LCA report
for Carbstones

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1. INTRODUCTION

1.1. General

This life cycle analysis (LCA) was drawn up on behalf of Orbix. This concerns an LCA calculation of Carbstones produced by Gubbels based on the raw materials supplied by Orbix . This report provides substantiation for the environmental performance of the Carbstones . Various variants of this product are being investigated, including: Carbstone, Carbstone ClimaSono, Carbstone Kimblok, Carbstone Filling Stone (B12, B16, B20, VB12), and Carbstone Soundblox (G, W, N, A).

This report meets the requirements of ISO 14025 [1], ISO 14040 [2], ISO 14044[1] [3], NEN-EN 15804+A2 [4]and B-EPD Construction Product Category Rules version 18.10.2022 [5].

The LCA calculation was prepared with SimaPro v9.4 software. The reference databases used are:
- Ecoinvent database 3.6

1.2. Objective and target group

The goal is to conduct an LCA study and prepare a complete LCA file for testing according to the B-EPD standards. The study provides insight into the environmental effects in the production chain as a result of the extraction of raw materials, transport, production and end-of-life processing of 1 m ^{2} wall of Carbstone, Carbstone ClimaSono, Carbstone Kimblok, Carbstone Filling Stone (B12, B16, B20). , VB12), and Carbstone Soundblox (G, W, N, A).

This data can be used, among other things, for TOTEM. This is a calculation tool used to calculate the environmental effects of buildings. In this tool, the environmental performance of buildings is calculated by multiplying the results of the LCA (per impact category) by a set of weighting factors. This results in an aggregated value for the environmental performance of a construction product. To enable comparisons between different projects, the total score of the building is divided by the gross floor area and the lifespan of the building: the result is a single-score indicator of environmental performance per square meter per year. Therefore, the results of this study are presented as characterized and weighted scores.

The expected application of the environmental statement is the passing on of environmental information in the construction chain, for example for use in LCA databases and calculations of complete buildings. The LCA can also be used for communication between companies. The target groups of this study are:
- Orbix and Gubbels who will gain insight into the environmental performance of their products;
- Users of third-party verified environmental data such as manufacturers, designers, architects and construction companies.

This LCA cannot be compared with LCAs that have not been drawn up in accordance with the B-EPD version 18.10.2022 and EN 15804+A2.

1.3. Product description

The Carbstones are carbonated hollow quick-build bricks and solid bricks with dimensions as mentioned in paragraph 1.2. The applied carbonation technique, developed by Orbix, transforms metal slag from the steel industry into circular construction products.
Carbstones are characterized by the fact that they absorb CO_2 through carbonation. This happens because the Carbstones have metallic slag as ingredients, which is a calcium-rich material. The calcium reacts with water and CO_2 to form calcium carbonate, a strong binder. As a result, the Carbstone has a binding agent of CO_2 instead of cement. The building material has the same characteristics as a concrete block. The difference is in the capture of the CO_2 .

This report includes seven Carbstone product groups. One product from each of this product group has been chosen to explain the results in this report, this is the most sold product of that product group in 2022. Table 1 Table 1the product groups, the most sold product of the group and the other products

[1] As an exception to the provisions in ISO14044, the environmental impact results are weighted to a "single point" (weighting) .

on display (note: not every product group is sold equally, namely the Climasono only represents a maximum of 3% of the turnover of the Carbstone).

Table 1Overview of the associated product groups

Product group	Most sold product	Other products
Carbstone hollow	Carbstone hollow 39/14/19	Carbstone hollow 39/09/19, Carbstone hollow 39/19/19, Carbstone hollow 39/19/29, Carbstone hollow 29/14/19, Carbstone hollow 29/19/19, Carbstone hollow 29/14/14, Carbstone hollow 29/19/12, Carbstone hollow calibrated 40/14/20, Carbstone hollow calibrated 40/19/20, Carbstone hollow calibrated 50/14/24, Carbstone hollow calibrated 50/19/24.
Carbstone vol	Carbstone full 29/14/19	Carbstone full 29/09/09, Carbstone full 29/09/19, Carbstone full 29/09/14, Carbstone full 29/19/19
Carbstone ClimaSono hollow	Carbstone ClimaSono hollow 39/14/19	Carbstone ClimaSono hollow 39/09/19, Carbstone ClimaSono hollow 39/19/19, Carbstone ClimaSono hollow calibrated 40/14/20, Carbstone ClimaSono hollow calibrated 40/19/20, Carbstone ClimaSono hollow 29/14/14, Carbstone ClimaSono hollow calibrated 50/14/24, Carbstone ClimaSono hollow calibrated 50/19/24
Carbstone ClimaSono vol	Carbstone ClimaSono vol 29/14/19	Carbstone ClimaSono vol 29/09/19, Carbstone ClimaSono vol 29/19/19,
Carbstone Kimblok vol	Carbstone Kimblok vol 29/14/22	Carbstone Kimblok vol 29/09/22, Carbstone Kimblok vol 29/19/22
Carbstone Fulstone	Carbstone Vulsteen B12 hol 49/12/20	Carbstone Vulsteen B16 hol 49/16/20, Carbstone Vulsteen B20 hol 49/20/20, Carbstone Vulsteen VB12 hol 31/12/20
Carbstone Soundblox	Carbstone Soundblox W hol 39/14/19	Carbstone Soundblox G hol 39/09/19, Carbstone Soundblox N hol 32/19/19, Carbstone Soundblox A hol 49.5/19/19

The tables below show the dimensions and weight per stone. The tables are divided by product group.

Table 2Product specifications of Carbstone hollow and Carbstone calibrated

Length	Width	Height	Volumic mass (kg/stone)
39	9	19	13.22
39	14	19	17.82
39	19	19	22.07
39	19	29	32.71
29	14	19	13.18
29	19	19	16.74
29	14	14	11.91
29	19	14	13.18
40	14	20	19.29
40	19	20	24.09
50	14	24	30.95
50	19	24	38.3

Table 3Product specifications of Carbstone vol

Length	Width	Height	Volumic mass (kg/stone)
29	9	9	5.85
29	9	19	12.50
29	9	14	9.16
29	14	19	19.12
29	19	19	26.77

Table 4Product specifications of Carbstone ClimaSono hollow and hollow calibrated

Length	Width	Height	Volumic mass (kg/stone)
39	9	19	8.67
39	14	19	11.94
39	19	19	14.82

40	14	20	12.95
40	19	20	16,18
29	14	14	8.00
50	14	24	20.8
50	19	24	25.72

Table 5Product specifications of Carbstone ClimaSono vol

Length	Width	Height	Volumic mass (kg/stone)
29	9	19	8.37
29	14	19	12.80
29	19	19	17.93

Table 6Product specifications of Carbstone Kimblok

Length	Width	Height	Volumic mass (kg/stone)
29	9	22	9.74
29	14	22	15.03
29	19	22	20.64

Table 7Product specifications of Carbstone Filling Stone

Product	Length	Width	Height	Volumic mass (kg/stone)
Carbstone Filler Stone B12	49	14	20	15.04
Carbstone Filler B16	49	16	20	16.80
Carbstone Filler Stone B20	49	20	20	17.31
Carbstone Filler Stone VB12	31	12	20	8.02

Table 8Product specifications of Carbstone Soundblox

Product	Length	Width	Height	Volumic mass (kg/stone)
Carbstone Soundblox G	39	9	19	10.64
Carbstone Soundblox W	39	14	19	15.21
Carbstone Soundblox N	32	19	19	14.44
Carbstone Soundblox A	49.5	19	19	23.60

1.4. Functional unit

The functional units of the Carbstone are determined according to the B-EPD calculation rules (PCR Construction products , this is 1 m^2 wall of Carbstones . The functional unit includes the material to secure the Carbstones (adhesive mortar).

The lifespan of the products is 100 years [7].

NEN-EN 15804 phases
The following table lists the NEN-EN 15804 modules that apply to this LCA [2].

Table 9EN 15804 modules

A1	A2	A3	A4	A5	b	C1	C2	C3	C4	D
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

[2] ✓= Data collection and impact assessment are the subject of this study
ND= Not declared

1.5. Data collection and quality

Input and output data are provided by Orbix and Gubbels for the following data categories:

- Materials (raw materials and consumables);
- Energy (electricity and heat);
- Emissions to air, water and soil.

Waste and other economic flows are also included in the data collection.

1.6. System boundaries

All material, energy and waste flows that occur during production (cradle-to-gate) are part of this study. The other life cycle phases are modeled based on standard principles from the B-EPD Construction Product Category Rules.

When using secondary materials, the impact is calculated from the moment these flows lose their waste status. For outgoing flows of secondary material, modeling is also continued until the moment these flows lose their waste status. For waste, this is modeled until the moment of final waste processing.

To create the LCA, the reference databases mentioned were used for the background processes (NMD process database 3.7 and Ecoinvent 3.6).

1.7. Cut-off criteria for inputs and outputs

All relevant and known processes and materials are included. The following processes are not included in this study because the contribution to the various environmental impacts is expected to be less than 1%:

- Maintenance and use of auxiliary materials and equipment, with the exception of such processes included in the Ecoinvent background processes.
- Capital goods and infrastructure processes, excluding such processes included in the Ecoinvent background processes. The capital goods of the crushing, sieving and separation process at Orbix are included.
- PMD, paper and cardboard, and waste oil are not included because the masses are lower than 0.008% and this mainly concerns office waste.

There are no suspicions that any relevant inputs or outputs have been omitted. The criteria for input and output have been adhered to in accordance with the B-EPD, paragraph A17 and NEN-EN 15804, paragraph 6.2.

2. LIFE CYCLE INVENTORY

2.1. Description of the production process

Orbix produces the raw materials from metal recovery. This happens in 2 physical separation processes. In a first process (based on crushing, jigging, upflow columns), metal is recovered from the stainless steel slag. The following products are created: metal, gravel fraction (Stinox), sand fraction (Stinox), fine fraction (Carbinox) and midlings. The midlings then go to a second processing process (based on grinding, magnetic separation) during which further extensive metal recovery takes place from the midlings. The following products are created: metal and Fillinox.

Air liquide supplies the liquid CO_2 to Gubbels. The CO_2 is extracted from a mix of biomass and non-biomass as a source. This mix of biogenic and non-biogenic CO_2 comes from production processes where the CO_2 is captured (including SMR process and CO_2 removal from biogas). This CO_2 is cleaned and then liquefied by Air Liquide installations. Air liquide then sells the biogenic and non-biogenic CO_2 according to a credit system, which is controlled by Vinçotte . In practice, this means that biogenic liquid CO_2 does not have to come entirely from biogenic origins. The book & claim approach is therefore used here. This biogenic liquid CO_2 is sold according to the principle of the Guarantee of Origins , so for every quantity of biogenic certified liquid $CO_{2\ sold}$ there is proof that an equal amount of biogenic CO_2 was produced. Gubbels purchases the liquid CO_2 at the location in Geleen, where no biogenic liquid CO_2 is currently produced, but with the book & claim approach it is possible to speak of biogenic liquid CO_2 that is purchased by Gubbels [7].

Argex produces the expanded clay pellets for Gubbels.

Gubbels mixes the raw materials from Orbix and for the climasono also the expanded clay granules from Argex and presses this mixture into a block shape on a vibrating press. This pressed mix then goes to a climate chamber, in this chamber these stones remain for 24 hours, here the liquid CO_2 is injected into the process. It is measured how much CO_2 goes into the chamber and how much is left after 24 hours. The difference is then, taking into account the losses in the chamber and the process, recorded by the stones were created through carbonation and calcium carbonate. After this, the stones may be sharpened. Finally, they go to a stacking/packing machine, which sorts the Carbstones for storage and transport to customers.

2.2. Flowchart

Figure Figure 1Carbstones . The figure shows that production waste and dust from calibration also goes back into the process during mixing. This has not been included in this report, it has been assumed that this is a closed loop where as much production waste and dust from calibration is emitted as is entered into the process.

