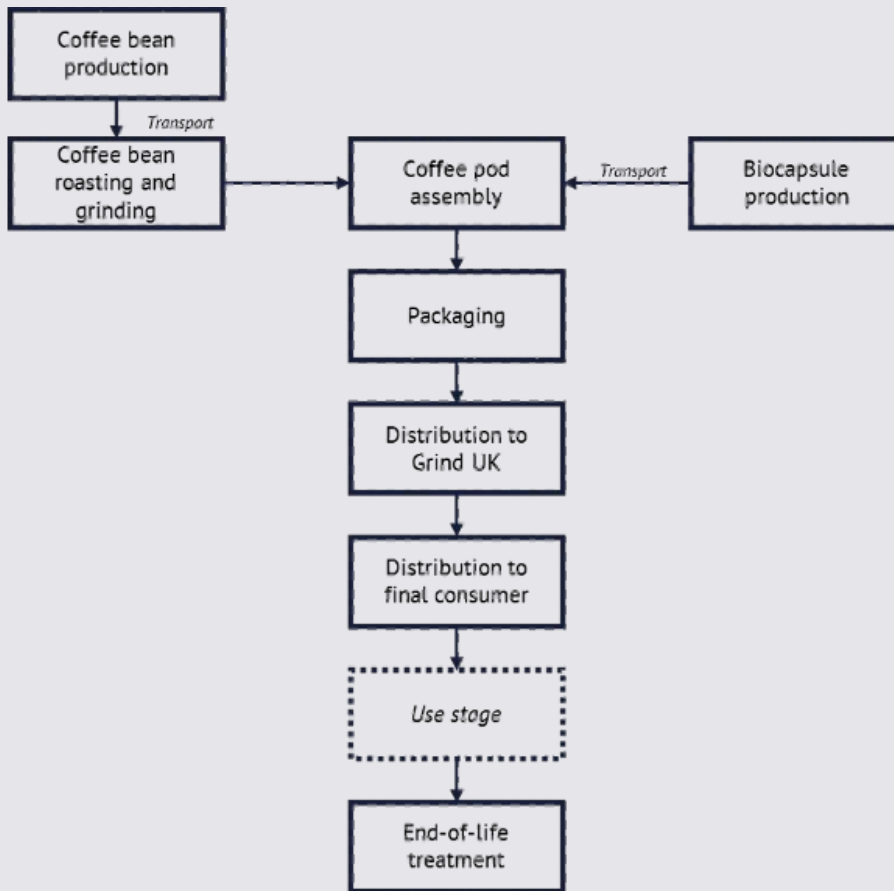


Figure 2: Flow chart of the product system

### 3.3.1. Allocation and cut-off criteria

The waste treatment processes are allocated to the module in which they originate. The allocation of materials to this or the next life cycle has taken place on the basis of the end-of-waste status. For example, the production waste streams have no economic value and are therefore still a waste stream. These waste streams are transported to a waste treatment facility. The cut-off occurs after the waste treatment process.



## 4.1. Life Cycle Inventory

The life cycle inventory (LCI) constitutes the collection of data and the calculation procedures used to quantify the relevant environmental inputs and outputs (incoming and outgoing flows) of a product system. Energy, raw materials and transport data are included and converted into emissions to air, soil, water and raw material extractions.

## 4.2. Data collection

The relevant environmental data covered in this study is mainly collected through Grind. Suppliers of Grind were asked to supply specific environmental data. The suppliers have provided specific information regarding energy and material consumption. However no specific environmental data in the form of LCA's or environmental product declarations were received. Any missing data is supplemented with literature data where necessary. On the basis of the collected data, representative references are selected from the Ecoinvent v3.6 database. The selected references and the applied amounts are presented in section 4.2.

## 4.3. Inventory and allocation

This section describes the quantity and quality of the materials used, energy flows, and emissions. The requirements for system boundaries outlined in the PEF methodology have been taken into account for this description.

### 4.3.1. Production stage

The production stage consists of all stages from the extraction of resources to the final product assembly.

#### Coffee bean production

The production starts at the cultivation of the coffee beans. The coffee beans are cultivated in Varginha, Brasil. The inventory of the coffee bean cultivation is presented in Table 1. These inputs represent an annual yield of 1,800 kg of coffee beans per hectare.

*Table 1: Energy and material inputs for the production of 1,800 kg coffee beans*

Material/resource	Amount	Unit
Copper oxide	4.00	kg
Ammonium nitrate (N content = 33%)	400	kg
Electricity	15.41	kWh
Gypsum, mineral	660	kg
Packaging, for fertilisers	1.00	kg
Packaging, for pesticides	0.18	kg
Coffee husks	6000	kg
Chicken manure	3000	kg

### Modelling of emissions

The emissions during cultivation are modelled according to the PEF guidelines for agricultural emissions [4]. In line with this, fertiliser emissions are modelled by multiplying the amount of nitrogen (N) that is applied per hectare with the amount of emissions that occur (Table 2), and to which compartment they should be modelled.

Table 2: Modelling of the nitrogen emissions of the synthetic and manure fertiliser

Compartment	Value to be applied
Air	<b>0.022 kg N<sub>2</sub>O/ kg N fertiliser applied</b>
Air	kg NH <sub>3</sub> = kg N * FracGASF= 1*0.1* (17/14)= <b>0.12 kg NH<sub>3</sub> / kg N fertiliser applied</b>
Air	kg NH <sub>3</sub> = kg N*FracGASF= 1*0.2* (17/14)= <b>0.24 kg NH<sub>3</sub> / kg N manure applied</b>
Water	kg NO <sub>3</sub> <sup>-</sup> = kg N*FracLEACH = 1*0.3*(62/14) = <b>1.33 kg NO<sub>3</sub><sup>-</sup> / kg N applied</b>

The coffee bean supplier uses ammonium nitrate which has a 33% N content. The used chicken manure has an N content of 2.20% [6].

Phosphorus emissions are modelled as the amount of P applied on the agricultural field (through manure or fertilisers) and the emission compartment 'soil' is used. The amount of P in the chicken manure is approximately 3% [6].

The pesticides (boric acid and copper oxide) applied on the field are modelled as 90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water.

### Transport

After harvesting, the coffee beans are transported to Fano, Italy, where the beans are roasted. The beans are packaged in jute bags and are transported from Varginha to the port of Santos for 398 km by truck. From the Port, the beans are shipped to Ancona, Italy over a distance of 10,971 km. The final 60 kilometre from Ancona to Fano is travelled by truck.

