LCA: Pool Covers FB400, CGU, S+G, RG and EGST + weave

Plastipack Ltd

Dany Jammal, Peter Mitchell

October 2024

Contents

Figures

Tables

Glossary

ADP-fossil – Abiotic depletion for fossil resources potential

ADP-mineral & metals – Abiotic depletion potential for non-fossil resources

AP – Acidification potential, accumulated exceedance

CGU – CoolGuard™ Ultra

CRU – Components for reuse

EE – Exported Energy

EGST – EnergyGuard ™ Selective Transmission

EI – Environmental Impact

EoL – End-of-Life

EP-freshwater – Eutrophication potential, fraction of nutrients reaching freshwater end compartment

EP-marine – Eutrophication potential, fraction of nutrients reaching marine end compartment

EP-terrestrial – Eutrophication potential terrestrial

FW – Net use of fresh water

GHG – Greenhouse Gases

GLO - Global

GWP – Global Warming Potential

GWP-biogenic – Global warming potential, biogenic

GWP-fossil – Global warming potential, fossil fuels

GWP-luluc – Global warming potential, land use and land use change

GWP-total – Global warming potential, total

HDPE – High density polyethylene

HH – Human Health

HWD – Hazardous waste disposed

Kg – Kilogram

Kg.km – Kilogram kilometre

FB400 – French Blue 400

LCA – Life Cycle Assessment

LDPE – Low-density polyethylene

LLDPE – Linear low-density polyethylene

MER – Materials for energy recovery

MFR – Materials for recycling

NHWD – Non-hazardous waste disposed

NRSF – Use of non-renewable secondary fuels

ODP – Ozone layer depletion potential

PENRE – Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials

PENRM – Use of non-renewable primary energy resources used as raw materials

PENRT – Total use of non-renewable primary energy resource SM – Use of secondary material

PERE – Use of renewable primary energy excluding renewable primary energy used as raw materials

PERM – Use of renewable primary energy resources used as raw materials

PERT – Total use of renewable primary energy resources

POCP – Formation potential of tropospheric ozone

RER – Rest of Europe

RG - RaeGuard™

RoW – Rest of World

RSF – Use of renewable secondary fuels

RWD – Radioactive waste disposed

S+G – Sol + Guard™

VSC – Valpak Sustainability Consultancy

WDP – Water deprivation potential, deprivation-weighted water consumption

1. Executive Summary

1.1 Introduction

Plastipack commissioned Valpak's Sustainability Consultancy (VSC) to establish the environmental impacts of the lifecycle of five pool covers made respectively from the following GeoBubble™ materials (Plastipack's pool cover materials):

- French Blue 400 (FB400),
- CoolGuard™ Ultra (CGU),
- Sol + Guard™ (S+G),
- RaeGuard™ (RG), and
- EnergyGuard™ Selective Transmission with weave (EGST+ weave).

The environmental impacts of the sub-components and materials used to form the five pool covers are analysed separately using LCA methodology to quantify the impacts at the following life cycle stages:

- Assembly 1 stage (Plastipack):
  - Materials: extraction of raw materials, processing and manufacture of raw materials, ancillary materials and inbound and outbound packaging materials used in the production and packaging of the GeoBubble™ material
  - Transport: Delivery of the raw materials and packaging materials to assembly site 1 (Plastipack's facility in Leonards on Sea)
  - Assembly: the energy, water ancillary materials used, the management of wastes (including waste water) and offcuts at the assembly site
- Distribution to customers: Delivery of the product and packaging to assembly site 2[1] for welding
- Assembly 2 stage (Customer):
  - Materials: extraction of materials, processing and manufacture of inbound and outbound packaging materials used
  - Transport: The delivery of the packaging materials to assembly site 2
  - Assembly: the energy used for the welding and cutting process and the treatment and disposal of wastes and offcuts at the assembly site
- Distribution (End user): the shipment of the packaged pool cover to the end user
- Maintenance: the water used to clean and maintain the pool cover for the lifespan of its use and the waste water produced as a result
- End-of-Life (EoL): the treatment and disposal of the pool cover and its packaging at the end of its lifespan.

[1] refers to the facility of the party purchasing Plastipack's GeoBubble™ products (referred to in this report as Plastipack customers) at which welding and cutting takes place before packing and distribution to the end user.