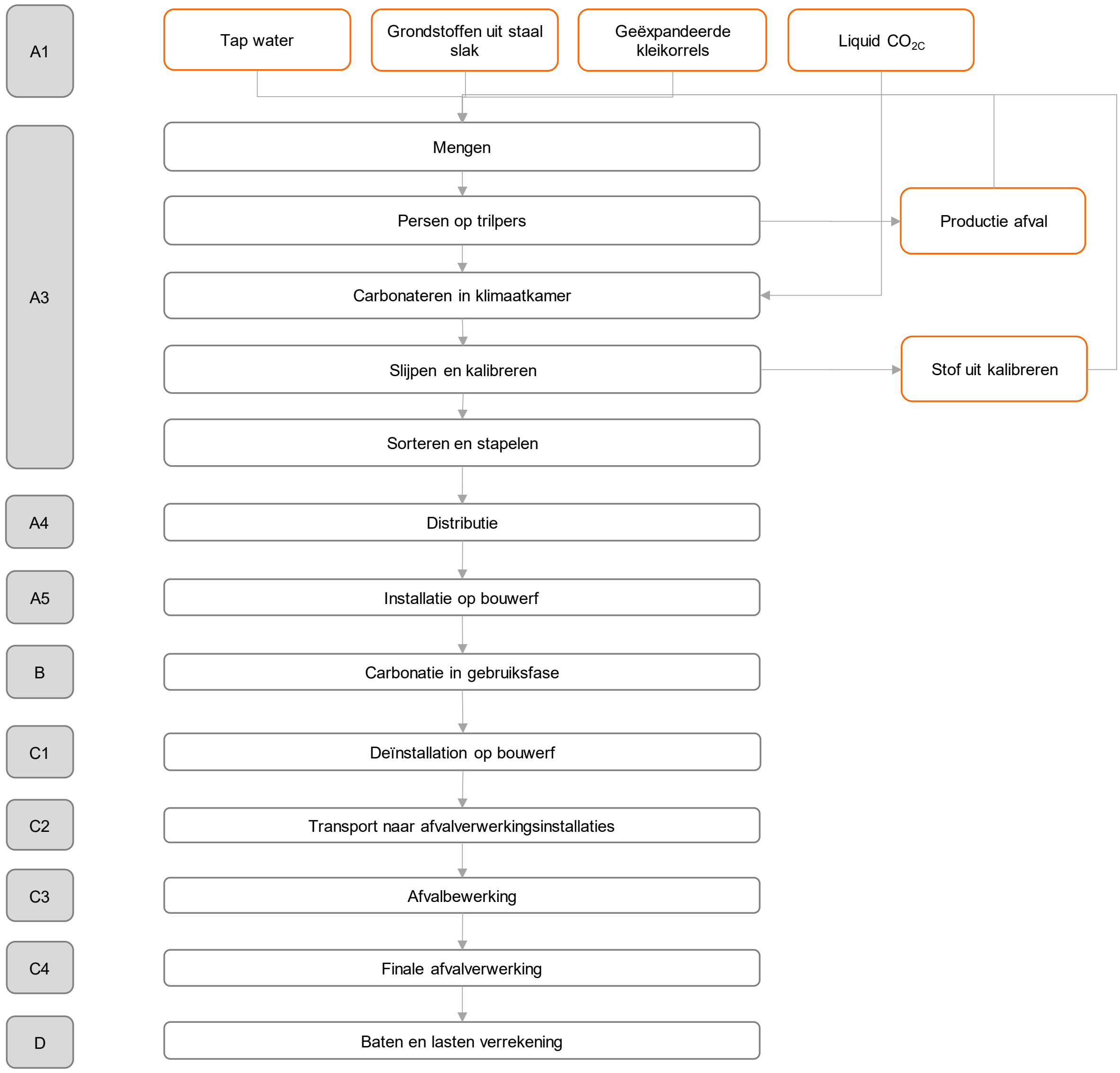

Figure 1Flowchart of Carbstones .

2.3. Extraction of raw materials (A1)

Table Table 10shows which materials are used for the different types of Carbstone and in what proportion .

Table 10Composition of materials per Carbstone in percentages

Material	Carbstone hollow	Carbstone vol	ClimaSono hollow	ClimaSono vol	Kimblok	Filler stone	Soundblox
Water	0.4%	0.5%	1.8%	4.0%	4.0%	0.5%	0.5%
Mixed sand (Stinox and Carbinox)	68.1%	61.8%	-	-	-	61.0%	68.0%
Stinox	22.0%	28.2%%	-	-	-	29.0%	22.0%
Carbinox	-	-	56.8%	55.5%	55.5%	-	-
Expanded clay granules	-	-	26.9%	26.3%	26.3%	-	-
Liquid $_{CO2}$	9.5%	9.5%	14.5%	14.2%	14.2%	9.5%	9.5%

Table 11Reference processes per material

Material	Reference process	Source	Explanation
Liquid $_{CO2}$	Carbon dioxide, liquid {RER}| production | Cutoff, U AIRLIQUIDE	[7]	See paragraph Liquid CO $_2$
Expanded clay granules	Expanded clay granules, AG 0/4 - 500 GEO, ARGEX, EN15804 A1+A2, 05-20-2026	[9]	See section Expanded clay granules
Carbinox	A1-3 Carbinox	[8]	See section Mixed sand, Stinox and Carbinox
Mixed sand	Mixed sand	[8]	See section Mixed sand, Stinox and Carbinox
Stinox	A1-3 Stinox gravel	[8]	See section Mixed sand, Stinox and Carbinox
Masterfix Glue	Cement/sand glue	[10]	See Glue section
Water	Tap water {RER}| market group for | Cutoff, U	[11]	Gubbels uses tap water, this process is assumed to be representative.
Pallet	EUR flat pallet {RER}| production | Cutoff, U	[11]	Gubbels transports the Carbstones on recycled pallets. Pallets have a usage cycle of 25 [12], so the quantity is done times 1/25.
PET straps	PET straps	[11]	Gubbels transports the carbstones with PET straps . The assumption is that the PET straps are made of polypropylene and extrusion takes place.

Mixed sand, Stinox and Carbinox

The mixed sand, Stinox and Carbinox all come from Orbix. These raw materials are taken from Orbix's LCA [8]. The allocation percentages have been adjusted for this report, as Gubbels can purchase raw materials at different prices. The economic allocation differences can be seen in the table below. Carbinox is Carbinox in the table, Stinox is Stinox granules in the table, and the Mixed Sand consists of 40% Stinox sand and 60% Carbinox.

Table 12Difference in economic allocation of Orbix's raw materials

Material	Location Genk			Location Châtelet		
	Original	New	Difference	Original	New	Difference
Carbinox	2.1%	0,02%	2,08	3,0%	0,04%	2,96
Stinox grind	8,1%	8,5%	-0,4	10,7%	11,1%	-0,4
Stinox zand	1,2%	1,3%	-0,1	2,2%	2,3%	-0,1

Liquid CO_2
Air Liquide had provided production data in the areas of emissions, energy use, additives and waste. This conversation revealed that no waste is produced during the production of liquid CO_2, the CO_2 and CH_4 are separated. In this process, methane is the main product and CO_2 is the by-product. When stripping CO_2 into biogas, the CO_2 cannot be separated 100% from methane, so liquid CO_2 contains a minimum amount of CH_4 (5ppm) and CH_4 also contains some CO_2.

To liquefy CO_2, a coolant (ammonia) or water is used for cooling. The coolants, water and chemicals to prevent mold, etc. (in cooling water) have not been taken into account in this LCA. It has been ignored because it is assumed that the impact of the coolant, chemicals and water will be limited (they are sealed systems). The biogas is also made into CO_2 at the location where biogas is produced. The emissions that take place occur during loading and unloading of the truck, so they are also limited emissions (5% is assumed based on Air Liquid's experience figures).

Liquid CO_2 is traded in certificates, which means that Orbix/Gubbels liquid CO_2 purchases in Geleen is of unknown origin, but is considered biogenic with the certificate. This principle works the same as Guarantee of Origin on the electricity market. The CO_2 is physically indistinguishable from the fossil or biogenic CO_2. So it is assumed that this will have no difference. Since the location of CO_2 liquefaction takes place at the location of the production of, among other things, biogas, the production locations are spread across Europe.

Capital goods are from the process " *Carbon dioxide, liquid {RER}| production* | *Cut-off, U* " adopted, see Table 13.

Table 13Processes for modeling Liquid CO_2 from Air Liquide (1 kg)

Ecoinvent processes	In or out	Quantity	Unit	Comments
Chemical factory, organics {RER}| construction | Cutoff, U	Input	4.00E-10	p	Capital goods are taken from the process " *Carbon dioxide, liquid {RER}| production* | *Cutoff, U* "
Electricity, medium voltage {RER}| market for | Cutoff, U	Input	0.22	kWh	Production of liquid CO_2 is spread across Europe. Per kg of liquid CO2, between 0.16-0.22 kWh of electricity is used based on data from AirLiquid , with large installations often being more efficient and therefore having lower energy consumption. However, CO_2 from biogas is often extracted with smaller installations. Therefore, worst-case scenario, it is assumed that 0.22 kWh is used.
Carbon dioxide, biogenic	Output	0.05 – 0.05 * 0.00018% =0.05	kg	Process adapted to biogenic , because biogenic liquid CO_2 is used.
Carbon dioxide, biogenic	Output	-1.005	Kg	CO2 intake including CO_2 leak, from liquid CO_2.
Methane , biogenic	Output	0.05 * 0.00018% = 9 E -6	kg	Process adapted to biogenic , because biogenic liquid CO_2 is used.

Expanded clay granules
Argex of the expanded clay granules, the size AG 0/4 – 500 GEO is used for [9]the Carbstones .

Glue

During construction, the Carbstones are stacked with glue. We assumed a thickness of 0.2 cm of glue (which is 2 mm when gluing), this was multiplied by the surface area of the stones that are stacked and multiplied by the density 1650 kg/m3 [10]. Masterfix consists of sand, cement and water, the technical specifications of Masterfix have not reported any proportions of the raw materials. As a result, the (conservative) assumption has been made that 30% consists of sand, 50% of cement and 20% of water.

Table14 Masterfix glue modeling (1 kg)

Ecoinvent processes	In or out	Quantity	Unit	Comments
Sand {CH}| market for sand | Cutoff, U	In	0.3	Kg	
Cement, Portland {Europe without Switzerland}| market for | Cutoff, U	In	0.5	Kg	
Tap water {CH}| market for | Cutoff, U	In	0.2	Kg	

Packaging

The Carbstones are transported on pallets and secured to the pallets with PET straps .

Table 15Pallet modeling (1 kg)

Ecoinvent processes	In or out	Unit	Comments
EUR flat pallet {RER}| production | Cutoff, U	In	Kg	The quantity (kg) of pallets used is divided by 24, 1 pallet weighs 24 kg according to the Ecoinvent process. It is also divided by 25, this is because the usage cycle of the pallet is 25 times [12].

PET straps modeling table 16(0.996 kg)

Ecoinvent processes	In or out	Quantity	Unit	Comments
Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Cutoff, U	In	1	Kg	From the Ecoinvent extrusion processes , 1 kg results in 0.996 kg of straps .
Extrusion, plastic pipes {RER}| extrusion, plastic pipes | Cutoff, U	In	1	Kg	From the Ecoinvent extrusion processes , 1 kg results in 0.996 kg of straps .
Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Cutoff, U	Out	0.004	kg	1 kg of extrusion pipes results in 0.996 kg of product. The worst-case assumption is that it will be completely burned.

2.4. Transport raw materials (A2)

Table Table 17distances of the materials with the modality.

Table 17Distances of materials and raw materials to Gubbels

Material	Modality	Distance [km]	Reference process	Source
Carbinox	Truck 16-32t Euro 6	15.8	Transport, freight, lorry 16-32 metric tons, euro6 {RER}| market for transport, freight, lorry 16-32 metric tons, EURO6 | Cutoff, U	[11]
Stinox	Truck 16-32t Euro 6	15.8	Transport, freight, lorry 16-32 metric tons, euro6 {RER}| market for transport, freight, lorry 16-32 metric tons, EURO6 | Cutoff, U	[11]
Mixed sand	Vrachtwagen 16-32t Euro 6	15,8	Transport, freight, lorry 16-32 metric ton, euro6 {RER}| market for transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, U	[11]
Liquid CO_2	Vrachtwagen 16-32t Euro 6	18	Transport, freight, lorry 16-32 metric ton, euro6 {RER}| market for transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, U	[11]
Argex	Vrachtwagen 16-32t Euro 5	107	Transport, freight, lorry >32 metric ton, euro5 {RER}| market for transport, freight, lorry >32 metric ton, EURO5 | Cut-off, U	[13]
Pallets	Vrachtwagen 16-	8	Transport, freight, lorry 16-32 metric ton, euro6	[11]

	32t Euro 6		{RER}| market for transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, U	
PET	Vrachtwagen 3,5-7,5t Euro 6	90	Transport, freight, lorry 3.5-7.5 metric ton, euro6 {RER}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO6 | Cut-off, U	[11]

2.5. Productie (A3)

Table Table 18shows the energy and emissions of the production process . Gubbels generates electricity himself from solar panels. Net electricity is generated than used throughout the year, so it is assumed that all solar electricity is used. These are modeled by adjusting the low voltage market mix of Belgium to completely solar energy. The ratio of the Ecoinvent process " *Electricity, low voltage {BE}| market for* | *Cut-off, U* " for solar energy have been used to determine the new quantities to make 1 kWh of solar electricity.

Furthermore, there is the emission of carbon dioxide into the air. This emission is caused by the fact that some CO $_{2\ \text{always}}$ remains in the reaction chamber and escapes when it is opened.

Table 18Production of the carbstone

Process	Reference process	Source quantity
Electricity	Electricity, low voltage {BE}| market for | Cut-off, U Gubbels PV	[11]
Carbon dioxide to air	Carbon dioxide, biogenic	[11]

2.6. Distribution and transport (A4 and C2)

The B-EPD prescribes that the process " *Transport, freight , lorry 16-32 metric tons, euro5 {RER}*| *market for transport, freight , lorry 16-32 metric tons, EURO5* | *Cut-off, U* " should be used for the transportation provided that no other information is available about how the transportation will proceed.

Gubbels had reported that deliveries are made to various locations to middlemen. The average distance to the middlemen is 40 km. This is based on the average distances of the following locations:

- Hasselt, 26 km
- Genk, 12 km
- Hoeselt, 24 km
- Tongeren, 37 km
- Pelt, 38 km
- Maasmechelen, 8 km
- Brussels, 97 km
- Grobbendonk, 74 km
- Mole, 58 km
- Bree, 19 km

There are also fixed values that should be used in the absence of specific data, which is the case here. These distances are:

- For A4 from the intermediary to the construction site: 35 km.
- For C2 to the recycling facility: 30 km.
- For C2 to the incinerator: 100 km.
- For C2 to the dump: 50 km.

The distance from A4 is therefore 75 km for the carbstones . The adhesive is supposed to go directly from the manufacturer to the construction site. The packaging waste is also transported to waste processing plants, this is done in A5 with the same standard values.