### Bio pod production

The coffee pods are made from a specific biopolymer (PHA) that is produced in Erlstätt, Germany. The supplier of the bio pods has provided an overview of the bill-of-materials and the transport distance to their respective suppliers of semi-finished products. This information is presented in Table 3. For the production of 1000 bio pods, 2.13 kWh of electricity is consumed. This electricity is fully generated from hydropower.

Table 3: Materials and energy required to produce 1000 pods

Material/resource	Amount	Unit	Distance from supplier (km)	Transport mode
PHA Biopolymer	1.70	kg	630	Truck (>32t)
Paperring	0.30	kg	14	Truck (3,5-7,5t)
LDPE-Foil	0.50	kg	285	Truck (>32t)
Carton box packaging	0.23	kg	16	Truck (>32t)
Euro pallet	0.50	kg	450	Truck (>32t)

### Roasting and final assembly

In Italy, the coffee beans are roasted and grinded and the final product is assembled. These processes require a total of 0.039 kWh of electricity, 0.0072 m<sup>3</sup> of natural gas and 0.023 litres of water per pod. The roasting of the coffee beans results in a net loss of coffee bean weight of 17% due to the moisture content that evaporates and the loss of the outer shells of the coffee bean.

### *Electricity mix Ultramar*

The coffee beans are roasted at Ultramar, which has provided their specific electricity mix [8]. Table 4 shows how this electricity is modelled in this LCA. Within the LCA model, the transformation loss from high to medium voltage is accounted for.

*Table 4: Modelling of the electricity mix at the Ultramar facility, per kWh*

Source	Amount	Unit	Background reference
Hydropower	0.301	kWh	electricity production, hydro, reservoir, alpine region   electricity, high voltage   Cutoff, U [IT]
Wind	0.150	kWh	electricity production, photovoltaic, 570 kWp open ground installation, multi-Si   electricity, low voltage   Cutoff, U [IT]
Geothermal	0.030	kWh	electricity production, deep geothermal   electricity, high voltage   Cutoff, U [IT]
Solar	0.028	kWh	electricity production, wind, <1MW turbine, onshore   electricity, high voltage   Cutoff, U [IT]
Coal-fired	0.063	kWh	electricity production, hard coal   electricity, high voltage   Cutoff, U [IT]
Fuel-oil	0.094	kWh	electricity production, oil   electricity, high voltage   Cutoff, U [IT]
Combined cycle gas	0.209	kWh	electricity production, natural gas, combined cycle power plant   electricity, high voltage   Cutoff, U [IT]
Nuclear	0.125	kWh	electricity production, nuclear, pressure water reactor   electricity, high voltage   Cutoff, U [SLO]

After roasting and grinding the coffee, the coffee pod are filled and closed off. Transport details of intermediate products to the production site in Italy are presented in Table 5.

*Table 5: Transport information of intermediate products to Ultramar.*

Material	Amount (g)	Production location	Transport distance	Transport mode
Biopods	1.65	Erlstätt, Germany	700	Truck
Top lid	0.07	Saint-Séverin, France	1200	Truck
Top lid packaging, LDPE	1.00	Saint-Séverin, France	1200	Truck
Packaging, cardboard	16.62	Verona, Italy	307	Truck



For the final assembly of the pods 0.39 kWh of electricity, 0.07 m<sup>3</sup> of natural gas and 0.227 l of water are consumed per 10 packed coffee pods. The intermediate packaging for the top lids, bio pods and the coffee beans are assumed to be incinerated without energy recovery.

#### Final distribution to Grind

After the pods are packed in Italy, they are shipped to Grind in London, UK. See Table 6 for the exact transport distances and transport modes.

Table 6: Final distribution to Grind

Route	Distance (km)	Transport mode
Fano - Ancona	60	Truck
Ancona - London Gateway	5310	Ship
London Gateway - Grind (London)	47	Truck

#### **4.3.2. Distribution stage**

This study considers distribution to a hypothetical final consumer in Manchester, UK. The distribution scenario is the following:

- 350 km transport by truck from London to a distribution centre in Manchester.
- 10 km transport by light commercial vehicle from distribution centre to the final consumer.

#### **4.3.3. Use stage**

The use stage is excluded from this study as this is dependent on the type of machines that can be used to make coffee with these coffee pods.

#### **4.3.4. End-of-life stage**

The end-of-life stage includes the treatment of the secondary packaging and treatment of the coffee pods. The cardboard packaging is assumed to be treated according to the 'market for waste paperboard {GB}' reference from Ecoinvent. The Grind coffee pod is fully home compostable and it is therefore assumed that the final consumer fully composts the pod at home, including the coffee grounds.

## 5.1. Data Validation

This chapter contains a qualitative description of the quality, representativeness, completeness and reproducibility of the collected data and the environmental impact and emission sources used.

## 5.2. Data quality

The data quality is based on the principle that the quality of the foreground process data of the producer of the product must be higher than that of the background process data. Furthermore, the principle is applied that the economic flows should approach reality as closely as possible within practically feasible limits for the person carrying out the LCA. The data quality is assessed below, in section 5.2.1.

### 5.2.1. Consistency and representativeness

The technological coverage of this study is representative as specific business, product and process data of the year 2022 are used to model the product system. Therefore, these data are representative of state-of-the-art production technology. The allocation of impact to materials has been consistently performed on the basis of the economic turning point (the end-of-waste status). This prevents double counting of emissions within the product system.

The used background database references for the production of all intermediate and semi-finished products are representative for the geographical area of where they are produced. Further downstream processes are relevant for the geographical area of Europe. Relevant references are selected from the Ecoinvent v3.6 database.

### 5.2.2. Completeness of environmental and economic flows

All identified environmental emissions have been translated into environmental effects. Direct emissions from the inventory are all characterised via the characterisation factors of the Environmental Footprint impact categories. The database references used for the production process are selected from Ecoinvent v3.6. This ensures that all relevant environmental flows are characterised.

### 5.2.3. Reproducibility

The process descriptions and quantities in this study are fully quantitatively reproducible with the references used. In the context of reproducibility, all references of the sources, both primary and public sources and literature, are recorded in the References chapter.

### 5.3.4 Qualitative and quantitative description of processes, scenarios and sources

This paragraph describes all background processes that are used to perform this LCA. Table 7 describes which references are selected for each emissions source, from which database this reference is collected, and why this reference is fitting.