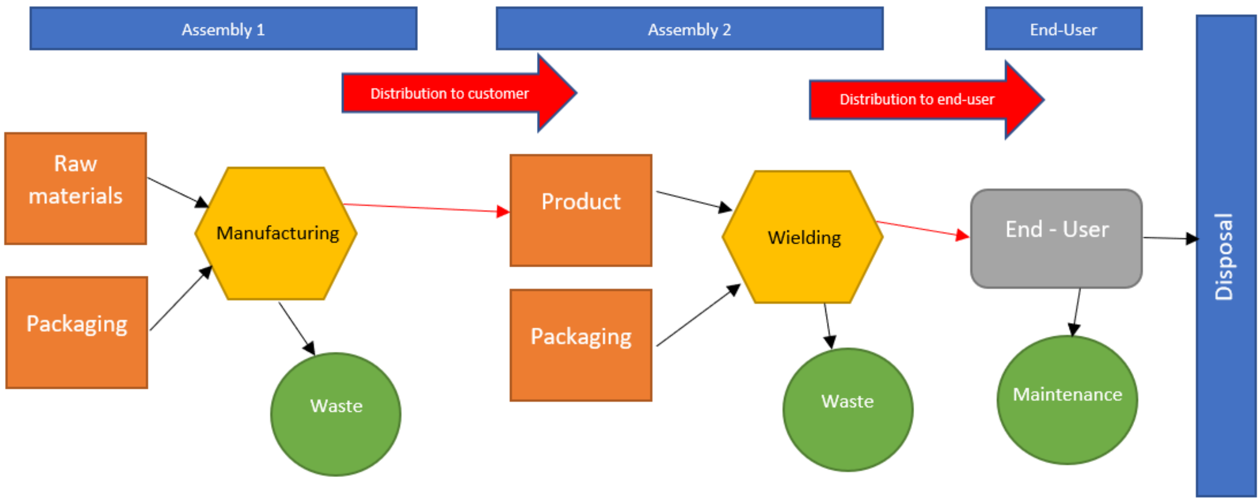
The overall impacts aggregated across the lifecycle stages are quantified. The key environmental impacts of interest to Plastipack in this assessment, and for the life cycle stages, are[2]:

- The carbon footprint, GHG emissions measured as Kg CO_2eq per unit[3]
- Water deprivation potential (m^3 per unit[4]).

1.2 Manufacturing Process

The manufacturing process is summarised in Figure 1.

Figure 1: GeoBubble™ pool cover life cycle



1.3 Key Points

The key points to note are as follows:

- The function unit is the manufacture of 1 m^2 of pool cover using GeoBubble™ material, its packaging and distribution to end users, maintenance during its expected lifespan, and EoL. The expected lifespan of FB400 is 4 years and that of CGU, S+G, RG and EGST + weave is 8 years.
- This life cycle assessment report studies 5 pool covers using FB400, CGU, S+G, RG, EGST + weave respectively, and their associated weights per 1 m^2 are:
-
    - 0.36 kg/m^2 for FB400,
    - 0.46 kg/m^2 for CGU, S+G and RG, and
    - 0.64 kg/m^2 for EGST + weave.

- The system boundary for this LCA study is cradle-to-grave and module D.
- The process specific input data provided by Plastipack is regarded as being of high quality and high accuracy, and an accurate representation (in terms of timeliness, geography and technology) for all processes used in manufacture and supply of the pool cover materials at the Plastipack production site in the UK. The production datasets at Assembly 1 site are a combination of 2022 data (for materials processes) and three-year average data (for water, fuels and off-cuts, as well as for the distribution to

---

[2] The carbon footprint and the water deprivation potential are included in the full range of mandatory environmental indicators calculated for compliance with EN 15804:A2 + 2019.
[3],[4] per m^2 of GeoBubble™ material

customers for welding). Assumptions and averages have been applied where necessary – methodologies for these are outlined in detail in this report in the Inventory section.