2.7. Installation (A5)

In this phase the carbstones are placed on the construction site. The placement of the stones is done manually.

The packaging waste is also processed here, this is shown in the table below. Avoided energy is not included , this is because very little packaging material (wood and polypropylene) is burned.

Table 19Installation of the Carbstone

Process	Reference process	Explanation
Transportation	Transport, freight, lorry >32 metric tons, euro5 {RER}| market for transport, freight, lorry >32 metric tons, EURO5 | Cutoff, U	The worst-case assumption is that the pallet and PET are incinerated.
Incineration of PET	Waste polypropylene {CH}| treatment of, municipal incineration | Cutoff, U	The worst-case assumption is that the PET is incinerated.
Recycling pallet	Wood chipping, industrial residual wood, stationary electric chipper {GLO}| market for | Cutoff, U	Belgian law requires that wood must be recycled. The Environmentally Responsible Management of Household Waste Implementation Plan (UPHA) indicates that collected wood may not be burned unless the contamination of the wood is too great for recycling[14]

2.8. Use phase (B)

In the use phase, carbonation also takes place over the years. This is because there is still CaOH present that will eventually react with CO_2 from the ambient air, which is converted into calcium carbonates. The carbonation of the hollow blocks in the use phase is still 0.39%, for the full blocks in the use phase it is 1.87%.

Via a Thermogravimetric (TGA) analysis measures how many hydroxides remain after the blocks have been in the climate chamber for 24 hours. These will eventually be converted into calcium carbonates. The degree of carbonation can vary due to the method of pressing, which in turn has an effect on the cavities/pores of the Carbstone. A higher content of granules in full blocks will probably result in better pressing. As a result, the Carbstones have more pores and will allow more CO_2 diffusion.

2.9. Uninstallation (C1)

The Carbstone is manually uninstalled , so no impact occurs in this phase.

2.10. End of waste processing (C3, C4 and D)

The Carbstone has a similar function to concrete, which is why it was decided to follow this waste scenario. This means that 99% is sent to landfill and 1% is recycled. This deviates from the concrete waste scenario prescribed by B-EPD, because according to Belgian law it is mandatory to fully recycle concrete. The adhesive follows the scenario of finishing layers adhered to stony waste. It is assumed that the glue follows the same scenario, they are also not separated so they follow the same processes.

The energy avoided is not included in the calculation, as the amount of packaging is very little. The exported energy and heat as impact categories have therefore not been calculated.

Table: 20End of waste processing of the carbstone

Process	Reference process	Explanation
Recycling in C3	Waste concrete, not reinforced {Europe without Switzerland}| treatment of waste concrete, not reinforced, recycling | Cutoff, U	The assumption is that this product is comparable to cement, and therefore has the same processes. Both the recycling of the carbstone and glue are included here.
Landfill in C4	Waste concrete {Europe without Switzerland}| treatment of waste concrete, inert material landfill | Cutoff, U	The assumption is that this product is comparable to cement, and therefore has the same processes. Both the dump of the Carbstone and glue have been taken here.
Recycling in D	A1-3 Stinox gravel	The assumption is that the recycled Carbstone is comparable to Orbix's coarsest raw material (Stinox gravel). Only the recycling of the carbstone is included here , not the glue.

2.11. Energy content and secondary material

In accordance with EN 15804, primary energy sources must be included in the results as material use. To this end, primary renewable and non-renewable materials are distinguished, which are called PERM and PENRM respectively. Table 9 shows the energy content of the different materials based on their net calorific value.

The information about energy content and secondary content is also used in the calculations of module D. The calculations for the loss of secondary material and energy recovery are as follows:

Energy recovery:

*kg of material to be burned * LHV of material * % energy recovery (electricity and heat)*

Loss of secondary material (analysis per material):

*kg material used * (recycling percentage - secondary content)*

Table 21Energy and secondary content of materials

Material	LHV (MJ/kg)	Secondary content (%)	Source	Reference
Stainless steel steel slag		100%		Ecoinvent
Wood	13.99	0%	Renewable	Ecoinvent
Polypropylene	32.78	0%	Not renewable	Ecoinvent

Material	LHV (MJ/kg)	Secondary content (%)	Source	Reference
Liquid $_{CO2}$		n/a .		AirLiquide

3. LIFE CYCLE IMPACT ASSESSMENT

3.1. Characterized results

The values of the effect categories have been calculated by assigning environmental interventions from the inventory to effect categories. Table Table 22to

Table 28products from the 7 different Gubbels product groups. No connections were found that can be applied to the results of the best-selling products to calculate the other products in the group. This is due to a number of constant values in the inventory (electricity and Liquid CO2) , so no conversion factors have been found that fit. Now only the most sold products are included in this report from the 7 different Gubbels product groups, the others can be found in Appendix A

Table 22Characterized set 2 results of 1 m^2 Carbstone hollow 39/14/19

Impact category	Unit	Total	A1-3	A4	A5	b	C2	C3	C4	D
051.Climate change	kg CO2 eq	-8.15E+00	-1.18E+01	3.12E+00	4.26E-02	-9.23E-01	1.24E+00	9.74E-01	1.30E-02	-8.05E-01
052. Climate change - Fossil	kg CO2 eq	1.45E+01	9,97E+00	3,11E+00	4,26E-02	0,00E+00	1,24E+00	9,73E-01	1,29E-02	-8,02E-01
053. Climate change - Biogenic	kg CO2 eq	-2,27E+01	-2,18E+01	1,66E-03	3,66E-05	-9,23E-01	6,60E-04	2,71E-04	2,57E-05	-3,05E-03
054. Climate change - Land use and LU ch	kg CO2 eq	6,66E-03	5,50E-03	1,09E-03	1,21E-05	0,00E+00	4,32E-04	7,67E-05	3,61E-06	-4,51E-04
055. Ozone depletion	kg CFC11 eq	1,72E-06	6,79E-07	7,07E-07	7,20E-09	0,00E+00	2,81E-07	2,10E-07	5,33E-09	-1,68E-07
056. Acidification	mol H+ eq	6,61E-02	4,47E-02	1,27E-02	1,38E-04	0,00E+00	5,05E-03	1,02E-02	1,23E-04	-6,82E-03
057. Eutrophication, freshwater	kg P eq	4,54E-04	4,23E-04	2,44E-05	3,42E-07	0,00E+00	9,71E-06	3,54E-06	1,45E-07	-7,25E-06
058. Eutrophication, marine	kg N eq	1,70E-02	1,00E-02	3,77E-03	4,04E-05	0,00E+00	1,50E-03	4,49E-03	4,22E-05	-2,85E-03
059. Eutrophication, terrestrial	mol N eq	1,94E-01	1,17E-01	4,17E-02	4,47E-04	0,00E+00	1,66E-02	4,93E-02	4,66E-04	-3,17E-02
060. Photochemical ozone formation	kg NMVOC eq	5,43E-02	3,13E-02	1,28E-02	1,42E-04	0,00E+00	5,08E-03	1,36E-02	1,35E-04	-8,64E-03
061. Resource use, minerals and metals	kg Sb eq	5,42E-04	4,40E-04	8,42E-05	5,20E-07	0,00E+00	3,35E-05	1,49E-06	1,18E-07	-1,83E-05
062. Resource use, fossils	MJ	1,64E+02	9,94E+01	4,69E+01	4,95E-01	0,00E+00	1,86E+01	1,34E+01	3,62E-01	-1,49E+01
063. Water use	m3 depriv.	1,41E+00	1,28E+00	1,31E-01	1,85E-03	0,00E+00	5,19E-02	1,79E-02	1,62E-02	-9,29E-02
064. Particulate matter	disease inc.	1,67E-06	3,00E-07	2,17E-07	2,80E-09	0,00E+00	8,60E-08	1,23E-06	2,38E-09	-1,70E-07
065. Ionising radiation	kBq U-235 eq	5,99E-01	3,57E-01	2,05E-01	2,18E-03	0,00E+00	8,15E-02	5,74E-02	1,48E-03	-1,06E-01
066. Ecotoxicity, freshwater	CTUe	2,71E+02	2,18E+02	3,76E+01	4,09E-01	0,00E+00	1,49E+01	8,07E+00	2,35E-01	-8,44E+00
067. Human toxicity, cancer	CTUh	8,77E-09	7,34E-09	1,06E-09	1,13E-11	0,00E+00	4,20E-10	2,82E-10	5,42E-12	-3,47E-10
068. Human toxicity, non-cancer	CTUh	2,71E-07	2,14E-07	4,10E-08	4,54E-10	0,00E+00	1,63E-08	6,93E-09	1,67E-10	-7,42E-09
069. Land use	Pt	1,24E+02	7,90E+01	3,24E+01	5,43E-01	0,00E+00	1,29E+01	1.71E+00	7.58E-01	-2.98E+00

Table 23Characterized set 2 results of 1 m ^{2} Carbstone full 29/14/19

Impact category	Unit	Total	A1-3	A4	A5	b	C2	C3	C4	D
051.Climate change	kg CO2 eq	-1.82E+01	-1.83E+01	4.43E+00	4.29E-02	-6.38E+00	1.77E+00	1.39E+00	1.85E-02	-1.16E+00
052. Climate change - Fossil	kg CO2 eq	1,94E+01	1,29E+01	4,43E+00	4,28E-02	0,00E+00	1,77E+00	1,39E+00	1,85E-02	-1,15E+00
053. Climate change - Biogenic	kg CO2 eq	-3,76E+01	-3,12E+01	2,36E-03	3,69E-05	-6,38E+00	9,42E-04	3,87E-04	3,66E-05	-4,40E-03
054. Climate change - Land use and LU ch	kg CO2 eq	9,10E-03	7,46E-03	1,55E-03	1,22E-05	0,00E+00	6,18E-04	1,10E-04	5,15E-06	-6,50E-04
055. Ozone depletion	kg CFC11 eq	2,40E-06	9,19E-07	1,01E-06	7,25E-09	0,00E+00	4,01E-07	3,00E-07	7,61E-09	-2,42E-07
056. Acidification	mol H+ eq	9,07E-02	6,03E-02	1,81E-02	1,39E-04	0,00E+00	7,22E-03	1,45E-02	1,75E-04	-9,83E-03
057. Eutrophication, freshwater	kg P eq	6,30E-04	5,86E-04	3,48E-05	3,44E-07	0,00E+00	1,39E-05	5,06E-06	2,07E-07	-1,04E-05
058. Eutrophication, marine	kg N eq	2,33E-02	1,33E-02	5,37E-03	4,06E-05	0,00E+00	2,14E-03	6,42E-03	6,03E-05	-4,10E-03
059. Eutrophication, terrestrial	mol N eq	2,66E-01	1,57E-01	5,94E-02	4,50E-04	0,00E+00	2,37E-02	7,04E-02	6,65E-04	-4,57E-02
060. Photochemical ozone formation	kg NMVOC eq	7,45E-02	4,18E-02	1,82E-02	1,43E-04	0,00E+00	7,25E-03	1,94E-02	1,93E-04	-1,24E-02
061. Resource use, minerals and metals	kg Sb eq	7,67E-04	6,23E-04	1,20E-04	5,24E-07	0,00E+00	4,78E-05	2,13E-06	1,69E-07	-2,64E-05
062. Resource use, fossils	MJ	2,28E+02	1,36E+02	6,68E+01	4,99E-01	0,00E+00	2,66E+01	1,91E+01	5,17E-01	-2,15E+01
063. Water use	m3 depriv.	1,89E+00	1,72E+00	1,86E-01	1,86E-03	0,00E+00	7,41E-02	2,56E-02	2,32E-02	-1,34E-01
064. Particulate matter	disease inc.	2,37E-06	4,18E-07	3,08E-07	2,82E-09	0,00E+00	1,23E-07	1,76E-06	3,40E-09	-2,44E-07
065. Ionising radiation	kBq U-235 eq	8,29E-01	4,88E-01	2,92E-01	2,20E-03	0,00E+00	1,16E-01	8,20E-02	2,12E-03	-1,53E-01
066. Ecotoxicity, freshwater	CTUe	3,77E+02	3,02E+02	5,35E+01	4,12E-01	0,00E+00	2,13E+01	1,15E+01	3,35E-01	-1,22E+01
067. Human toxicity, cancer	CTUh	1,22E-08	1,02E-08	1,50E-09	1,14E-11	0,00E+00	5,99E-10	4,03E-10	7,75E-12	-5,00E-10
068. Human toxicity, non-cancer	CTUh	3,76E-07	2,95E-07	5,83E-08	4,58E-10	0,00E+00	2,33E-08	9,90E-09	2,38E-10	-1,07E-08
069. Land use	Pt	1,65E+02	1,01E+02	4,60E+01	5,47E-01	0,00E+00	1,84E+01	2,44E+00	1,08E+00	-4,29E+00

Tabel 24Gekarekteriseerde set 2 results of 1 m [2] Carbstone ClimaSono hol 39/14/19