Table 7: Selected references for the different emissions sources

Emission source	Reference	Database	Argumentation
<i>Coffee bean production</i>			
Boric acid	market for boric acid, anhydrous, powder   boric acid, anhydrous, powder   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
Chicken manure	-	-	Utilised wastestream from chicken production. This enters the product system burden-free.
Coffee husks	-	-	Utilised wastestream from coffee bean production. This enters the product system burden-free.
Copper oxide	market for copper oxide   copper oxide   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
N, from ammonium nitrate	market for ammonium nitrate, as N   ammonium nitrate, as N   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
Electricity	electricity production, photovoltaic, 3kWp slanted-roof installation, multi-Si, panel, mounted   electricity, low voltage   Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference for electricity from PV.
Gypsum	market for gypsum, mineral   gypsum, mineral   Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference for the used product.
Packaging, for fertilisers	market for packaging, for fertilisers   packaging, for fertilisers   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
Packaging, for pesticides	market for packaging, for pesticides   packaging, for pesticides   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
Triazol and estrobilurina	market for ethoxylated alcohol (AE>20)   ethoxylated alcohol (AE>20)   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the used product.
Jute bag	market for textile, jute   textile, jute   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the jute bag in which the beans are transported.
Emissions from N fertiliser	NO <sub>2</sub> , to air / unspecified	Ecoinvent v3.6	Most representative reference for NO <sub>2</sub> emissions to air.
	NH <sub>3</sub> , to air / unspecified	Ecoinvent v3.6	Most representative reference for NH <sub>3</sub> to air.
	NO <sub>3</sub> -, to air / unspecified	Ecoinvent v3.6	Most representative reference for NO <sub>3</sub> -emissions to air.

Emissions from P fertiliser	P, to soil / unspecified	Ecoinvent v3.6	Most representative reference for phosphorus emissions to soil.
Emissions from pesticides	Boric acid, to air / unspecified	Ecoinvent v3.6	Most representative reference for boric acid emissions to air.
	Boric acid, to water / unspecified	Ecoinvent v3.6	Most representative reference for boric acid emissions to water.
	Pesticides, to soil / unspecified	Ecoinvent v3.6	Most representative reference for boric acid emissions to soil, due to the lack of a specific reference.
	Copper oxide, to air / unspecified	Ecoinvent v3.6	Most representative reference for copper oxide emissions to air.
	Copper oxide, to water / unspecified	Ecoinvent v3.6	Most representative reference for copper oxide emissions to water.
	Copper oxide, to soil / unspecified	Ecoinvent v3.6	Most representative reference for copper oxide emissions to soil.
Land use	Occupation, permanent crop, irrigated	Ecoinvent v3.6	Most representative reference to account for the land use of coffee bean cultivation.
	Transformation, from permanent crop, irrigated / unspecified	Ecoinvent v3.6	Most representative reference to account for the land use of coffee bean cultivation.
	Transformation, to permanent crop, irrigated / unspecified	Ecoinvent v3.6	Most representative reference to account for the land use of coffee bean cultivation.
<i>Biopod production</i>			
Material sourcing	market for transport, freight, lorry 3.5-7.5 metric ton, EURO5   transport, freight, lorry 3.5-7.5 metric ton, EURO5   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for used lorry of 3,5-7,5t.
	market for transport, freight, lorry >32 metric ton, EURO5   transport, freight, lorry >32 metric ton, EURO5   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for used lorry of >32t.
Biopolymer	polyester-complexed starch biopolymer production   polyester-complexed starch biopolymer   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used product.
	injection moulding   injection moulding   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for injection moulding of (bio)plastic.
Paperring	kraft paper production, unbleached   kraft paper, unbleached   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used product.
LDPE-Foil	polyethylene production, low density, granulate   polyethylene, low density, granulate   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used product.
	injection moulding   injection moulding   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for injection moulding of (bio)plastic.
Carton box packaging	corrugated board box production   corrugated board box   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used packaging.

Euro pallet	EUR-flat pallet production   EUR-flat pallet   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used packaging.
Electricity	electricity production, hydro, pumped storage   electricity, high voltage   Cutoff, U [GER]	Ecoinvent v3.6	Most representative reference for the consumed electricity. Based on energy supplier specific data.
Treatment cardboard, at roasting and final assembler	market for waste paperboard   waste paperboard   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for the treatment of cardboard, at the final assembly location in Italy.
Treatment LDPE, at roasting and final assembler	market for waste polyethylene   waste polyethylene   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for the treatment of LDPE, at the final assembly location in Italy.
Treatment pallet, at roasting and final assembler	market for waste wood, untreated   waste wood, untreated   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for the treatment of pallets, at the final assembly location in Italy.
Substituted energy generation	electricity production, natural gas, conventional power plant   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for the substituted electricity generation.
	heat and power co-generation, natural gas, conventional power plant, 100MW electrical   heat, district or industrial, natural gas   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for the substituted thermal energy generation.
<i>Roasting of coffee beans &amp; Final assembly</i>			
Transport to site	market for transport, freight, lorry, unspecified   transport, freight, lorry, unspecified   Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference for transport by land in Brazil.
	transport, freight, sea, container ship   transport, freight, sea, container ship   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for transport by ship.
	market for transport, freight, lorry, unspecified   transport, freight, lorry, unspecified   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for transport by land in Europe.
Natural gas	heat production, natural gas, at industrial furnace >100 kW   heat, district or industrial, natural gas   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for natural gas consumption.
Electricity	electricity production, hard coal   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from coal. Based on energy supplier specific information.
	electricity production, natural gas, combined cycle power plant   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from natural gas. Based on energy supplier specific information.
	electricity production, oil   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from oil. Based on energy supplier specific information.
	electricity production, deep geothermal   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from geothermal energy. Based on energy supplier specific information.



	electricity production, hydro, reservoir, alpine region   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from hydropower. Based on energy supplier specific information.
	electricity production, nuclear, pressure water reactor   electricity, high voltage   Cutoff, U [SLO]	Ecoinvent v3.6	Most representative reference for electricity from nuclear sources. Based on energy supplier specific information.
	electricity production, photovoltaic, 570 kWp open ground installation, multi-Si   electricity, low voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from PV. Based on energy supplier specific information.
	electricity production, wind, <1MW turbine, onshore   electricity, high voltage   Cutoff, U [IT]	Ecoinvent v3.6	Most representative reference for electricity from wind. Based on energy supplier specific information.
Water	market for tap water   tap water   Cutoff, U [Europe without Switzerland]	Ecoinvent v3.6	Most representative reference for water consumption.
Incineration of coffee shells during roasting	treatment of biowaste, municipal incineration   biowaste   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for the incineration of the coffee shell.
Top lid	kraft paper production, unbleached   kraft paper, unbleached   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used product.
	polyethylene production, low density, granulate   polyethylene, low density, granulate   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for packaging of the top lid.
	extrusion, plastic film   extrusion, plastic film   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for packaging of the top lid.
Final packaging - 10 pods	folding boxboard production   folding boxboard/chipboard   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used packaging, containing a high percentage of virgin material.
Final packaging - 100 pods	chipboard production, white lined   folding boxboard/chipboard   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for the used packaging, containing a high percentage of recycled material.
<i>Final transport to Grind</i>			
Transport to Grind	transport, freight, sea, container ship   transport, freight, sea, container ship   Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference for transport by ship.
	market for transport, freight, lorry, unspecified   transport, freight, lorry, unspecified   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for transport by land in Europe.
<i>Distribution stage</i>			
Distribution to final consumer	market for transport, freight, lorry, unspecified   transport, freight, lorry, unspecified   Cutoff, U [RER]	Ecoinvent v3.6	Most representative reference for transport by land in Europe.
	market for transport, freight, light commercial vehicle   transport, freight, light commercial vehicle   Cutoff, U [Europe without Switzerland]	Ecoinvent v3.6	Most representative reference for transport to final consumer from the distribution centre.
<i>End-of-life stage</i>			