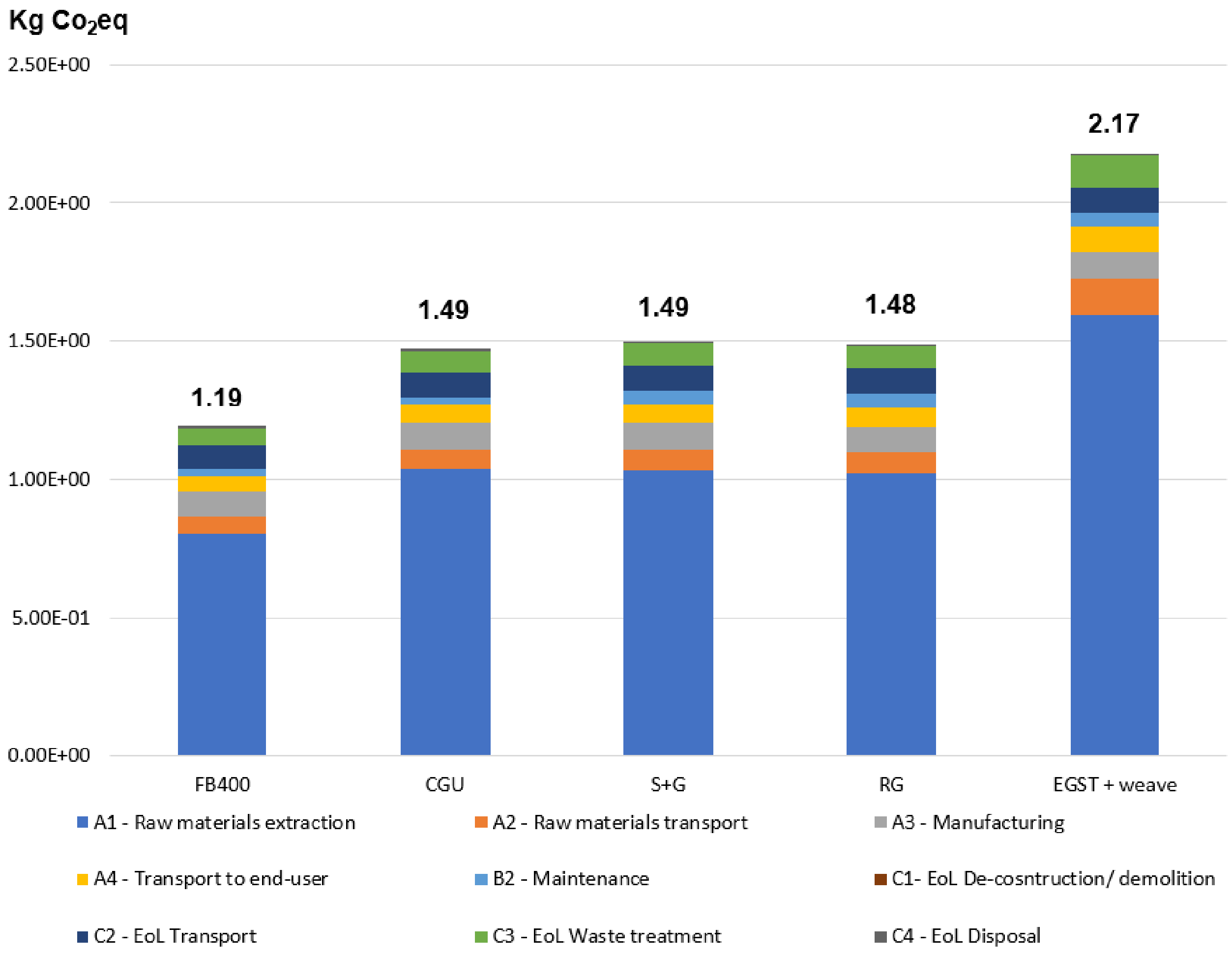
Table 1: The carbon footprints of the life cycles FB400, CGU, S+G, RG and EGST + weave pool covers

Pool cover materials	Unit	Per 1 m^2 of pool cover	Per standard 32 m^2 pool cover
FB400	kg CO_2eq	1.19	38.2
CGU	kg CO_2eq	1.49	47.8
S+G	kg CO_2eq	1.49	47.8
RG	kg CO_2eq	1.48	47.4
EGST + weave	kg CO_2eq	2.17	69.4

Table 2: The water deprivation potential of the life cycles of FB400 CGU, S+G, RG and EGST + weave pool covers