Impact category	Einheid	Total	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	kg CO2 eq	3,21E+00	6,67E-01	2,14E+00	4,26E-02	-6,19E-01	8,44E-01	6,64E-01	8,84E-03	-5,39E-01
052. Climate change - Fossil	kg CO2 eq	2,57E+01	2,26E+01	2,14E+00	4,26E-02	0,00E+00	8,43E-01	6,64E-01	8,82E-03	-5,37E-01
053. Climate change - Biogenic	kg CO2 eq	-2,25E+01	-2,18E+01	1,14E-03	3,66E-05	-6,19E-01	4,50E-04	1,85E-04	1,75E-05	-2,05E-03
054. Climate change - Land use and LU ch	kg CO2 eq	1,14E-02	1,06E-02	7,47E-04	1,21E-05	0,00E+00	2,95E-04	5,23E-05	2,46E-06	-3,02E-04
055. Ozone depletion	kg CFC11 eq	1,95E-06	1,23E-06	4,85E-07	7,20E-09	0,00E+00	1,92E-07	1,43E-07	3,63E-09	-1,13E-07
056. Acidification	mol H+ eq	4,55E-01	4,40E-01	8,73E-03	1,38E-04	0,00E+00	3,45E-03	6,94E-03	8,38E-05	-4,57E-03
057. Eutrophication, freshwater	kg P eq	1,71E-03	1,69E-03	1,68E-05	3,42E-07	0,00E+00	6,62E-06	2,42E-06	9,89E-08	-4,86E-06
058. Eutrophication, marine	kg N eq	2,54E-02	2,05E-02	2,59E-03	4,04E-05	0,00E+00	1,02E-03	3,06E-03	2,88E-05	-1,91E-03
059. Eutrophication, terrestrial	mol N eq	2,92E-01	2,38E-01	2,86E-02	4,47E-04	0,00E+00	1,13E-02	3,36E-02	3,18E-04	-2,13E-02
060. Photochemical ozone formation	kg NMVOC eq	1,01E-01	8,51E-02	8,77E-03	1,42E-04	0,00E+00	3,46E-03	9,25E-03	9,23E-05	-5,79E-03
061. Resource use, minerals and metals	kg Sb eq	5,38E-04	4,68E-04	5,78E-05	5,20E-07	0,00E+00	2,28E-05	1,02E-06	8,07E-08	-1,23E-05
062. Resource use, fossils	MJ	2,46E+02	2,01E+02	3,22E+01	4,95E-01	0,00E+00	1,27E+01	9,14E+00	2,47E-01	-1,00E+01
063. Water use	m3 depriv.	3,49E+00	3,41E+00	8,96E-02	1,85E-03	0,00E+00	3,54E-02	1,22E-02	1,11E-02	-6,22E-02
064. Particulate matter	disease inc.	3,72E-06	2,79E-06	1,49E-07	2,80E-09	0,00E+00	5,87E-08	8,40E-07	1,62E-09	-1,14E-07
065. Ionising radiation	kBq U-235 eq	1,04E+00	8,69E-01	1,41E-01	2,18E-03	0,00E+00	5,56E-02	3,91E-02	1,01E-03	-7,12E-02
066. Ecotoxicity, freshwater	CTUe	3,67E+02	3,31E+02	2,58E+01	4,09E-01	0,00E+00	1,02E+01	5,51E+00	1,60E-01	-5,65E+00
067. Human toxicity, cancer	CTUh	1,22E-08	1,12E-08	7,25E-10	1,13E-11	0,00E+00	2,86E-10	1,92E-10	3,70E-12	-2,33E-10
068. Human toxicity, non-cancer	CTUh	3,49E-07	3,09E-07	2,81E-08	4,54E-10	0,00E+00	1,11E-08	4,73E-09	1,14E-10	-4,97E-09
069. Land use	Pt	2,38E+02	2,07E+02	2.22E+01	5.43E-01	0.00E+00	8.77E+00	1.17E+00	5.17E-01	-2.00E+00

Table 25Characterized set 2 results of 1 m ^{2} Carbstone ClimaSono full 29/14/19

Impact category	Unit	Total	A1-3	A4	A5	b	C2	C3	C4	D
051.Climate change	kg CO2 eq	-7.28E-01	-9.04E-01	3.02E+00	4.29E-02	-4.27E+00	1,20E+00	9,44E-01	1,26E-02	-7,76E-01
052. Climate change - Fossil	kg CO2 eq	3,49E+01	3,05E+01	3,02E+00	4,28E-02	0,00E+00	1,20E+00	9,44E-01	1,25E-02	-7,73E-01
053. Climate change - Biogenic	kg CO2 eq	-3,56E+01	-3,13E+01	1,61E-03	3,69E-05	-4,27E+00	6,40E-04	2,62E-04	2,49E-05	-2,94E-03
054. Climate change - Land use and LU ch	kg CO2 eq	1,54E-02	1,42E-02	1,06E-03	1,22E-05	0,00E+00	4,19E-04	7,44E-05	3,50E-06	-4,35E-04
055. Ozone depletion	kg CFC11 eq	2,68E-06	1,67E-06	6,86E-07	7,25E-09	0,00E+00	2,72E-07	2,04E-07	5,17E-09	-1,62E-07
056. Acidification	mol H+ eq	6,47E-01	6,26E-01	1,23E-02	1,39E-04	0,00E+00	4,90E-03	9,87E-03	1,19E-04	-6,58E-03
057. Eutrophication, freshwater	kg P eq	2,20E-03	2,17E-03	2,37E-05	3,44E-07	0,00E+00	9,42E-06	3,44E-06	1,41E-07	-6,99E-06
058. Eutrophication, marine	kg N eq	3,51E-02	2,83E-02	3,66E-03	4,06E-05	0,00E+00	1,45E-03	4,36E-03	4,10E-05	-2,74E-03
059. Eutrophication, terrestrial	mol N eq	4,03E-01	3,28E-01	4,05E-02	4,50E-04	0,00E+00	1,61E-02	4,78E-02	4,52E-04	-3,06E-02
060. Photochemical ozone formation	kg NMVOC eq	1,40E-01	1,18E-01	1,24E-02	1,43E-04	0,00E+00	4,92E-03	1,31E-02	1,31E-04	-8,33E-03
061. Resource use, minerals and metals	kg Sb eq	7,53E-04	6,54E-04	8,17E-05	5,24E-07	0,00E+00	3,25E-05	1,45E-06	1,15E-07	-1,77E-05
062. Resource use, fossils	MJ	3,33E+02	2,70E+02	4,55E+01	4,99E-01	0,00E+00	1,81E+01	1,30E+01	3,51E-01	-1,44E+01
063. Water use	m3 depriv.	4,47E+00	4,35E+00	1,27E-01	1,86E-03	0,00E+00	5,03E-02	1,74E-02	1,57E-02	-8,96E-02
064. Particulate matter	disease inc.	5,28E-06	3,95E-06	2,10E-07	2,82E-09	0,00E+00	8,34E-08	1,19E-06	2,31E-09	-1,64E-07
065. Ionising radiation	kBq U-235 eq	1,42E+00	1,19E+00	1,99E-01	2,20E-03	0,00E+00	7,90E-02	5,57E-02	1,44E-03	-1,03E-01
066. Ecotoxicity, freshwater	CTUe	4,88E+02	4,37E+02	3,65E+01	4,12E-01	0,00E+00	1,45E+01	7,83E+00	2,27E-01	-8,14E+00
067. Human toxicity, cancer	CTUh	1,67E-08	1,53E-08	1,02E-09	1,14E-11	0,00E+00	4,07E-10	2,74E-10	5,26E-12	-3,35E-10
068. Human toxicity, non-cancer	CTUh	4,63E-07	4,08E-07	3,97E-08	4,58E-10	0,00E+00	1,58E-08	6,72E-09	1,62E-10	-7,16E-09
069. Land use	Pt	3,24E+02	2,80E+02	3,14E+01	5,47E-01	0,00E+00	1,25E+01	1,66E+00	7,35E-01	-2,87E+00

Tabel 26Gekarekteriseerde set 2 results of 1 m ^{2} Carbstone Kimblok 29/14/22

Impact category	Einheid	Total	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	kg CO2 eq	-3,26E+00	-3,41E+00	3,05E+00	3,71E-02	-4,34E+00	1,21E+00	9,55E-01	1,27E-02	-7,88E-01
052. Climate change - Fossil	kg CO2 eq	3,29E+01	2,84E+01	3,05E+00	3,71E-02	0,00E+00	1,21E+00	9,55E-01	1,27E-02	-7,85E-01
053. Climate change - Biogenic	kg CO2 eq	-3,61E+01	-3,18E+01	1,63E-03	3,19E-05	-4,34E+00	6,47E-04	2,65E-04	2,52E-05	-2,99E-03
054. Climate change - Land use and LU ch	kg CO2 eq	1,32E-02	1,20E-02	1,07E-03	1,05E-05	0,00E+00	4,24E-04	7,52E-05	3,54E-06	-4,42E-04
055. Ozone depletion	kg CFC11 eq	2,54E-06	1,52E-06	6,92E-07	6,27E-09	0,00E+00	2,76E-07	2,06E-07	5,22E-09	-1,65E-07
056. Acidification	mol H+ eq	6,46E-01	6,25E-01	1,25E-02	1,20E-04	0,00E+00	4,96E-03	9,98E-03	1,20E-04	-6,68E-03
057. Eutrophication, freshwater	kg P eq	1,40E-03	1,37E-03	2,39E-05	2,98E-07	0,00E+00	9,52E-06	3,47E-06	1,42E-07	-7,10E-06
058. Eutrophication, marine	kg N eq	3,43E-02	2,75E-02	3,70E-03	3,51E-05	0,00E+00	1,47E-03	4,41E-03	4,14E-05	-2,79E-03
059. Eutrophication, terrestrial	mol N eq	3,90E-01	3,15E-01	4,09E-02	3,89E-04	0,00E+00	1,63E-02	4,84E-02	4,57E-04	-3,11E-02
060. Photochemical ozone formation	kg NMVOC eq	1,36E-01	1,14E-01	1,25E-02	1,24E-04	0,00E+00	4,98E-03	1,33E-02	1,33E-04	-8,46E-03
061. Resource use, minerals and metals	kg Sb eq	7,28E-04	6,29E-04	8,25E-05	4,53E-07	0,00E+00	3,28E-05	1,46E-06	1,16E-07	-1,79E-05
062. Resource use, fossils	MJ	2,94E+02	2,30E+02	4,60E+01	4,31E-01	0,00E+00	1,83E+01	1,31E+01	3,55E-01	-1,46E+01
063. Water use	m3 depriv.	3,01E+00	2,89E+00	1,28E-01	1,61E-03	0,00E+00	5,09E-02	1,76E-02	1,59E-02	-9,10E-02
064. Particulate matter	disease inc.	5,25E-06	3,91E-06	2,12E-07	2,44E-09	0,00E+00	8,44E-08	1,21E-06	2,34E-09	-1,66E-07
065. Ionising radiation	kBq U-235 eq	1,31E+00	1,07E+00	2,01E-01	1,90E-03	0,00E+00	7,99E-02	5,63E-02	1,46E-03	-1,04E-01
066. Ecotoxicity, freshwater	CTUe	3,97E+02	3,45E+02	3,68E+01	3,56E-01	0,00E+00	1,46E+01	7,92E+00	2,30E-01	-8,26E+00
067. Human toxicity, cancer	CTUh	1,51E-08	1,37E-08	1,03E-09	9,87E-12	0,00E+00	4,12E-10	2,77E-10	5,32E-12	-3,40E-10
068. Human toxicity, non-cancer	CTUh	3,82E-07	3,26E-07	4,01E-08	3,96E-10	0,00E+00	1,60E-08	6,80E-09	1.64E-10	-7.27E-09
069. Land use	Pt	3.04E+02	2.60E+02	3.17E+01	4.73E-01	0.00E+00	1.26E+01	1.68E+00	7.44E-01	-2.92E+00

Table 27Characterized set 2 results of 1 m^2 Carbstone Filling stone B12

Impact category	Unit	Total	A1-3	A4	A5	b	C2	C3	C4	D
051.Climate change	kg CO2 eq	-8,01E+00	-1,02E+01	1,95E+00	2,62E-02	-5,99E-01	7,73E-01	6,08E-01	8,10E-03	-5,22E-01
052. Climate change - Fossil	kg CO2 eq	6,70E+00	3,86E+00	1,94E+00	2,61E-02	0,00E+00	7,73E-01	6,08E-01	8,08E-03	-5,20E-01
053. Climate change - Biogenic	kg CO2 eq	-1,47E+01	-1,41E+01	1,04E-03	2,25E-05	-5,99E-01	4,12E-04	1,69E-04	1,60E-05	-1,98E-03
054. Climate change - Land use and LU ch	kg CO2 eq	3,78E-03	3,06E-03	6,80E-04	7,44E-06	0,00E+00	2,70E-04	4,79E-05	2,25E-06	-2,92E-04
055. Ozone depletion	kg CFC11 eq	9,88E-07	3,41E-07	4,42E-07	4,42E-09	0,00E+00	1,75E-07	1,31E-07	3,33E-09	-1,09E-07
056. Acidification	mol H+ eq	3,56E-02	2,24E-02	7,94E-03	8,45E-05	0,00E+00	3,16E-03	6,36E-03	7,67E-05	-4,42E-03
057. Eutrophication, freshwater	kg P eq	2,60E-04	2,41E-04	1,53E-05	2,10E-07	0,00E+00	6,07E-06	2,21E-06	9,06E-08	-4,70E-06
058. Eutrophication, marine	kg N eq	9,05E-03	4,74E-03	2,36E-03	2,48E-05	0,00E+00	9,37E-04	2,81E-03	2,64E-05	-1,84E-03
059. Eutrophication, terrestrial	mol N eq	1,03E-01	5,57E-02	2,61E-02	2,75E-04	0,00E+00	1,04E-02	3,08E-02	2,91E-04	-2,06E-02
060. Photochemical ozone formation	kg NMVOC eq	2,93E-02	1,51E-02	7,98E-03	8,75E-05	0,00E+00	3,17E-03	8,47E-03	8,45E-05	-5,60E-03
061. Resource use, minerals and metals	kg Sb eq	3,39E-04	2,76E-04	5,26E-05	3,20E-07	0,00E+00	2,09E-05	9,32E-07	7,40E-08	-1,19E-05
062. Resource use, fossils	MJ	9,32E+01	5,31E+01	2,93E+01	3,04E-01	0,00E+00	1,16E+01	8,37E+00	2,26E-01	-9,68E+00
063. Water use	m3 depriv.	7,30E-01	6,54E-01	8,16E-02	1,14E-03	0,00E+00	3,24E-02	1,12E-02	1,01E-02	-6,02E-02
064. Particulate matter	disease inc.	1,02E-06	1,64E-07	1,35E-07	1,72E-09	0,00E+00	5,37E-08	7,70E-07	1,49E-09	-1,10E-07
065. Ionising radiation	kBq U-235 eq	3,30E-01	1,82E-01	1,28E-01	1,34E-03	0,00E+00	5,09E-02	3,59E-02	9,27E-04	-6,89E-02
066. Ecotoxicity, freshwater	CTUe	1,56E+02	1,23E+02	2,35E+01	2,51E-01	0,00E+00	9,33E+00	5,04E+00	1,47E-01	-5,47E+00
067. Human toxicity, cancer	CTUh	5,18E-09	4,29E-09	6,60E-10	6,96E-12	0,00E+00	2,62E-10	1,76E-10	3,39E-12	-2,25E-10
068. Human toxicity, non-cancer	CTUh	1,54E-07	1,19E-07	2.56E-08	2.79E-10	0.00E+00	1.02E-08	4.33E-09	1.04E-10	-4.81E-09
069. Land use	Pt	7.49E+01	4.67E+01	2.02E+01	3.34E-01	0.00E+00	8.03E+00	1.07E+00	4.74E-01	-1.93E+00