Treatment of packaging	market for waste paperboard   waste paperboard   Cutoff, U [GB]	Ecoinvent v3.6	Most representative reference for treatment of cardboard packaging in the UK.
Treatment of coffee pods	treatment of kitchen and garden biowaste, home composting in heaps and containers   biowaste, kitchen and garden waste   Cutoff, U [FR]	Ecoinvent v3.6	Most representative reference for composting of kitchen biowaste in Europe.

## 6. Life Cycle Impact Assessment

This chapter presents the full environmental profile of the Grind home-compostable pods. This environmental profile is presented in accordance with the impact categories from the Product Environmental Footprint. The environmental profile is shown in the tables below.

The values of the impact categories are calculated as follows: all environmental interventions from the inventory are multiplied per effect category by the characterization factors from the PEF. Finally, the values obtained are summed per effect category.

Table 8: Environmental profile per pod, packaged per 10

Impact category	Reference unit	Production	Distribution	End-of-life	Total
Climate change	kg CO2 eq	4,59E-02	5,55E-04	1,30E-03	<b>4,78E-02</b>
Climate change - Fossil	kg CO2 eq	4,56E-02	5,54E-04	2,29E-04	<b>4,64E-02</b>
Climate change - Biogenic	kg CO2 eq	3,03E-04	3,01E-07	1,07E-03	<b>1,37E-03</b>
Climate change - Land use and LU change	kg CO2 eq	4,74E-05	2,37E-07	4,58E-08	<b>4,76E-05</b>
Ozone depletion	kg CFC11 eq	6,19E-09	1,24E-10	1,05E-11	<b>6,33E-09</b>
Human toxicity, cancer	CTUh	1,23E-11	4,30E-13	2,41E-13	<b>1,30E-11</b>
Human toxicity, cancer - metals	CTUh	7,20E-12	1,16E-13	1,02E-13	<b>7,42E-12</b>
Human toxicity, cancer - organics	CTUh	5,10E-12	3,15E-13	1,39E-13	<b>5,55E-12</b>
Human toxicity, cancer - inorganics	CTUh	0,00E+00	0,00E+00	0,00E+00	<b>0,00E+00</b>
Human toxicity, non-cancer	CTUh	3,32E-10	9,11E-12	1,46E-11	<b>3,55E-10</b>
Human toxicity, non-cancer - metals	CTUh	2,76E-10	5,92E-12	4,53E-12	<b>2,87E-10</b>
Human toxicity, non-cancer - organics	CTUh	1,58E-11	7,56E-13	9,03E-12	<b>2,56E-11</b>

Human toxicity, non-cancer - inorganics	CTUh	4,36E-11	2,46E-12	1,03E-12	<b>4,71E-11</b>
Particulate matter	disease inc.	3,61E-09	5,16E-11	1,34E-11	<b>3,68E-09</b>
Ionising radiation	kBq U-235 eq	2,37E-03	3,73E-05	3,68E-06	<b>2,41E-03</b>
Photochemical ozone formation	kg NMVOC eq	1,34E-04	3,51E-06	6,90E-05	<b>2,07E-04</b>
Acidification	mol H+ eq	5,62E-04	3,15E-06	1,16E-06	<b>5,67E-04</b>
Eutrophication, terrestrial	mol N eq	2,02E-03	1,19E-05	4,50E-06	<b>2,04E-03</b>
Eutrophication, marine	kg N eq	2,62E-04	1,07E-06	1,17E-06	<b>2,65E-04</b>
Eutrophication, freshwater	kg P eq	7,87E-06	5,95E-09	1,83E-09	<b>7,88E-06</b>
Ecotoxicity, freshwater	CTUe	6,06E-01	7,52E-03	6,20E-03	<b>6,20E-01</b>
Ecotoxicity, freshwater - metals	CTUe	5,18E-01	5,26E-03	1,07E-03	<b>5,24E-01</b>
Ecotoxicity, freshwater - organics	CTUe	2,09E-02	4,86E-04	6,91E-04	<b>2,21E-02</b>
Ecotoxicity, freshwater - inorganics	CTUe	6,80E-02	1,77E-03	4,43E-03	<b>7,42E-02</b>
Land use	Pt	4,84E-01	6,30E-03	7,47E-04	<b>4,91E-01</b>
Water use	m3 depriv.	2,63E-02	2,86E-05	5,87E-05	<b>2,63E-02</b>
Resource use, fossils	MJ	7,50E-01	8,43E-03	1,43E-03	<b>7,60E-01</b>
Resource use, minerals and metals	kg Sb eq	2,92E-07	1,38E-08	1,17E-09	<b>3,07E-07</b>