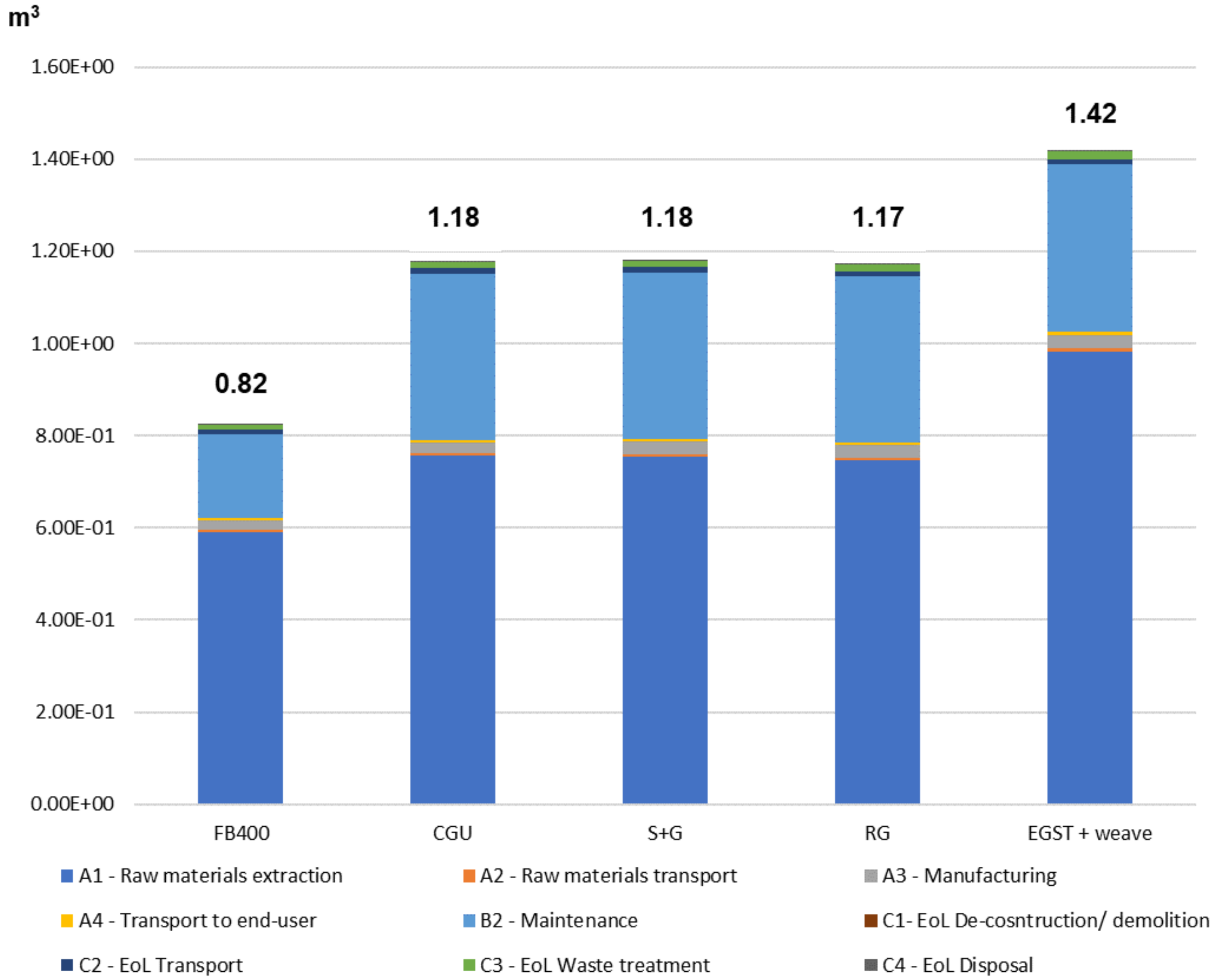
Pool cover materials	Unit	Per 1 m^2 of pool cover	Per standard 32 m^2 pool cover
FB400	m^3	0.82	26.4
CGU	m^3	1.18	37.7
S+G	m^3	1.18	37.8
RG	m^3	1.17	37.5
EGST + weave	m^3	1.42	45.4

Figure 2: Contribution of each of the life cycle stages to the overall carbon footprint, Kg CO2eq per 1 m² of pool cover



- The figure shows the overall carbon footprint of one functional unit of pool cover FB400, CGU, S+G, RG and EGST + weave broken down by lifecycle module. The lifecycle module A1 which represents raw materials extraction contributes the most to the overall carbon footprint, ranging between 74% and 79% for all five pool covers FB400, CGU, S+G, RG and EGST + weave. This can mostly be attributed to the carbon footprint of the raw materials of the pool covers. The carbon footprint for FB400 pool cover is the lowest of all five pool covers considered mostly due to the weight of the pool cover weighing less than the other pool covers considered per 1 m², therefore using less raw material. Similarly, the carbon footprint of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material.

Figure 3: Contribution of each of the life cycle stages by LCA module to the overall water deprivation potential, m^3 per 1 m^2 of pool cover



- Module A1 which represents raw materials extraction contributes the most to the overall water deprivation potential, ranging between 64% and 72% of the overall water deprivation potential of the five pool covers' lifecycles. The water deprivation potential for FB400 is the lowest out of all five pool covers considered due to the weight of the pool cover material weighing less than the other pool cover materials considered per 1 m^2, therefore using less LDPE as a raw material. The water deprivation potential of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material.
- Module D impacts are beyond the system boundary and arise from the avoided production of virgin LDPE from recycling the pool cover.

Table 3: Summary of carbon footprint and water deprivation potential avoided from recycling the pool covers and the avoided production of virgin LDPE

	Carbon footprint (kg CO_2eq)		Water Deprivation Potential (m^3)	
GeoBubble™ materials	Per 1 m^2 of pool cover	Per standard pool cover (32 m^2)	Per 1 m^2 of pool cover	Per standard pool cover (32 m^2)
FB400	0.731	23.4	0.519	16.6
CGU	0.934	29.9	0.663	21.2
S+G	0.934	29.9	0.663	21.2
RG	0.934	29.9	0.663	21.2
EGST + weave	1.30	41.6	0.923	29.5

2. Introduction

This assessment utilizes LCA modelling to quantify the environmental impacts of the lifecycle of five pool covers made respectively from the following GeoBubble™ materials (Plastipack's pool cover materials):

- French Blue 400 (FB400),
- CoolGuard™ Ultra (CGU),
- Sol + Guard™ (S+G),
- RaeGuard™ (RG), and
- EnergyGuard ™ Selective Transmission with weave (EGST + weave).