Table 28Characterized set 2 results of 1 m [2] Carbstone Soundblox W

Impact category	Unit	Total	A1-3	A4	A5	b	C2	C3	C4	D
051. Climate change	kg CO2 eq	-9,40E+00	2,67E+00	2,84E-02	-7,88E-01	1,06E+00	8,36E-01	1,11E-02	-6,87E-01	-9,40E+00
052. Climate change - Fossil	kg CO2 eq	9,11E+00	2,67E+00	2,84E-02	0,00E+00	1,06E+00	8,36E-01	1,11E-02	-6,84E-01	9,11E+00
053. Climate change - Biogenic	kg CO2 eq	-1,85E+01	1,42E-03	2,44E-05	-7,88E-01	5,67E-04	2,32E-04	2,20E-05	-2,61E-03	-1,85E+01
054. Climate change - Land use and LU ch	kg CO2 eq	4,80E-03	9,32E-04	8,07E-06	0,00E+00	3,71E-04	6,59E-05	3,10E-06	-3,85E-04	4,80E-03
055. Ozone depletion	kg CFC11 eq	6,02E-07	6,05E-07	4,80E-09	0,00E+00	2,41E-07	1,81E-07	4,58E-09	-1,44E-07	6,02E-07
056. Acidification	mol H+ eq	3,97E-02	1,09E-02	9,17E-05	0,00E+00	4,34E-03	8,74E-03	1,05E-04	-5,82E-03	3,97E-02
057. Eutrophication, freshwater	kg P eq	3,70E-04	2,09E-05	2,28E-07	0,00E+00	8,34E-06	3,04E-06	1,25E-07	-6,19E-06	3,70E-04
058. Eutrophication, marine	kg N eq	8,93E-03	3,23E-03	2,69E-05	0,00E+00	1,29E-03	3,86E-03	3,63E-05	-2,43E-03	8,93E-03
059. Eutrophication, terrestrial	mol N eq	1,05E-01	3,57E-02	2,98E-04	0,00E+00	1,42E-02	4,23E-02	4,00E-04	-2,71E-02	1,05E-01
060. Photochemical ozone formation	kg NMVOC eq	2,78E-02	1,09E-02	9,50E-05	0,00E+00	4,36E-03	1,16E-02	1,16E-04	-7,38E-03	2,78E-02
061. Resource use, minerals and metals	kg Sb eq	3,81E-04	7,21E-05	3,47E-07	0,00E+00	2,87E-05	1,28E-06	1,02E-07	-1,56E-05	3,81E-04
062. Resource use, fossils	MJ	8,74E+01	4,02E+01	3,30E-01	0,00E+00	1,60E+01	1,15E+01	3,11E-01	-1,27E+01	8,74E+01
063. Water use	m3 depriv.	1,14E+00	1,12E-01	1,23E-03	0,00E+00	4,46E-02	1,54E-02	1,39E-02	-7,93E-02	1,14E+00
064. Particulate matter	disease inc.	2,64E-07	1,85E-07	1,87E-09	0,00E+00	7,39E-08	1,06E-06	2,05E-09	-1,45E-07	2,64E-07
065. Ionising radiation	kBq U-235 eq	3,17E-01	1,76E-01	1,46E-03	0,00E+00	7,00E-02	4,93E-02	1,27E-03	-9,08E-02	3,17E-01
066. Ecotoxicity, freshwater	CTUe	1,91E+02	3,22E+01	2,73E-01	0,00E+00	1,28E+01	6,93E+00	2,01E-01	-7,20E+00	1,91E+02
067. Human toxicity, cancer	CTUh	6,38E-09	9,05E-10	7,56E-12	0,00E+00	3,60E-10	2,42E-10	4,66E-12	-2,96E-10	6,38E-09
068. Human toxicity, non-cancer	CTUh	1,88E-07	3,51E-08	3,03E-10	0,00E+00	1,40E-08	5,95E-09	1,43E-10	-6,34E-09	1,88E-07
069. Land use	Pt	6,45E+01	2,77E+01	3,62E-01	0,00E+00	1,10E+01	1,47E+00	6,51E-01	-2,54E+00	6,45E+01

3.2. Gewogen resultaten

The values of the effect categories have been calculated by assigning environmental interventions from the inventory to effect categories. Table
Table 29to Table 35products from the 7 different Gubbels product groups. Weighting has been applied according to the principles in the B-EPD calculation rules. The weighted results were calculated by multiplying the characterized results by the PEF normalization and the weighting set of the B-EPD. This can be found in A

Impact category	Total	A1-3	A4	A5	B	C2		C3	C4	D
051. Climate change	-2,12E-04	-3,07E-04	8,10E-05	1,11E-06	-2,40E-05	3,22E-05		2,53E-05	3,37E-07	-2,09E-05
052. Climate change - Fossil	3,78E-04	2,59E-04	8,10E-05	1,11E-06	0,00E+00	3,22E-05		2,53E-05	3,36E-07	-2,08E-05
053. Climate change - Biogenic	-5,90E-04	-5,66E-04	4,32E-08	9,53E-10	-2,40E-05	1,72E-08		7,04E-09	6,67E-10	-7,94E-08
054. Climate change - Land use and LU ch	1,73E-07	1,43E-07	2,83E-08	3,15E-10	0,00E+00	1,12E-08		1,99E-09	9,38E-11	-1,17E-08
055. Ozone depletion	2,02E-06	7,99E-07	8,32E-07	8,46E-09	0,00E+00	3,30E-07		2,47E-07	6,27E-09	-1,98E-07
056. Acidification	7,38E-05	4,99E-05	1,42E-05	1,54E-07	0,00E+00	5,64E-06		1,14E-05	1,37E-07	-7,62E-06
057. Eutrophication, freshwater	7,91E-06	7,37E-06	4,26E-07	5,96E-09	0,00E+00	1,69E-07		6,17E-08	2,53E-09	-1,26E-07
058. Eutrophication, marine	2,58E-05	1,52E-05	5,71E-06	6,11E-08	0,00E+00	2,27E-06		6,80E-06	6,40E-08	-4,31E-06
059. Eutrophication, terrestrial	4,08E-05	2,47E-05	8,76E-06	9,38E-08	0,00E+00	3,48E-06		1,03E-05	9,78E-08	-6,66E-06
060. Photochemical ozone formation	6,39E-05	3,68E-05	1,50E-05	1,68E-07	0,00E+00	5,98E-06		1,60E-05	1,59E-07	-1,02E-05
061. Resource use, minerals and metals	6,43E-04	5,22E-04	9,99E-05	6,17E-07	0,00E+00	3,97E-05		1,77E-06	1,40E-07	-2,17E-05
062. Resource use, fossils	2,10E-04	1,27E-04	6,01E-05	6,34E-07	0,00E+00	2,39E-05		1,71E-05	4,63E-07	-1,91E-05
063. Water use	1,04E-05	9,50E-06	9,69E-07	1,37E-08	0,00E+00	3,85E-07		1,33E-07	1,20E-07	-6,89E-07
064. Particulate matter	2,51E-04	4,51E-05	3,26E-05	4,22E-07	0,00E+00	1,30E-05		1,85E-04	3,59E-07	-2,55E-05
065. Ionising radiation	7,11E-06	4,24E-06	2,44E-06	2,59E-08	0,00E+00	9,68E-07		6,82E-07	1,76E-08	-1,26E-06
066. Ecotoxicity, freshwater	1,22E-04	9,82E-05	1,69E-05	1,84E-07	0,00E+00	6,72E-06		3,63E-06	1,06E-07	-3,80E-06
067. Human toxicity, cancer	1,11E-05	9,25E-06	1,33E-06	1,43E-08	0,00E+00	5,29E-07		3,56E-07	6,84E-09	-4,37E-07
068. Human toxicity, non-cancer	2,17E-05	1,72E-05	3,28E-06	3,64E-08	0,00E+00	1,30E-06		5,55E-07	1,34E-08	-5,95E-07
069. Land use	1,20E-05	7,65E-06	3,13E-06	5,26E-08	0,00E+00	1,25E-06		1,66E-07	7,35E-08	-2,89E-07

Table 29Weighted results of 1 m^2 Carbstone hollow 39/14/19

Tabel 30 Gewogen resultaten van 1 m^2 Carbstone vol 29/14/19

Impact categorie	Totaal	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	-4,72E-04	-4,75E-04	1,15E-04	1,12E-06	-1,66E-04	4,60E-05	3,62E-05	4,82E-07	-3,02E-05
052. Climate change - Fossil	5,05E-04	3,37E-04	1,15E-04	1,11E-06	0,00E+00	4,59E-05	3,62E-05	4,81E-07	-3,00E-05
053. Climate change - Biogenic	-9,78E-04	-8,12E-04	6,15E-08	9,60E-10	-1,66E-04	2,45E-08	1,01E-08	9,53E-10	-1,14E-07
054. Climate change - Land use and LU ch	2,37E-07	1,94E-07	4,03E-08	3,17E-10	0,00E+00	1,61E-08	2,85E-09	1,34E-10	-1,69E-08
055. Ozone depletion	2,82E-06	1,08E-06	1,18E-06	8,52E-09	0,00E+00	4,72E-07	3,53E-07	8,95E-09	-2,85E-07
056. Acidification	1,01E-04	6,73E-05	2,02E-05	1,55E-07	0,00E+00	8,06E-06	1,62E-05	1,96E-07	-1,10E-05
057. Eutrophication, freshwater	1,10E-05	1,02E-05	6,06E-07	6,00E-09	0,00E+00	2,42E-07	8,82E-08	3,61E-09	-1,82E-07
058. Eutrophication, marine	3,52E-05	2,02E-05	8,13E-06	6,15E-08	0,00E+00	3,24E-06	9,72E-06	9,14E-08	-6,21E-06
059. Eutrophication, terrestrial	5,57E-05	3,29E-05	1,25E-05	9,45E-08	0,00E+00	4,97E-06	1,48E-05	1,40E-07	-9,59E-06
060. Photochemical ozone formation	8,77E-05	4,92E-05	2,14E-05	1,69E-07	0,00E+00	8,54E-06	2,28E-05	2,27E-07	-1,47E-05
061. Resource use, minerals and metals	9,10E-04	7,39E-04	1,42E-04	6,22E-07	0,00E+00	5,67E-05	2,53E-06	2,01E-07	-3,13E-05
062. Resource use, fossils	2,92E-04	1,74E-04	8,55E-05	6,38E-07	0,00E+00	3,41E-05	2,45E-05	6,61E-07	-2,75E-05
063. Water use	1,40E-05	1,27E-05	1,38E-06	1,38E-08	0,00E+00	5,50E-07	1,90E-07	1,72E-07	-9,93E-07
064. Particulate matter	3,57E-04	6,29E-05	4,64E-05	4,25E-07	0,00E+00	1,85E-05	2,65E-04	5,12E-07	-3,68E-05
065. Ionising radiation	9,85E-06	5,79E-06	3,47E-06	2,61E-08	0,00E+00	1,38E-06	9,74E-07	2,52E-08	-1,82E-06
066. Ecotoxicity, freshwater	1,69E-04	1,36E-04	2,41E-05	1,85E-07	0,00E+00	9,59E-06	5,19E-06	1,51E-07	-5,47E-06
067. Human toxicity, cancer	1,54E-05	1,28E-05	1,89E-06	1,44E-08	0,00E+00	7,56E-07	5,08E-07	9,76E-09	-6,30E-07
068. Human toxicity, non-cancer	3,01E-05	2,36E-05	4,67E-06	3,67E-08	0,00E+00	1,86E-06	7,93E-07	1,91E-08	-8,57E-07
069. Land use	1,60E-05	9,75E-06	4,46E-06	5,30E-08	0,00E+00	1,78E-06	2,37E-07	1,05E-07	-4,16E-07
Totaal	1,16E-03	4,07E-04	6,09E-04	4,74E-06	-3,32E-04	2,43E-04	4,36E-04	3,49E-06	-2,08E-04