Table 9: Environmental profile per pod, packaged per 100

Impact category	Reference unit	Production	Distribution	End-of-life	Total
Climate change	kg CO2 eq	4,51E-02	5,49E-04	1,24E-03	<b>4,69E-02</b>
Climate change - Fossil	kg CO2 eq	4,48E-02	5,49E-04	2,25E-04	<b>4,55E-02</b>
Climate change - Biogenic	kg CO2 eq	3,06E-04	2,98E-07	1,01E-03	<b>1,32E-03</b>
Climate change - Land use and LU change	kg CO2 eq	5,02E-05	2,34E-07	4,43E-08	<b>5,05E-05</b>
Ozone depletion	kg CFC11 eq	6,14E-09	1,23E-10	9,98E-12	<b>6,27E-09</b>
Human toxicity, cancer	CTUh	1,17E-11	4,26E-13	2,28E-13	<b>1,24E-11</b>
Human toxicity, cancer - metals	CTUh	6,87E-12	1,15E-13	9,63E-14	<b>7,08E-12</b>
Human toxicity, cancer - organics	CTUh	4,83E-12	3,11E-13	1,32E-13	<b>5,27E-12</b>
Human toxicity, cancer - inorganics	CTUh	0,00E+00	0,00E+00	0,00E+00	<b>0,00E+00</b>
Human toxicity, non-cancer	CTUh	3,09E-10	9,02E-12	1,42E-11	<b>3,32E-10</b>
Human toxicity, non-cancer - metals	CTUh	2,59E-10	5,86E-12	4,29E-12	<b>2,69E-10</b>
Human toxicity, non-cancer - organics	CTUh	1,55E-11	7,49E-13	8,95E-12	<b>2,52E-11</b>
Human toxicity, non-cancer - inorganics	CTUh	3,89E-11	2,43E-12	9,76E-13	<b>4,23E-11</b>
Particulate matter	disease inc.	3,54E-09	5,11E-11	1,29E-11	<b>3,60E-09</b>
Ionising radiation	kBq U-235 eq	2,31E-03	3,69E-05	3,55E-06	<b>2,35E-03</b>
Photochemical ozone formation	kg NMVOC eq	1,31E-04	3,47E-06	6,90E-05	<b>2,03E-04</b>
Acidification	mol H+ eq	5,55E-04	3,12E-06	1,13E-06	<b>5,59E-04</b>
Eutrophication, terrestrial	mol N eq	2,01E-03	1,17E-05	4,39E-06	<b>2,02E-03</b>
Eutrophication, marine	kg N eq	2,61E-04	1,06E-06	1,11E-06	<b>2,64E-04</b>



Eutrophication, freshwater	kg P eq	7,81E-06	5,89E-09	1,78E-09	<b>7,82E-06</b>
Ecotoxicity, freshwater	CTUe	5,37E-01	7,44E-03	5,91E-03	<b>5,50E-01</b>
Ecotoxicity, freshwater - metals	CTUe	4,50E-01	5,20E-03	1,03E-03	<b>4,56E-01</b>
Ecotoxicity, freshwater - organics	CTUe	2,01E-02	4,81E-04	6,89E-04	<b>2,13E-02</b>
Ecotoxicity, freshwater - inorganics	CTUe	6,68E-02	1,76E-03	4,19E-03	<b>7,28E-02</b>
Land use	Pt	2,49E-01	6,24E-03	7,12E-04	<b>2,56E-01</b>
Water use	m3 depriv.	2,53E-02	2,83E-05	5,62E-05	<b>2,54E-02</b>
Resource use, fossils	MJ	7,39E-01	8,34E-03	1,39E-03	<b>7,49E-01</b>
Resource use, minerals and metals	kg Sb eq	2,73E-07	1,37E-08	1,12E-09	<b>2,88E-07</b>

## 7.1. Interpretation

In this chapter, the results of the LCA are further analysed with a contribution analysis in section 7.2.

## 7.2. Contribution analysis

In order to get a better understanding of which processes cause the environmental emissions for the coffee pods, a contribution analysis is made. By tracing the emissions back to the emissions source, it is possible to get a better understanding of the hot spots in the life cycle of both product systems.

Figure 3 and 4 present the contribution of the different emissions sources to the final environmental profile of the coffee pods. It can be observed that the roasting and final assembly stage contributes to a significant share of the impact in several categories. This is due to the energy consumption during this production step. Furthermore, the cultivation of coffee beans shows a high contribution to particulate matter, acidification and the eutrophication categories. The impact in these categories is primarily caused by the emissions of nitrogen and phosphorus during the cultivation process.

When comparing Figure 3 and 4, it can be observed that the packaging contributes less to the environmental impact for the pods that are packaged per 100. This is due to the fact that these products use less packaging (mass) per pod, as well as the fact that the used cardboard is made from recycled fibres, while the packaging for 10 pods is made from virgin paper.

For a more specific overview of the contribution of the different emission sources to the climate change impact, please see the Appendix.

Figure 3: Contribution analysis of the environmental impacts in the life cycle of the coffee pods, packaged per 10 pods