Also included are; transport, the use stage, and EoL management of the pool cover and its packaging. Process-specific inventory data for each of the pool cover materials (and their supply chains), the energy, water and packaging, and the intermediate and final transport journeys has been supplied by Plastipack Ltd and used to develop a complete model the life cycle using LCA methods that is compliant with ISO standards 14040/44 for LCA. The methodology is also compliant with EN15804+A2:2019 for sustainability of construction works.

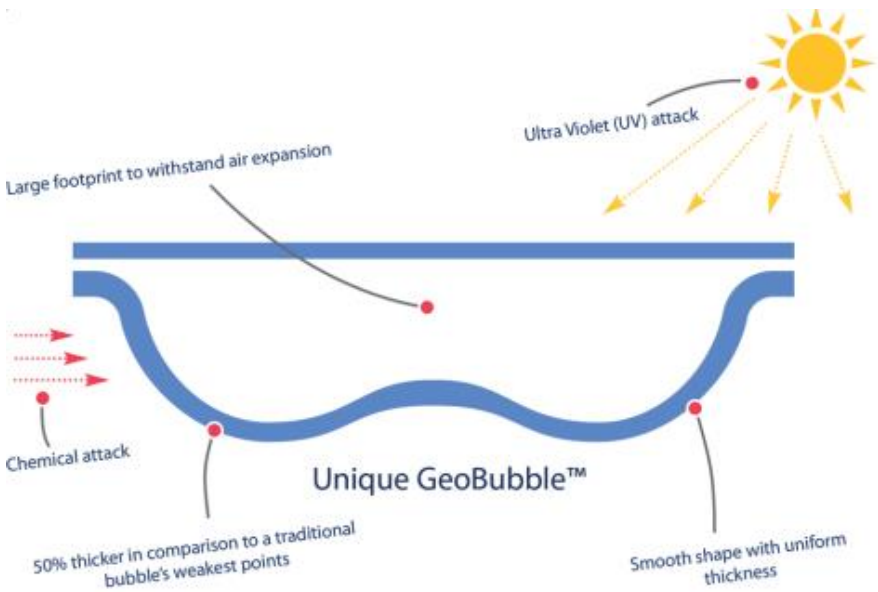
The system boundary for this LCA of the pool covers is cradle-to-grave and module D. Benefits/loads beyond the system boundary included arise from the avoided impacts of the production of virgin LDPE by recycling the pool covers.

The functional unit is the manufacture of 1 m^2 of pool cover using GeoBubble™ material, its packaging and distribution to end users, maintenance during their lifespan, and EoL. The background data processes, characterisation factors and assessment methods are sourced from Ecoinvent 3.8. The LCA modelling platform is OpenLCA v1.11.0.

2.1 Product Description

Plastipack manufacture pool cover materials, known as GeoBubble™ materials. These materials are designed to achieve energy and resource savings when the pool cover is in use, particularly to control water evaporation, reduce energy (from water heating and cooling) and chemical consumption (from Chlorine). Plastipack aim to provide products with the longest possible functional life (which for these products is FB400, CGU, S+G, RG, EGST + weave).

Figure 4: Functionality of the GeoBubble™ material



GeoBubble™ materials are used on the surface of water bodies such as outdoor swimming pools and industrial/ agricultural tanks or reservoirs. It should be noted that the materials studied in this report are used for swimming pools, and outdoor private swimming pools are the largest customer base of Plastipack. The material is comprised of two layers of polyethylene with pigments, UV and heat stabilizers added to the polymer formulation. The bottom layer of polyethylene goes through a vacuum forming process shortly before the two layers are laminated to produce a single material with air cells (similar to bubble wrap packaging).

The five pool covers considered in this LCA;

- French Blue 400 (FB400),
- CoolGuard™ Ultra (CGU),
- Sol + Guard™ (S+G),
- RaeGuard™ (RG), and
- EnergyGuard™ Selective Transmission with weave (EGST + weave).

The image below shows the standard CGU pool cover material.

Figure 5: Standard GeoBubble™ CoolGuard™ Ultra material

After the GeoBubble™ material is produced, it is packaged (rolls) and transported to the customers who weld the material into pool covers before packing and shipping it to end users.

FB400, CGU, S+G, RG and EGST + weave materials each have their own properties when used, determined by the weight and composition of these materials, outlined in detail in the inventory data section.

2.2 Dangerous Substances Declaration

No substances included in the Candidate List of Substances of Very High Concern for authorization under the REACH regulations are present in the products FB400, CGU, S+G, RG and EGST + weave either above the threshold for registration with the European Chemicals Agency or above 0.1%.