Tabel 31 Gewogen resultaten van 1 m² Carbstone ClimaSono hol 39/14/19

Impact categorie	Totaal	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	8,34E-05	1,74E-05	5,56E-05	1,11E-06	-1,61E-05	2,20E-05	1,73E-05	2,30E-07	-1,40E-05
052. Climate change - Fossil	6,69E-04	5,87E-04	5,56E-05	1,11E-06	0,00E+00	2,19E-05	1,73E-05	2,29E-07	-1,40E-05
053. Climate change - Biogenic	-5,84E-04	-5,68E-04	2,96E-08	9,53E-10	-1,61E-05	1,17E-08	4,80E-09	4,55E-10	-5,32E-08
054. Climate change - Land use and LU ch	2,97E-07	2,76E-07	1,94E-08	3,15E-10	0,00E+00	7,67E-09	1,36E-09	6,40E-11	-7,86E-09
055. Ozone depletion	2,29E-06	1,45E-06	5,71E-07	8,46E-09	0,00E+00	2,25E-07	1,69E-07	4,27E-09	-1,33E-07
056. Acidification	5,08E-04	4,91E-04	9,74E-06	1,54E-07	0,00E+00	3,85E-06	7,75E-06	9,35E-08	-5,10E-06
057. Eutrophication, freshwater	2,98E-05	2,95E-05	2,92E-07	5,96E-09	0,00E+00	1,15E-07	4,21E-08	1,72E-09	-8,47E-08
058. Eutrophication, marine	3,84E-05	3,11E-05	3,92E-06	6,11E-08	0,00E+00	1,55E-06	4,64E-06	4,36E-08	-2,89E-06
059. Eutrophication, terrestrial	6,12E-05	5,01E-05	6,01E-06	9,38E-08	0,00E+00	2,37E-06	7,06E-06	6,67E-08	-4,46E-06
060. Photochemical ozone formation	1,19E-04	1,00E-04	1,03E-05	1,68E-07	0,00E+00	4,08E-06	1,09E-05	1,09E-07	-6,82E-06
061. Resource use, minerals and metals	6,38E-04	5,55E-04	6,86E-05	6,17E-07	0,00E+00	2,71E-05	1,21E-06	9,58E-08	-1,46E-05
062. Resource use, fossils	3,15E-04	2,57E-04	4,12E-05	6,34E-07	0,00E+00	1,63E-05	1,17E-05	3,16E-07	-1,28E-05
063. Water use	2,59E-05	2,53E-05	6,65E-07	1,37E-08	0,00E+00	2,63E-07	9,08E-08	8,20E-08	-4,62E-07
064. Particulate matter	5,60E-04	4,19E-04	2,24E-05	4,22E-07	0,00E+00	8,83E-06	1,26E-04	2,45E-07	-1,71E-05
065. Ionising radiation	1,23E-05	1,03E-05	1,67E-06	2,59E-08	0,00E+00	6,60E-07	4,65E-07	1,20E-08	-8,46E-07
066. Ecotoxicity, freshwater	1,65E-04	1,49E-04	1,16E-05	1,84E-07	0,00E+00	4,58E-06	2,48E-06	7,20E-08	-2,54E-06
067. Human toxicity, cancer	1,54E-05	1,41E-05	9,14E-07	1,43E-08	0,00E+00	3,61E-07	2,43E-07	4,66E-09	-2,93E-07
068. Human toxicity, non-cancer	2,79E-05	2,48E-05	2,25E-06	3,64E-08	0,00E+00	8,89E-07	3,79E-07	9,11E-09	-3.98E-07
069. Land use	2.31E-05	2.01E-05	2.15E-06	5.26E-08	0.00E+00	8.49E-07	1.13E-07	5.01E-08	-1.93E-07
Total	2.71E-03	2.21E-03	2.93E-04	4.71E-06	-3.22E-05	1.16E-04	2.08E-04	1.66E-06	-9.68E-05

Table 32Weighted results of 1 m 2 Carbstone ClimaSono full 29/14/19

Impact category	Total	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	-1,89E-05	-2,35E-05	7,86E-05	1,12E-06	-1,11E-04	3,12E-05	2,46E-05	3,27E-07	-2,02E-05
052. Climate change - Fossil	9,08E-04	7,92E-04	7,85E-05	1,11E-06	0,00E+00	3,12E-05	2,45E-05	3,26E-07	-2,01E-05
053. Climate change - Biogenic	-9,25E-04	-8,14E-04	4,19E-08	9,60E-10	-1,11E-04	1,66E-08	6,83E-09	6,47E-10	-7,66E-08
054. Climate change - Land use and LU ch	4,00E-07	3,71E-07	2,75E-08	3,17E-10	0,00E+00	1,09E-08	1,93E-09	9,09E-11	-1,13E-08
055. Ozone depletion	3,16E-06	1,97E-06	8,07E-07	8,52E-09	0,00E+00	3,20E-07	2,40E-07	6,08E-09	-1,91E-07
056. Acidification	7,22E-04	6,99E-04	1,38E-05	1,55E-07	0,00E+00	5,47E-06	1,10E-05	1,33E-07	-7,34E-06
057. Eutrophication, freshwater	3,83E-05	3,78E-05	4,13E-07	6,00E-09	0,00E+00	1,64E-07	5,99E-08	2,45E-09	-1,22E-07
058. Eutrophication, marine	5,32E-05	4,29E-05	5,54E-06	6,15E-08	0,00E+00	2,20E-06	6,60E-06	6,20E-08	-4,16E-06
059. Eutrophication, terrestrial	8,45E-05	6,88E-05	8,50E-06	9,45E-08	0,00E+00	3,37E-06	1,00E-05	9,48E-08	-6,42E-06
060. Photochemical ozone formation	1,65E-04	1,39E-04	1,46E-05	1,69E-07	0,00E+00	5,79E-06	1,55E-05	1,54E-07	-9,81E-06
061. Resource use, minerals and metals	8,93E-04	7,76E-04	9,69E-05	6,22E-07	0,00E+00	3,85E-05	1,72E-06	1,36E-07	-2,10E-05
062. Resource use, fossils	4,26E-04	3,46E-04	5,83E-05	6,38E-07	0,00E+00	2,31E-05	1,66E-05	4,49E-07	-1,84E-05
063. Water use	3,32E-05	3,23E-05	9,40E-07	1,38E-08	0,00E+00	3,73E-07	1,29E-07	1,17E-07	-6,65E-07
064. Particulate matter	7,95E-04	5,95E-04	3,16E-05	4,25E-07	0,00E+00	1,26E-05	1,80E-04	3,48E-07	-2,46E-05
065. Ionising radiation	1,69E-05	1,41E-05	2,36E-06	2,61E-08	0,00E+00	9,38E-07	6,61E-07	1,71E-08	-1,22E-06
066. Ecotoxicity, freshwater	2,20E-04	1,96E-04	1,64E-05	1,85E-07	0,00E+00	6,51E-06	3,52E-06	1,02E-07	-3,66E-06
067. Human toxicity, cancer	2,10E-05	1,92E-05	1,29E-06	1,44E-08	0,00E+00	5,13E-07	3,45E-07	6,63E-09	-4,22E-07
068. Human toxicity, non-cancer	3,71E-05	3,27E-05	3,18E-06	3,67E-08	0,00E+00	1,26E-06	5,38E-07	1,30E-08	-5,73E-07
069. Land use	3,14E-05	2,71E-05	3,04E-06	5,30E-08	0,00E+00	1,21E-06	1,61E-07	7.12E-08	-2.78E-07
Total	3.50E-03	2.98E-03	4.15E-04	4.74E-06	-2.22E-04	1.65E-04	2.96E-04	2.37E-06	-1.39E-04

Table 33Weighted results of 1 m 2 Carbstone Kimblok 19/14/22

Impact category	Total	A1-3	A4	A5	b	C2	C3	C4	D
051.Climate change	-8.49E-05	-8.87E-05	7.94E-05	9,65E-07	-1,13E-04	3,16E-05	2,48E-05	3,31E-07	-2,05E-05
052. Climate change - Fossil	8,56E-04	7,39E-04	7,93E-05	9,64E-07	0,00E+00	3,15E-05	2,48E-05	3,30E-07	-2,04E-05
053. Climate change - Biogenic	-9,39E-04	-8,26E-04	4,23E-08	8,30E-10	-1,13E-04	1,68E-08	6,90E-09	6,54E-10	-7,77E-08
054. Climate change - Land use and LU ch	3,43E-07	3,13E-07	2,77E-08	2,74E-10	0,00E+00	1,10E-08	1,96E-09	9,20E-11	-1,15E-08
055. Ozone depletion	2,99E-06	1,79E-06	8,14E-07	7,37E-09	0,00E+00	3,24E-07	2,42E-07	6,15E-09	-1,94E-07
056. Acidification	7,21E-04	6,97E-04	1,39E-05	1,34E-07	0,00E+00	5,53E-06	1,11E-05	1,34E-07	-7,46E-06
057. Eutrophication, freshwater	2,43E-05	2,38E-05	4,17E-07	5,19E-09	0,00E+00	1,66E-07	6,05E-08	2,48E-09	-1,24E-07
058. Eutrophication, marine	5,20E-05	4,16E-05	5,60E-06	5,32E-08	0,00E+00	2,23E-06	6,67E-06	6,27E-08	-4,22E-06
059. Eutrophication, terrestrial	8,19E-05	6,61E-05	8,58E-06	8,17E-08	0,00E+00	3,41E-06	1,02E-05	9,59E-08	-6,52E-06
060. Photochemical ozone formation	1,61E-04	1,34E-04	1,47E-05	1,46E-07	0,00E+00	5,86E-06	1,57E-05	1,56E-07	-9,96E-06
061. Resource use, minerals and metals	8,64E-04	7,46E-04	9,79E-05	5,38E-07	0,00E+00	3,89E-05	1,74E-06	1,38E-07	-2,13E-05
062. Resource use, fossils	3,76E-04	2,95E-04	5,88E-05	5,52E-07	0,00E+00	2,34E-05	1,68E-05	4,54E-07	-1,87E-05
063. Water use	2,24E-05	2,15E-05	9,49E-07	1,19E-08	0,00E+00	3,78E-07	1,31E-07	1,18E-07	-6,75E-07
064. Particulate matter	7,90E-04	5,88E-04	3,19E-05	3,68E-07	0,00E+00	1,27E-05	1,82E-04	3,52E-07	-2,50E-05
065. Ionising radiation	1,56E-05	1,28E-05	2,39E-06	2,26E-08	0,00E+00	9,49E-07	6,68E-07	1,73E-08	-1,24E-06
066. Ecotoxicity, freshwater	1,78E-04	1,55E-04	1,66E-05	1,60E-07	0,00E+00	6,59E-06	3,56E-06	1,04E-07	-3,72E-06
067. Human toxicity, cancer	1,90E-05	1,72E-05	1,30E-06	1,24E-08	0,00E+00	5,19E-07	3,49E-07	6,70E-09	-4,28E-07
068. Human toxicity, non-cancer	3,06E-05	2,61E-05	3,21E-06	3,17E-08	0,00E+00	1,28E-06	5,45E-07	1,31E-08	-5,82E-07
069. Land use	2,95E-05	2,52E-05	3,07E-06	4,58E-08	0,00E+00	1,22E-06	1,62E-07	7,21E-08	-2,83E-07
Totaal	3,20E-03	2,68E-03	4,19E-04	4,10E-06	-2,26E-04	1,67E-04	2,99E-04	2,39E-06	-1,41E-04

Tabel 34 Gewogen resultaten van 1 m² Carbstone Vulsteen B12

Impact categorie	Totaal	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	-2,08E-04	-2,67E-04	5,06E-05	6,81E-07	-1,56E-05	2,01E-05	1,58E-05	2,11E-07	-1,36E-05
052. Climate change - Fossil	1,74E-04	1,00E-04	5,06E-05	6,80E-07	0,00E+00	2,01E-05	1,58E-05	2,10E-07	-1,35E-05
053. Climate change - Biogenic	-3,83E-04	-3,67E-04	2,70E-08	5,86E-10	-1,56E-05	1,07E-08	4,40E-09	4,17E-10	-5,15E-08
054. Climate change - Land use and LU ch	9,82E-08	7,97E-08	1,77E-08	1,93E-10	0,00E+00	7,02E-09	1,25E-09	5,86E-11	-7,61E-09
055. Ozone depletion	1,16E-06	4,01E-07	5,19E-07	5,20E-09	0,00E+00	2,06E-07	1,54E-07	3,91E-09	-1,28E-07
056. Acidification	3,97E-05	2,50E-05	8,87E-06	9,43E-08	0,00E+00	3,52E-06	7,10E-06	8,56E-08	-4,94E-06
057. Eutrophication, freshwater	4,53E-06	4,20E-06	2,66E-07	3,66E-09	0,00E+00	1,06E-07	3,86E-08	1,58E-09	-8,19E-08
058. Eutrophication, marine	1,37E-05	7,18E-06	3,57E-06	3,75E-08	0,00E+00	1,42E-06	4,25E-06	4,00E-08	-2,79E-06
059. Eutrophication, terrestrial	2,16E-05	1,17E-05	5,47E-06	5,77E-08	0,00E+00	2,17E-06	6,47E-06	6,11E-08	-4,32E-06
060. Photochemical ozone formation	3,45E-05	1,78E-05	9,40E-06	1,03E-07	0,00E+00	3,73E-06	9,97E-06	9,95E-08	-6,59E-06
061. Resource use, minerals and metals	4,02E-04	3,27E-04	6,24E-05	3,79E-07	0,00E+00	2,48E-05	1,11E-06	8,77E-08	-1,41E-05
062. Resource use, fossils	1,19E-04	6,79E-05	3,75E-05	3,90E-07	0,00E+00	1,49E-05	1,07E-05	2,89E-07	-1,24E-05
063. Water use	5,42E-06	4,85E-06	6,05E-07	8,43E-09	0,00E+00	2,41E-07	8,32E-08	7,51E-08	-4,47E-07
064. Particulate matter	1,53E-04	2,47E-05	2,04E-05	2,59E-07	0,00E+00	8,09E-06	1,16E-04	2,24E-07	-1,65E-05
065. Ionising radiation	3,92E-06	2,16E-06	1,52E-06	1,59E-08	0,00E+00	6,05E-07	4,26E-07	1,10E-08	-8,18E-07
066. Ecotoxicity, freshwater	7,01E-05	5,53E-05	1,06E-05	1,13E-07	0,00E+00	4,20E-06	2,27E-06	6,59E-08	-2,46E-06
067. Human toxicity, cancer	6,52E-06	5,41E-06	8,32E-07	8,78E-09	0,00E+00	3,30E-07	2,22E-07	4,27E-09	-2,84E-07
068. Human toxicity, non-cancer	1,24E-05	9,50E-06	2,05E-06	2,24E-08	0,00E+00	8,15E-07	3,47E-07	8,35E-09	-3.85E-07
069. Land use	7,25E-06	4,52E-06	1,96E-06	3,23E-08	0,00E+00	7,78E-07	1,03E-07	4,59E-08	-1,87E-07
Total	4,78E-04	3,45E-05	2,67E-04	2,89E-06	-3,11E-05	1,06E-04	1,91E-04	1,52E-06	-9,36E-05