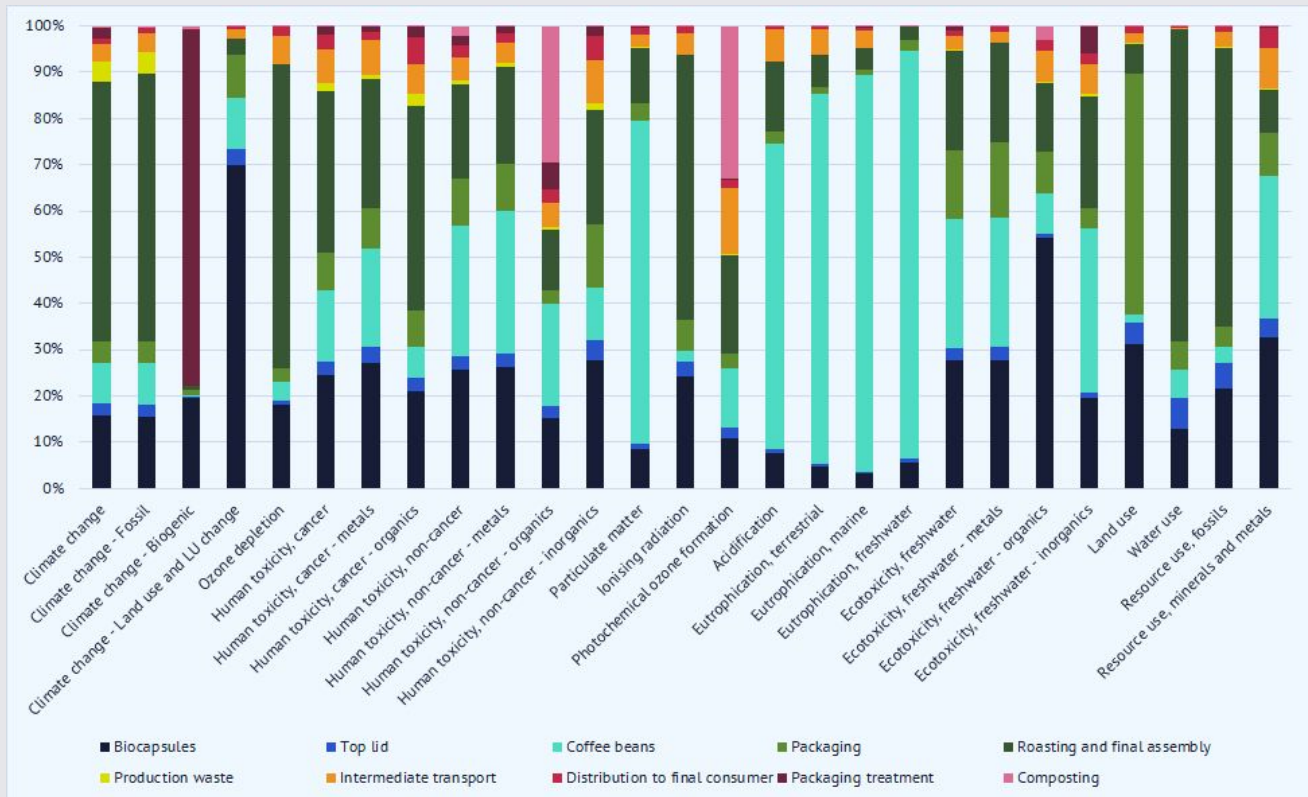
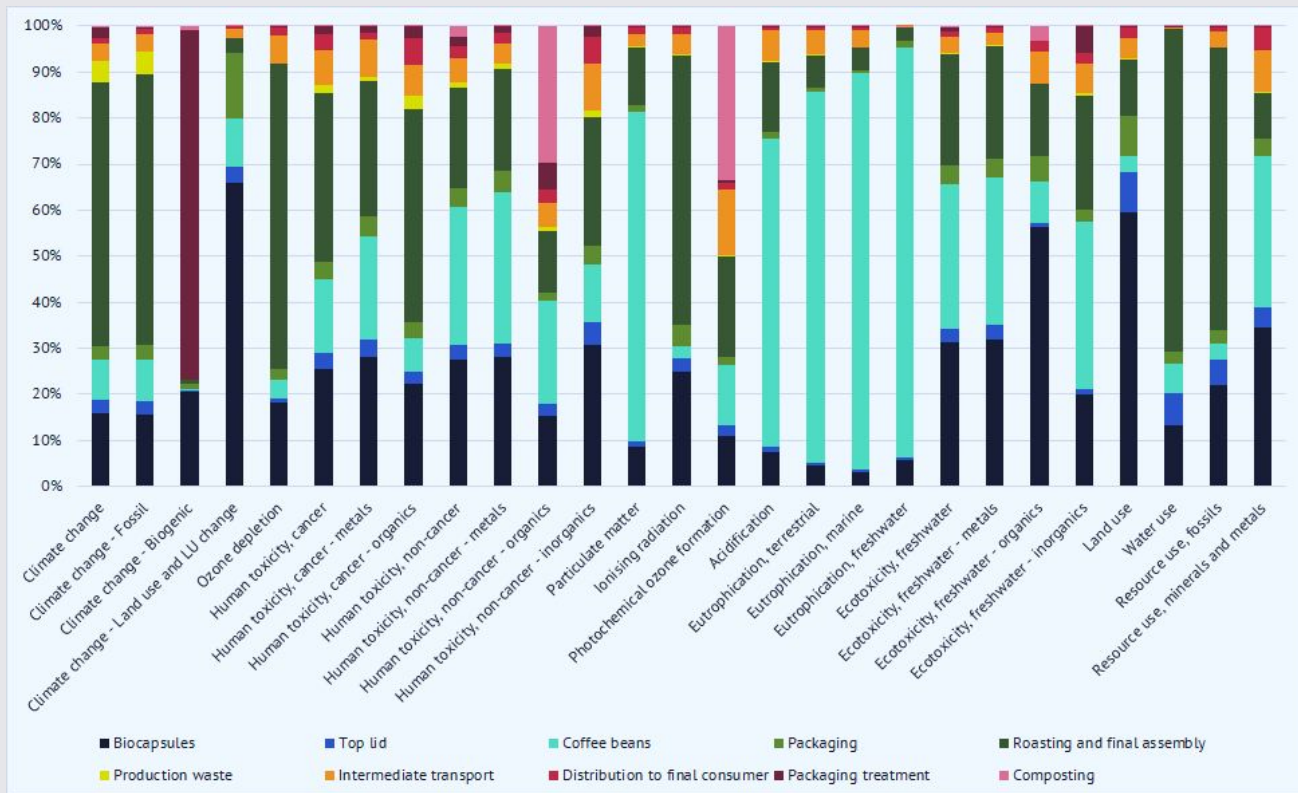


Figure 4: Contribution analysis of the environmental impacts in the life cycle of the coffee pods, packaged per 100 pods



## REFERENCES

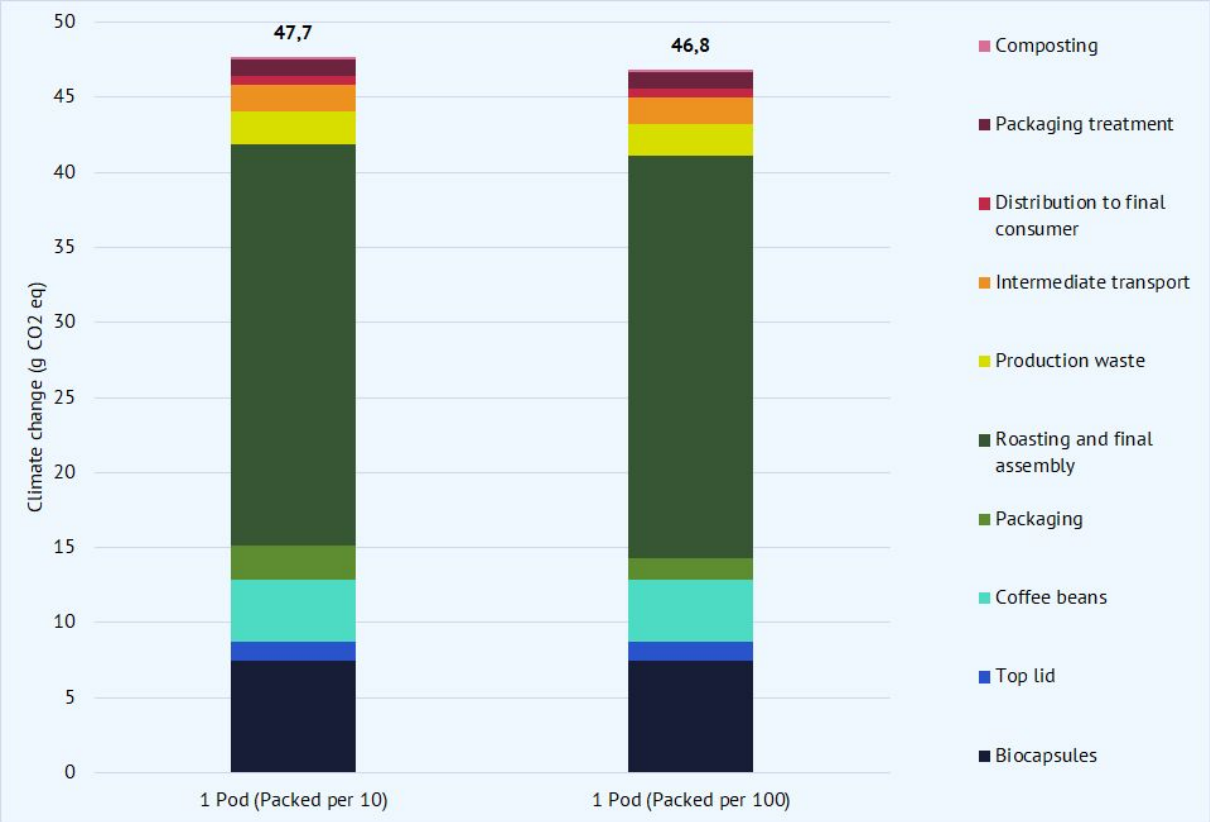
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APPENDIX