2.3 Methodology

To complete the LCA the following four key steps were undertaken for each of the pool covers:

- Goal and scope definition – A clear definition of both the goal and scope of the project, the system boundaries, and the functional unit
- Inventory analysis – Product data collection and modelling the life cycle with all the environmental inputs and outputs
- Impact assessment - Analysing the environmental impacts in terms of GHG emissions (establishing the carbon footprint) and water deprivation potential, and
- Interpretation – interpretation and discussion of results, conclusions of the study.

2.4 Peer review statement

This study has not been externally peer reviewed.

3. Goal and Scope

This initial stage of the LCA defines the goal and scope of the study, defines the functional unit and sets the system boundaries within which the LCA is conducted to quantify the environmental impacts.

The goal of the analysis is to quantify the environmental impacts of FB400, CGU, S+G, RG and EGST + weave pool covers using LCA modelling to establish the carbon footprint, water use, and other mandatory impacts based on the impact assessment method EN 15804 + A2:2019 for sustainability of construction works (the indicator for total global warming potential, GWP Total - measured as kg CO_2eq, and the indicator for water deprivation potential is Water Usage, AWARE).

The LCA methodology incorporates site-specific information on FB400, CGU, S+G, RG and EGST + weave materials (and their supply chains) supplied by Plastipack Ltd, combined with environmental impact factors and LCIA methods sourced by VSC. The LCA processes are sourced from the Greendelta's add-on EN15804 version of Ecoinvent 3.8 database. The LCA methodology is compliant with ISO standards 14040/44 and EN 15804:2019 +A2.

3.1 Functional Unit

The functional unit (FU) in this LCA study is:

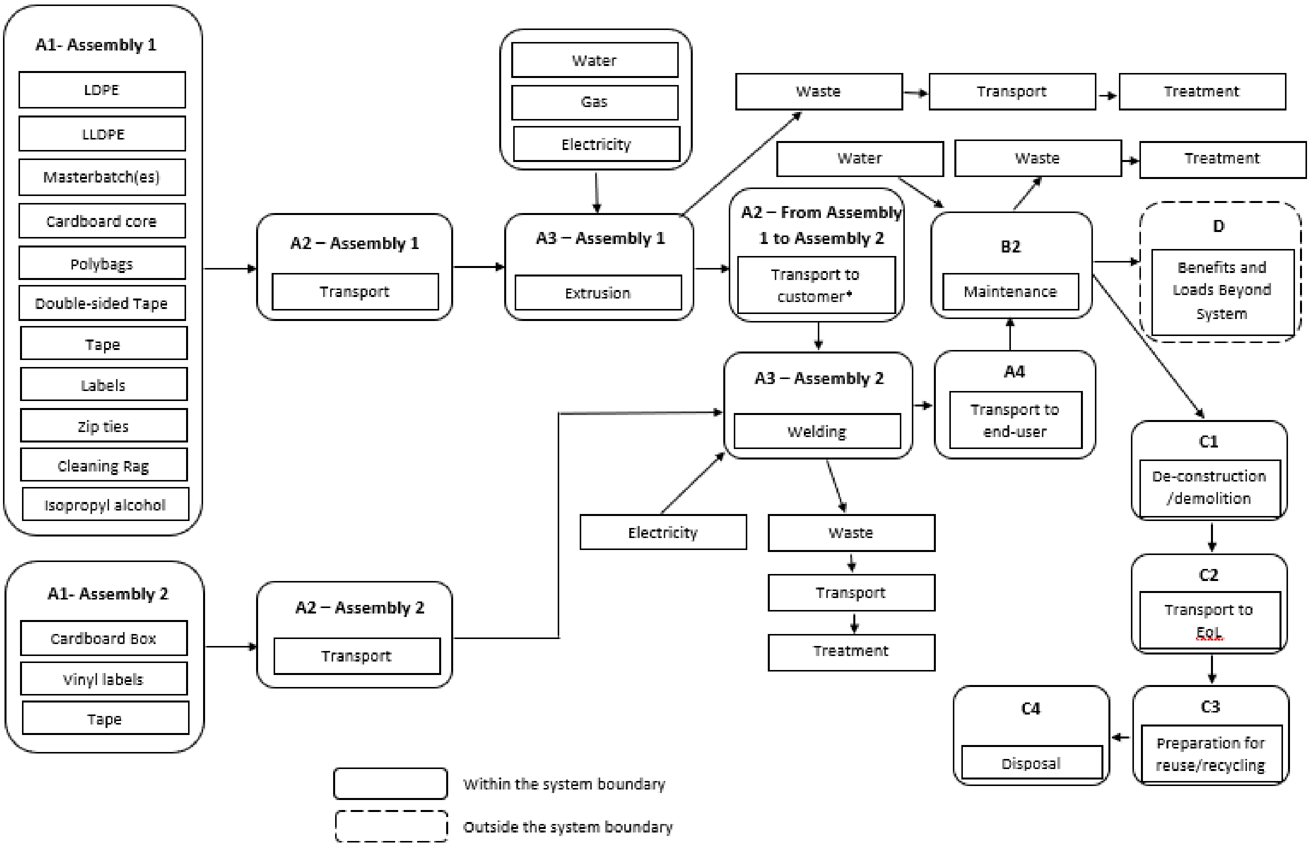
The manufacture of 1 m^2 of pool cover using GeoBubble™ material, its packaging and distribution to end users, maintenance during a its expected lifespan, and EoL.