Table 35Gewogen resultaten van 1 m [2] Carbstone Soundblox W

Impact categorie	Totaal	A1-3	A4	A5	B	C2	C3	C4	D
051. Climate change	-1,63E-04	-2,45E-04	6,94E-05	7,39E-07	-2,05E-05	2,76E-05	2,17E-05	2,90E-07	-1,79E-05
052. Climate change - Fossil	3,39E-04	2,37E-04	6,93E-05	7,38E-07	0,00E+00	2,76E-05	2,17E-05	2,89E-07	-1,78E-05
053. Climate change - Biogenic	-5,02E-04	-4,81E-04	3,70E-08	6,35E-10	-2,05E-05	1,47E-08	6,05E-09	5,73E-10	-6,78E-08
054. Climate change - Land use and LU ch	1,51E-07	1,25E-07	2,42E-08	2,10E-10	0,00E+00	9,66E-09	1,71E-09	8,06E-11	-1,00E-08
055. Ozone depletion	1,76E-06	7,08E-07	7,12E-07	5,64E-09	0,00E+00	2,84E-07	2,12E-07	5,38E-09	-1,69E-07
056. Acidification	6,48E-05	4,43E-05	1,22E-05	1,02E-07	0,00E+00	4,84E-06	9,76E-06	1,18E-07	-6,50E-06
057. Eutrophication, freshwater	6,90E-06	6,44E-06	3,65E-07	3,97E-09	0,00E+00	1,45E-07	5,30E-08	2,17E-09	-1,08E-07
058. Eutrophication, marine	2,26E-05	1,35E-05	4,89E-06	4,07E-08	0,00E+00	1,95E-06	5,84E-06	5,49E-08	-3,68E-06
059. Eutrophication, terrestrial	3,58E-05	2,20E-05	7,50E-06	6,26E-08	0,00E+00	2,99E-06	8,89E-06	8,40E-08	-5,68E-06
060. Photochemical ozone formation	5,60E-05	3,28E-05	1,29E-05	1,12E-07	0,00E+00	5,13E-06	1,37E-05	1,37E-07	-8,68E-06
061. Resource use, minerals and metals	5,55E-04	4,51E-04	8,56E-05	4,12E-07	0,00E+00	3,41E-05	1,52E-06	1,21E-07	-1,85E-05
062. Resource use, fossils	1,83E-04	1,12E-04	5,14E-05	4,23E-07	0,00E+00	2,05E-05	1,47E-05	3,97E-07	-1,63E-05
063. Water use	9,29E-06	8,49E-06	8,30E-07	9,15E-09	0,00E+00	3,31E-07	1,14E-07	1,03E-07	-5,88E-07
064. Particulate matter	2,17E-04	3,97E-05	2,79E-05	2,81E-07	0,00E+00	1,11E-05	1,59E-04	3,08E-07	-2,18E-05
065. Ionising radiation	6,22E-06	3,76E-06	2,09E-06	1,73E-08	0,00E+00	8,31E-07	5,85E-07	1,51E-08	-1,08E-06
066. Ecotoxicity, freshwater	1,06E-04	8,60E-05	1,45E-05	1,23E-07	0,00E+00	5,77E-06	3,12E-06	9,06E-08	-3,24E-06
067. Human toxicity, cancer	9,58E-06	8,04E-06	1,14E-06	9,52E-09	0,00E+00	4,54E-07	3,05E-07	5,87E-09	-3,73E-07
068. Human toxicity, non-cancer	1,90E-05	1,51E-05	2,81E-06	2,43E-08	0,00E+00	1,12E-06	4,77E-07	1,15E-08	-5,08E-07
069. Land use	1,00E-05	6.25E-06	2.68E-06	3.51E-08	0.00E+00	1.07E-06	1.42E-07	6.31E-08	-2.46E-07
Total	9.77E-04	3.61E-04	3.66E-04	3.14E-06	-4.10E-05	1.46E-04	2.62E-04	2.10E-06	-1.23E-04

4. LIFE CYCLE INTERPRETATION

4.1. Approach interpretation

In this chapter the results from the previous chapter are interpreted in two ways. Firstly, the focus of the characterized results is examined. Second, a sensitivity analysis is performed based on the characterized results.

4.2. Center of gravity analysis

Figure Figure **2**, Figure 3and Figure 4stone that does not use glue in laying the stone. The Carbstone ClimaSono 39/14/19 has expanded clay granules and Carbinox, and the Carbstone hollow 39/14/19 has Mengsand and Stinox. The assumption is that these products are representative of all products. The proportions of the materials are not expected to lead to significant differences in the center of gravity analysis.

What is striking in the figures is that the liquid CO $_2$ and the glue have a high impact in almost every category. In the Carbstone ClimaSono there is also a high impact of the expanded clay granules, but here we do not have more information about the cause of the high contribution to the environmental profiles since the data comes from an EPD.

In the Carbstone Filling Stone there is also a high impact due to the mixed sand, because the impact of the glue is also missing. The Carbstone cave also has an impact from the mixed sand, this is mainly due to the transport in inland waters of the Carbinox and Stinox. This causes the impact in eutrohpication - marine and - terrestrial , also it also results in the impact in ecotoxicity .

Liquid $_{CO2}$ has An high impact in resource use, minerals and metals through the infrastructure process " *Chemical factory, organics {RER}| construction* | *Cutoff, U* ". This is due to the use of zinc and gold in the construction of the " *Building, multi- storey {RER}| construction* | *Cut-off, U",* but mainly due to the copper and rubber use in " *Chemical factory {RER}| construction* | *Cutoff, U"* . Furthermore, Liquid CO $_2$ has a high impact in human toxicity , non- cancer due to monoethanolamine which is released as emissions to the air according to the Ecoinvent process.

The Masterfix glue has a high impact in Climate change - fossil , this is due to the use of (Portland) clinker in the glue where emissions are released in the production process.