Figure 5: Contribution analysis, with extended insights in the climate change impact (in g CO2 eq)



GRIND

FUTUREPLUS



# ENVIRONMENTAL PRODUCT DECLARATION

According to ISO 14025

## ENVIRONMENTAL PRODUCT DECLARATION

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### **Biodegradable Coffee Pods**

Packaged per 10 or 100 pods

Owner of Declaration	Grind
Publisher	Hedgehog Company B.V.
Program operator	N.a.
Calculation number	EPD-2023-3301
Issue Date	14-02-2023

General information

Company

Manufacturer	Grind
Production Location	United Kingdom
Address	8-10 New North Place, London
EC2A 4JA	
E-mail	info@hahnplastics.com
Website	https://www.hahnplastics.com/

EPD information

EPD for	Grind
Project number	EPD-2023-3301
Date of issue	14-02-2023
Product Category Rules	Product Environmental Footprint
Declared unit	1 pod

Scope of declaration

This is a cradle-to-gate, with options, EPD for the Grind Nespresso® compatible coffee pods. The declared life cycle stages contain all relevant upstream processes to the production site, as well as core production processes including material and energy inputs and related emissions. Further distribution and end-of-life treatment are also included. The use stage is omitted. The results of other LCA studies and resulting Environmental Product Declarations (EPDs) are only comparable if they have been carried out according to the same calculation rules.

Verification statement of the background LCA

Independent verification of the background LCA report and data, according to EN ISO 14040/14044:



Internal



External

## Product description

The product of this study comprises biodegradable coffee pods. These coffee pods are made from a biopolymer which makes the pods fully biodegradable. The pods are filled with arabica coffee beans, produced in Brazil. After roasting and grinding the coffee beans, the pods are assembled and packaged for shipment. This EPD considers the Biodegradable Coffee Pods packed per 10 and per 100 pods. These pods are shipped to the final consumer. This EPD considers the final consumer to be in Manchester, U.K. The coffee pods are assumed to be composted at end-of-life.

## Declaration of material content of SVHC

No substances of very high concern of authorisation to declare.

## Calculation rules

The method used to quantify the environmental performance of the product in question is the LCA (LCA) regulated by ISO 14040 and ISO 14044. Process data over the year of 2022 is used to model the product system. Ecoinvent v3.6 is used as a background database.

For the evaluation of the environmental impact, process units included in the system boundaries comprise the following:

- Consumption of materials, energy and water during the cultivation of coffee beans and pods;
- Transport of resources to the roasting and assembly facility;
- Consumption of materials, energy and water during the roasting, grinding of the coffee beans and final product assembly;
- Production and collection of used packaging materials;
- Final distribution to end-consumer;
- End-of-life treatment of the product including packaging.



## Environmental impact per declared unit

The environmental impact results are presented in accordance with PEF. Table 9 presents the full environmental profile.

Table 9: Environmental profile of the production of 1 pod, packaged per 10 pods

Impact category name	Reference	Production	Distribution	End-of-Life	Total
<b>Climate change</b>	<b>kg CO2 eq</b>	<b>4,59E-02</b>	<b>5,55E-04</b>	<b>1,30E-03</b>	<b>4,78E-02</b>
Climate change - Fossil	kg CO2 eq	4,56E-02	5,54E-04	2,29E-04	4,64E-02
Climate change - Biogenic	kg CO2 eq	3,03E-04	3,01E-07	1,07E-03	1,37E-03
Climate change - Land use and LU change	kg CO2 eq	4,74E-05	2,37E-07	4,58E-08	4,76E-05
<b>Ozone depletion</b>	<b>kg CFC11 eq</b>	<b>6,19E-09</b>	<b>1,24E-10</b>	<b>1,05E-11</b>	<b>6,33E-09</b>
<b>Human toxicity, cancer</b>	<b>CTUh</b>	<b>1,23E-11</b>	<b>4,30E-13</b>	<b>2,41E-13</b>	<b>1,30E-11</b>
Human toxicity, cancer - metals	CTUh	7,20E-12	1,16E-13	1,02E-13	7,42E-12
Human toxicity, cancer - organics	CTUh	5,10E-12	3,15E-13	1,39E-13	5,55E-12
Human toxicity, cancer - inorganics	CTUh	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<b>Human toxicity, non-cancer</b>	<b>CTUh</b>	<b>3,32E-10</b>	<b>9,11E-12</b>	<b>1,46E-11</b>	<b>3,55E-10</b>
Human toxicity, non-cancer - metals	CTUh	2,76E-10	5,92E-12	4,53E-12	2,87E-10
Human toxicity, non-cancer - organics	CTUh	1,58E-11	7,56E-13	9,03E-12	2,56E-11
Human toxicity, non-cancer - inorganics	CTUh	4,36E-11	2,46E-12	1,03E-12	4,71E-11
<b>Particulate matter</b>	<b>disease inc.</b>	<b>3,61E-09</b>	<b>5,16E-11</b>	<b>1,34E-11</b>	<b>3,68E-09</b>
<b>Ionising radiation</b>	<b>kBq U-235 eq</b>	<b>2,37E-03</b>	<b>3,73E-05</b>	<b>3,68E-06</b>	<b>2,41E-03</b>
<b>Photochemical ozone formation</b>	<b>kg NMVOC eq</b>	<b>1,34E-04</b>	<b>3,51E-06</b>	<b>6,90E-05</b>	<b>2,07E-04</b>
<b>Acidification</b>	<b>mol H+ eq</b>	<b>5,62E-04</b>	<b>3,15E-06</b>	<b>1,16E-06</b>	<b>5,67E-04</b>
<b>Eutrophication, terrestrial</b>	<b>mol N eq</b>	<b>2,02E-03</b>	<b>1,19E-05</b>	<b>4,50E-06</b>	<b>2,04E-03</b>
<b>Eutrophication, marine</b>	<b>kg N eq</b>	<b>2,62E-04</b>	<b>1,07E-06</b>	<b>1,17E-06</b>	<b>2,65E-04</b>
<b>Eutrophication, freshwater</b>	<b>kg P eq</b>	<b>7,87E-06</b>	<b>5,95E-09</b>	<b>1,83E-09</b>	<b>7,88E-06</b>
<b>Ecotoxicity, freshwater</b>	<b>CTUe</b>	<b>6,06E-01</b>	<b>7,52E-03</b>	<b>6,20E-03</b>	<b>6,20E-01</b>
Ecotoxicity, freshwater - metals	CTUe	5,18E-01	5,26E-03	1,07E-03	5,24E-01
Ecotoxicity, freshwater - organics	CTUe	2,09E-02	4,86E-04	6,91E-04	2,21E-02
Ecotoxicity, freshwater - inorganics	CTUe	6,80E-02	1,77E-03	4,43E-03	7,42E-02
<b>Land use</b>	<b>Pt</b>	<b>4,84E-01</b>	<b>6,30E-03</b>	<b>7,47E-04</b>	<b>4,91E-01</b>
<b>Water use</b>	<b>m3 depriv.</b>	<b>2,63E-02</b>	<b>2,86E-05</b>	<b>5,87E-05</b>	<b>2,63E-02</b>
<b>Resource use, fossils</b>	<b>MJ</b>	<b>7,50E-01</b>	<b>8,43E-03</b>	<b>1,43E-03</b>	<b>7,60E-01</b>
<b>Resource use, minerals and</b>	<b>kg Sb eq</b>	<b>2,92E-07</b>	<b>1,38E-08</b>	<b>1,17E-09</b>	<b>3,07E-07</b>