All stages of the pool cover's manufacture are covered including; the manufacture and packaging of the pool cover material at Plastipack's UK production site, its distribution to customers around the world to form pool covers, packaging and distribution of the pool covers to end users, maintenance during their lifespan, and waste management of pool cover and its packaging at EoL. The expected lifespans of the pool covers are 4 years for FB400 and 8 years for CGU, S+G, RG and EGST + weave. The duration of the maintenance stage of the life cycle of these pool covers are the same as their expected lifespans.

3.2 System Boundary

The system boundary in this LCA to establish the environmental impacts of the pool covers is shown in Figure 6.

Figure 6: The system boundary for the life cycle assessment of the pool covers FB400, CGU, S+G, RG and EGST + weave



*Transport to customer refers to transport of the GeoBubble™ material to pool cover distributors for welding.

Table 4: System Boundaries included in the life cycle assessment of pool covers FB400, CGU, S+G, RG and EGST + weave

Stage	Description
A1	The extraction and processing of raw materials (and packaging) used to manufacture the pool cover materials at Plastipack ltd. For example, this covers the environmental impacts caused by the extraction and processing of low-density polyethylene, linear low-density polyethylene, masterbatch(es), as well as ancillary materials (cleaning rags and isopropyl alcohol), and cardboard, nylon, paper and plastic packaging materials. The extraction and processing of packaging used at the customer's welding site. For example, this covers the cardboard, paper and plastic packaging materials at the customer's welding site.
A2	The transport of raw materials, ancillary materials and packaging from supplier locations to Plastipack's manufacturing site in the UK. The transport of pool cover materials and packaging to the customer's welding site. The transport of packaging from supplier locations to customer's welding site.
A3	The energy, fuels and water used and wastes (as well as the fate of the wastes) generated in the processes required to manufacture the pool cover material at Plastipack's manufacturing site in the UK. The energy and wastes (as well as the fate of the wastes) generated in the process required to weld the pool cover materials at customer site.
A4	The transport of the pool covers (final product) to the end user.
B2	Maintenance of the pool cover. It assumed that it is rinsed with tap water twice a year.
C1	It is assumed there are no environmental impacts associated with the removal of the pool cover material at EoL.
C2	It is assumed that (on average) the transport to the household waste recycling centre from the end user of the pool cover is a journey of 8.35 km by an average car.
C3	It is assumed that the pool cover is recycled due to its LDPE content. It is assumed that the cardboard packaging component is recycled by the end-user
C4	It is assumed that the packaging tape and label shipped with the pool cover goes to general waste.
D	The main benefit beyond the system boundary arises from the avoided impacts of the production of virgin LDPE by recycling the pool cover.

4. Inventory

This section details the inventory data information and assumptions as well as the materials (raw materials and packaging), energy, fuels, water, and wastes associated with the production of the pool covers at the two Assembly stages. The inventory data encompasses the transport journeys of materials and packaging to Assembly 1 (Plastipack), the transport journey to Assembly 2, Assembly 2 (Customer), the distribution to end user, the maintenance of a unit (1 m^2) of pool cover over its lifespan, and management of wastes at its EoL.

The inventory data is mostly composed of data provided by Plastipack for the year 2022 or in some cases using a 3-year average (instances of this are specified below). Some assumptions are made by Valpak using information provided by Plastipack. The source of inventory data is specified at every stage of the process.

4.1 Inventory data and assumptions

4.1.1 Assembly 1 (Plastipack)

4.1.1.1 A1

The materials data used and information on the supply chains at Assembly 1 are supplied by Plastipack for the year 2022. This information has been used to create assumptions on the composition of Masterbatches. The weight of raw materials at the beginning of the manufacturing process per 1 m^2 has been calculated by Valpak using information provided by Plastipack. This information includes the percentage of each raw material used per 1 m^2 and offcuts created during Assembly 1.

4.1.1.2 A2

The associated inbound movements of packaging materials have been provided by Plastipack.