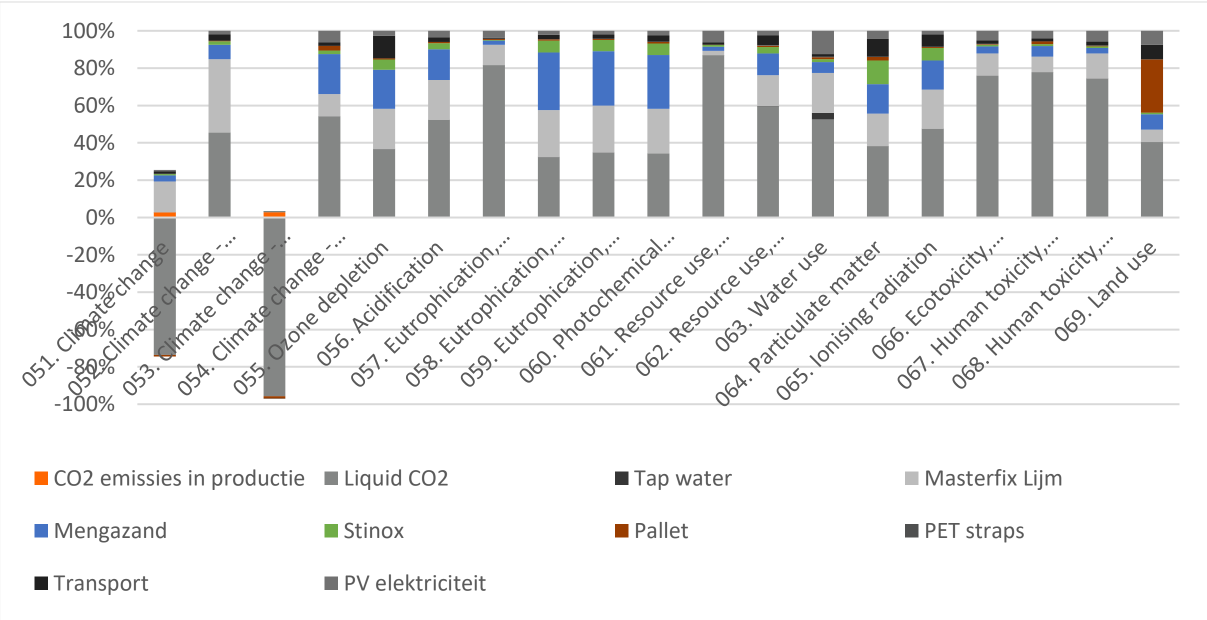

Figure 2Center of gravity analysis Carbstone hollow 39/14/19

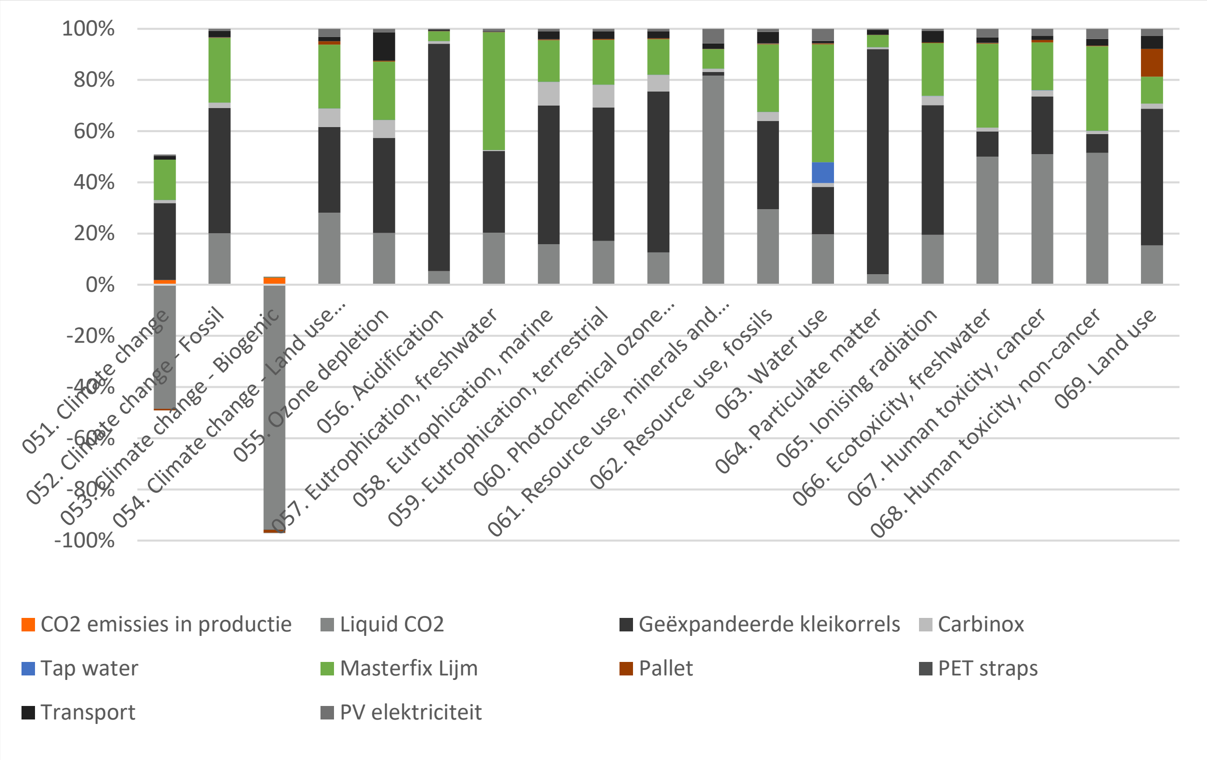

Figure 3Center of gravity analysis Carbstone ClimaSono 39/14/19

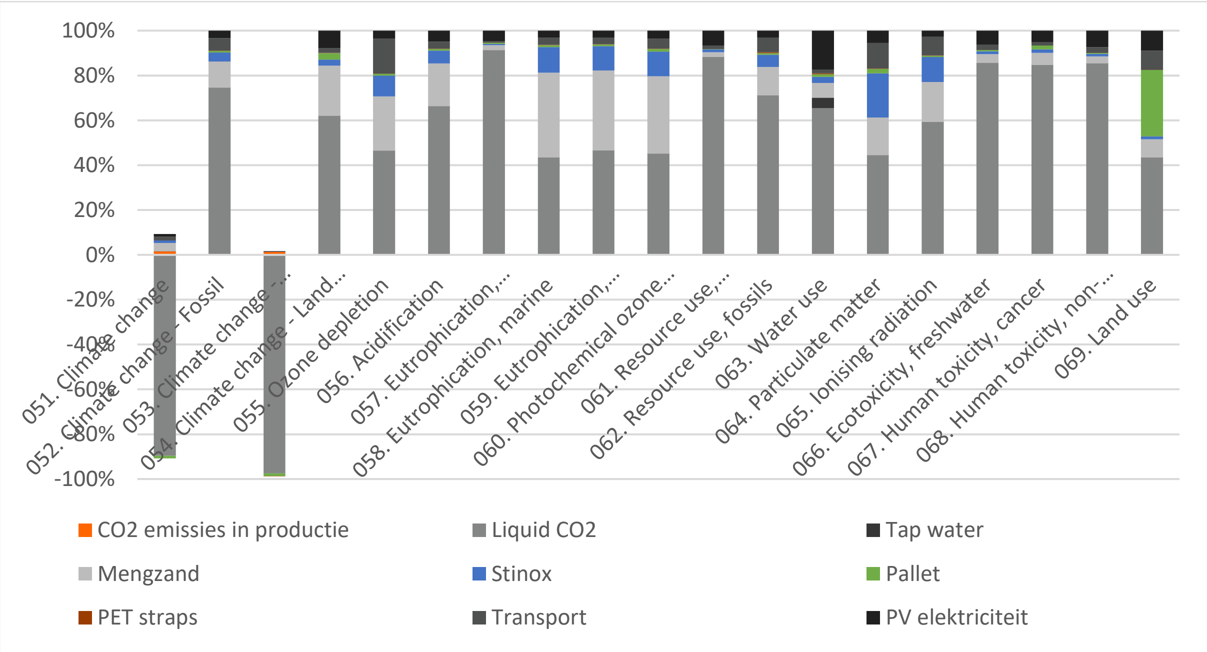

Figure 4Center of gravity analysis Carbstone Filler stone B12

4.1. Sensitivity analysis

Sensitivity analyzes determine the influence of the most important choices and assumptions on the end results. In this way the robustness of the results can be mapped out. This report only examines sensitivity analyzes of the product Carbstone ClimaSono hollow 39/14/19. This is because this product has the most impact among the topics liquid CO_2, raw materials from metal recovery and it covers a relatively large group of products (8).

Sensitivity analysis table36

Subject of sensitivity analysis	Rode
Distribution of group averages	Specific production locations were examined, no sensitivity analysis is required.
Geographical distribution	Specific production locations were examined, no sensitivity analysis is required.
Technological spread	Although the Liquid CO_2 of Air Liquide was determined using a mass balance approach, it was still decided in this study to follow the biogenic origin. This analysis compares the impact of fossil $_{CO2}$.
Spread in composition	An average of products from the year 2022 has been calculated.
Waste processing scenarios	The current waste processing scenario for cellular concrete within the B-EPD has been assumed. A sensitivity analysis is not considered necessary.
Influence of allocation	In this study, no assumptions were made for allocation that could be expected to significantly influence the outcome of the study. Since the allocation percentages differ from the percentages for Orbix's LCA, a sensitivity analysis has been done to see whether this has an impact.
Groupings within product groups	The final analysis looks at what the deviations of products within the group would be if they used an average of the group.

The figure below shows that the impact of the use of liquid CO_2 is biogenic or fossil in origin. The Ecoinvent process was used for this comparison “Carbon dioxide, liquid {RER}| production | Cutoff, U”. The difference is particularly large in climate change, this is because biogenic CO_2 also includes absorbed CO_2 and not fossil CO 2. Furthermore, the energy consumption has also been adjusted at AirLiquid to 0.22 kWh, the additives have been removed from the Ecoinvent process, and the losses of CO_2 and CH_4 emissions are lower at AirLiquid compared to the Ecoinvent process.

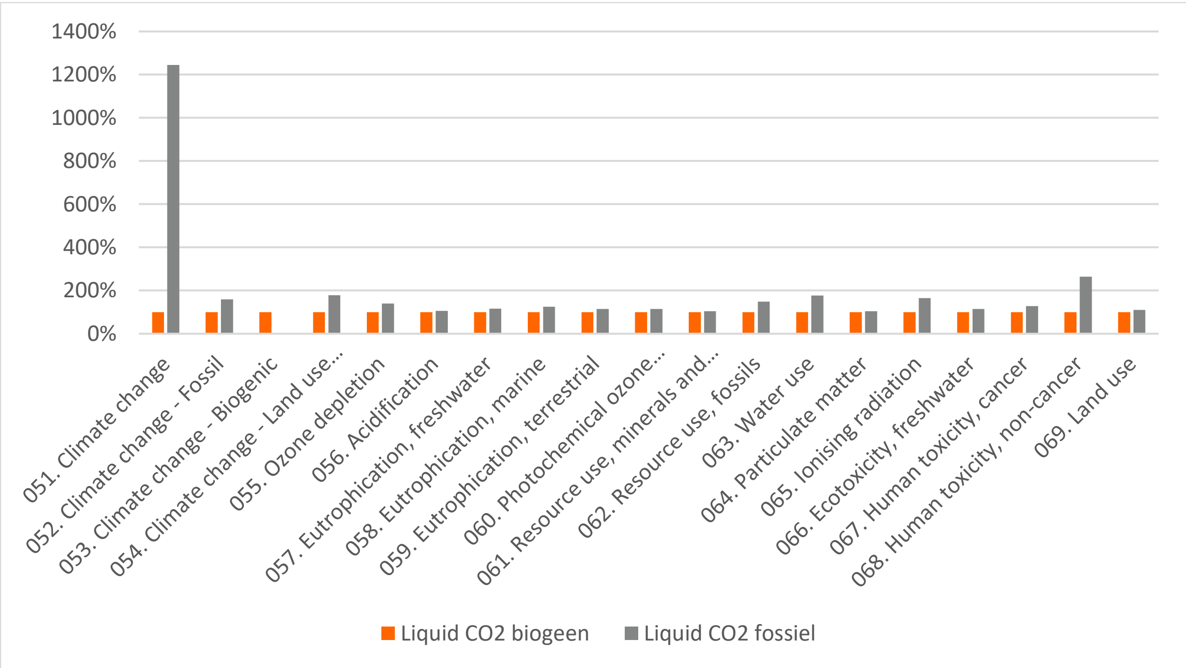

Figure 5Sensitivity analysis of origin of CO_2 in the liquid CO_2

Because Gubbels uses Orbix products that are not specified as such in the Orbix LCA, a number of additional products have been calculated for this report. In these calculations, the allocation is different because a mix of other products has been assumed (common products plus the products specially formulated for Gubbels). The figure below compares the differences in the impact of the allocation of the Orbix products for Gubbels and those used in its own LCA report. The difference limits visibility to 6%.

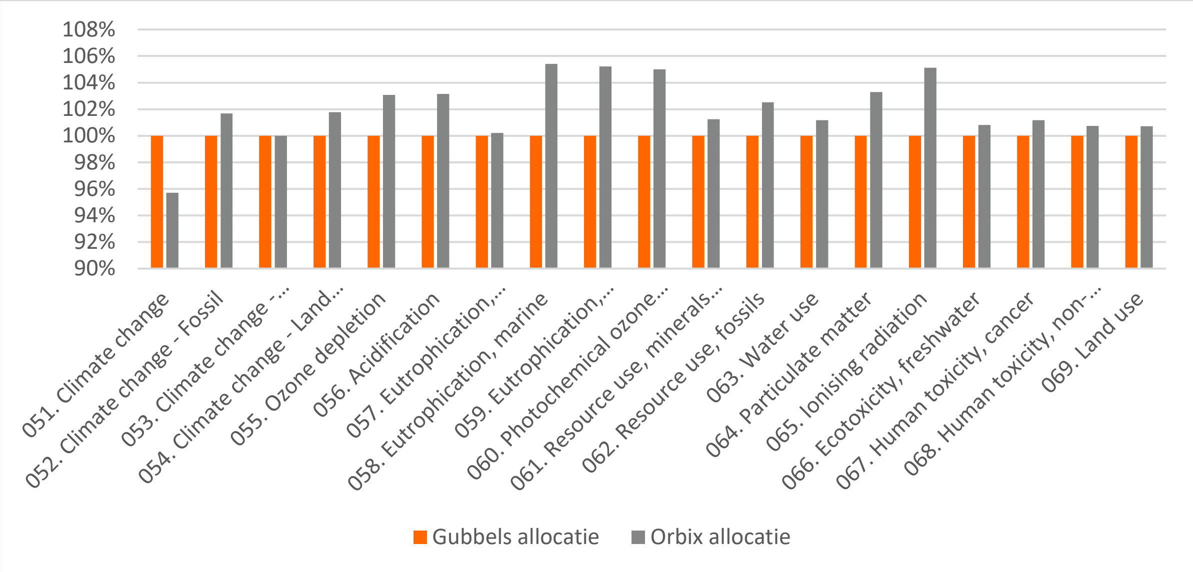

Figure 6Sensitivity analysis allocation of the metal recovery raw materials

The table below calculates what the deviations in percentages would be per product in Carbstone ClimaSono if an average of the product group were reported. Product with dimensions 39/09/19 is the largest deviation within the product group. This can be explained by the fact that approximately the same kWh of electricity and CO_2 emissions occur per brick, even though the brick is a lot smaller. The rest of the group falls within 17% deviation from the mean.

The other group averages can be found in Appendix A. The EPDs will report the average of Carbstones per group. Most stones have a limited deviation from the average per category.

Table 37Deviations from an average product in the Carbstone ClimaSono grouping

Impact categorie	Gemiddelde impact	391419	390919	391919	k401420	k401920	291414	k501424	k501924
051. Climate change	3,227657	99%	55%	143%	91%	131%	148%	51%	81%
052. Climate change - Fossil	28,17019	91%	65%	116%	91%	115%	114%	92%	116%
053. Climate change - Biogenic	-24,8928	90%	67%	112%	90%	113%	110%	97%	120%
054. Climate change - Land use and LU ch	0,012466	92%	66%	116%	91%	115%	116%	91%	114%
055. Ozone depletion	2,14E-06	91%	66%	115%	91%	115%	113%	93%	117%
056. Acidification	0,503082	90%	67%	113%	91%	113%	111%	96%	119%
057. Eutrophication, freshwater	0,001858	92%	64%	119%	91%	117%	118%	87%	111%
058. Eutrophication, marine	0,027892	91%	66%	114%	91%	114%	113%	94%	117%
059. Eutrophication, terrestrial	0,320476	91%	66%	114%	91%	115%	113%	94%	117%
060. Photochemical ozone formation	0,111124	91%	66%	114%	91%	114%	113%	94%	118%
061. Resource use, minerals and metals	0,000591	91%	67%	113%	91%	113%	114%	94%	117%
062. Resource use, fossils	269,2585	91%	65%	116%	91%	115%	114%	92%	116%
063. Water use	3,758272	93%	62%	119%	91%	117%	121%	86%	110%
064. Particulate matter	4,11E-06	91%	66%	113%	91%	114%	111%	96%	119%
065. Ionising radiation	1,13815	91%	66%	115%	91%	115%	114%	93%	117%
066. Ecotoxicity, freshwater	399,9981	92%	65%	117%	91%	116%	117%	90%	113%
067. Human toxicity, cancer	1,34E-08	91%	66%	115%	90%	114%	115%	93%	116%
068. Human toxicity, non-cancer	3,8E-07	92%	66%	117%	91%	115%	117%	90%	113%
069. Land use	261,5832	91%	66%	114%	90%	114%	114%	93%	117%

5. BIBLIOGRAPHY

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[9] Distance Aperam in Châtelet to Orbix in Châtelet, from https://www.google.nl/maps/dir/Aperam+Stainless+Belgium,+M%C3%A9taux,+Rue+des+Ateliers,+Ch%C3%A2telet ,+Belgi%C3%AB/Rue+des+Ateliers,+6200,+Belgi%C3%AB/@50.441825,4.5035657,12.21z/data=!4m14!4m13!1m5!1.

A. APPENDIX: COMPLETE RESULTS

See the Excel file:

- For the results of Carbstones hollow/hollow calibrated: *2023 11 27 Results Carbstone hollow and carbstone hollow calibrated.xlsx*
- For the results of Carbstones vol: *2023 11 27 Results Carbstone vol.xlsx*
- For the results of Carbstone ClimaSono hollow/hollow calibrated: *2023 11 27 Results Carbstone ClimaSono.xlsx*
- For the results of Carbstone ClimaSono vol: *2023 11 27 Results Carbstone ClimaSono vol.xlsx*
- For the results of Carbstone Kimblok: *2023 11 27 Results Kimblok.xlsx*
- For the results of Carbstone Filling Stone: *2023 11 27 Results Filling Stone.xlsx*
- For Carbstone Soundblox results: *2023 11 27 Results Soundblox.xlsx*

B. APPENDIX: INVENTORY OF DATA

See the Excel file *2023 11 27 LCA questionnaire Orbix carbo construction product Gubbels.xlsx* .