Table 10: Environmental profile of the production of 1 pod, packaged per 100 pods

Impact category name	Reference	Production	Distribution	End-of-Life	Total
<b>Climate change</b>	<b>kg CO2 eq</b>	<b>4,51E-02</b>	<b>5,49E-04</b>	<b>1,24E-03</b>	<b>4,69E-02</b>
Climate change - Fossil	kg CO2 eq	4,48E-02	5,49E-04	2,25E-04	4,55E-02
Climate change - Biogenic	kg CO2 eq	3,06E-04	2,98E-07	1,01E-03	1,32E-03
Climate change - Land use and LU change	kg CO2 eq	5,02E-05	2,34E-07	4,43E-08	5,05E-05
<b>Ozone depletion</b>	<b>kg CFC11 eq</b>	<b>6,14E-09</b>	<b>1,23E-10</b>	<b>9,98E-12</b>	<b>6,27E-09</b>
<b>Human toxicity, cancer</b>	<b>CTUh</b>	<b>1,17E-11</b>	<b>4,26E-13</b>	<b>2,28E-13</b>	<b>1,24E-11</b>
Human toxicity, cancer - metals	CTUh	6,87E-12	1,15E-13	9,63E-14	7,08E-12
Human toxicity, cancer - organics	CTUh	4,83E-12	3,11E-13	1,32E-13	5,27E-12
Human toxicity, cancer - inorganics	CTUh	0,00E+00	0,00E+00	0,00E+00	0,00E+00
<b>Human toxicity, non-cancer</b>	<b>CTUh</b>	<b>3,09E-10</b>	<b>9,02E-12</b>	<b>1,42E-11</b>	<b>3,32E-10</b>
Human toxicity, non-cancer - metals	CTUh	2,59E-10	5,86E-12	4,29E-12	2,69E-10
Human toxicity, non-cancer - organics	CTUh	1,55E-11	7,49E-13	8,95E-12	2,52E-11
Human toxicity, non-cancer - inorganics	CTUh	3,89E-11	2,43E-12	9,76E-13	4,23E-11
<b>Particulate matter</b>	<b>disease inc.</b>	<b>3,54E-09</b>	<b>5,11E-11</b>	<b>1,29E-11</b>	<b>3,60E-09</b>
<b>Ionising radiation</b>	<b>kBq U-235 eq</b>	<b>2,31E-03</b>	<b>3,69E-05</b>	<b>3,55E-06</b>	<b>2,35E-03</b>
<b>Photochemical ozone formation</b>	<b>kg NMVOC eq</b>	<b>1,31E-04</b>	<b>3,47E-06</b>	<b>6,90E-05</b>	<b>2,03E-04</b>
<b>Acidification</b>	<b>mol H+ eq</b>	<b>5,55E-04</b>	<b>3,12E-06</b>	<b>1,13E-06</b>	<b>5,59E-04</b>
<b>Eutrophication, terrestrial</b>	<b>mol N eq</b>	<b>2,01E-03</b>	<b>1,17E-05</b>	<b>4,39E-06</b>	<b>2,02E-03</b>
<b>Eutrophication, marine</b>	<b>kg N eq</b>	<b>2,61E-04</b>	<b>1,06E-06</b>	<b>1,11E-06</b>	<b>2,64E-04</b>
<b>Eutrophication, freshwater</b>	<b>kg P eq</b>	<b>7,81E-06</b>	<b>5,89E-09</b>	<b>1,78E-09</b>	<b>7,82E-06</b>
<b>Ecotoxicity, freshwater</b>	<b>CTUe</b>	<b>5,37E-01</b>	<b>7,44E-03</b>	<b>5,91E-03</b>	<b>5,50E-01</b>
Ecotoxicity, freshwater - metals	CTUe	4,50E-01	5,20E-03	1,03E-03	4,56E-01
Ecotoxicity, freshwater - organics	CTUe	2,01E-02	4,81E-04	6,89E-04	2,13E-02
Ecotoxicity, freshwater - inorganics	CTUe	6,68E-02	1,76E-03	4,19E-03	7,28E-02
<b>Land use</b>	<b>Pt</b>	<b>2,49E-01</b>	<b>6,24E-03</b>	<b>7,12E-04</b>	<b>2,56E-01</b>
<b>Water use</b>	<b>m3 depriv.</b>	<b>2,53E-02</b>	<b>2,83E-05</b>	<b>5,62E-05</b>	<b>2,54E-02</b>
<b>Resource use, fossils</b>	<b>MJ</b>	<b>7,39E-01</b>	<b>8,34E-03</b>	<b>1,39E-03</b>	<b>7,49E-01</b>
<b>Resource use, minerals and</b>	<b>kg Sb eq</b>	<b>2,73E-07</b>	<b>1,37E-08</b>	<b>1,12E-09</b>	<b>2,88E-07</b>

Figure 6: Contribution of the different emission sources to the climate change impact of the pods