4.1.1.3 A3

The energy, water packaging and ancillary materials data used per 1 m^2 has been provided by Plastipack. The journey distances between the suppliers and the production site are sourced by Plastipack. The waste data from inbound packaging is supplied by Plastipack for the year 2022, whereas the polymer waste is supplied by Plastipack using a 3-year average. Plastipack has shared the company that they have employed for waste management services. This information is used by Valpak to find the closest location to Plastipack to determine the transport distance of waste from Assembly 1 to general waste/recycling facilities. The distance from Plastipack to the waste/recycling facilities is provided through the use of Google™ maps. Plastipack confirmed that their pallets are part of a return scheme, and therefore only the environmental impact of their transport, and not production, has been included. The transport data of polymer waste to external manufacturers has been sourced by Plastipack.

Site-specific production data for the assembly 1 site, such as fuels (electricity and gas) and water used in the manufacturing process, is supplied by Plastipack using a three-year average. This is divided by the average of the total units (1 m^2) of pool cover materials produced to obtain fuels and water used per unit of pool cover material.

4.1.2 Transport to Customers

4.1.2.1 A2

The destination countries for all GeoBubble™ materials has been provided by Plastipack using a 3-year average of the number of units sold per destination country. This information has been used by Valpak to model four separate journeys; UK, France and Spain, Continental Europe (excluding France and Spain) and Rest of the World.. Plastipack to customer making up 96% of all transport journeys to customers (as 96% of sales were made to destinations with transport data), in order to be reflective of the different journey types to different destinations. Each of the proportions of total purchases to the four journeys each are scaled to 96% to account for 100% of transport journeys. The proportions are then applied to the weight of 1 m^2 of GeoBubble™ material to capture the different transport modes and their relative contributions to the average.

4.1.3 Assembly 2 (Customer)

4.1.3.1 A1

The materials used at Assembly 2 have been determined through assumptions conducted by Plastipack.

4.1.3.2 A2

Eco-invent ‘market processes’, which assume generic transport, have been used to ‘account for’ inbound movements of packaging materials where no specific information is available.

4.1.3.3 A3

The waste data has been sourced by Plastipack with the additional assumption that the inbound packaging becomes waste at the end of Assembly 2 determined by Valpak. The electricity used by Assembly 2 has been sourced by Plastipack. The journey distances between the suppliers and the production site; production site and the general waste/ recycling facilities are unavailable. Eco-invent ‘market processes’, which assume generic transport, have been used to ‘account for’ the journey distances of materials where no specific information is available.

4.1.4 Transport to end user

4.1.4.1 A4

The journey distance to end users (from Assembly 2) is assumed by Plastipack to be 250 km, on average.

4.1.5 Maintenance

4.1.5.1 B2

Information on the maintenance of the pool cover has been provided by Plastipack, including the average water use per pool cover rinse, the number of rinses the pool cover undergoes per year and the average lifespan Of FB400, CGU, S+G, RG and EGST + weave in years[5][6][7][8][9]. This information has been used by Valpak to calculate the water used to maintain a pool cover during its life span.

4.1.6 EoL

4.1.6.1 C1

It is assumed there are no environmental impacts associated with the removal of the pool cover material at EoL.

4.1.6.2 C2

The fate of the pool covers at EoL has been provided by Plastipack. It is assumed that the pool cover would be recycled at household waste recycling centre closest to the end user’s home in France. The model for End-of-Life takes place in France as 52% of total GeoBubble™ pool cover material produced by Plastipack is sold to customers based in France. The packaging is assumed to be placed in general waste/recycling household collections. No information on journey distances for treatment/disposal have been provided by Plastipack. The transport of packaging from general waste/recycling household collections are accounted for using Eco-invent ‘market processes’, which assume generic transport, due to no specific information is available. An average distance from end user to household waste recycling centre has been estimated by Valpak using a combination of information from Google™ maps. Further detail on these assumptions is provided in 4.11: End-of-Life.

4.1.6.3 C3

The weights of the pool cover and packaging are provided by Plastipack. The pool cover is modelled to be recycled. The recovery rate for cardboard in France is applied to the cardboard box to determine the amount recycled.

4.1.6.4 C4

The weight of the packaging for general waste are provided by Plastipack.

---

[5] https://www.geobubblepoolcovers.com/products/#standard2
[6] https://www.geobubblepoolcovers.com/product/raeguard/
[7] https://www.geobubblepoolcovers.com/product/coolguard-ultra/
[8] https://www.geobubblepoolcovers.com/product/solguard/
[9] https://www.geobubblepoolcovers.com/product/energyguard-st/

4.2 Raw Materials

4.2.1 FB400

The materials data used at Assembly 1 are supplied by Plastipack for the year 2022. This information includes the percentage of each raw material used per 1 m^2 of FB400. Overall, 1 m^2 of pool cover made from FB400 GeoBubble™ material weighs 0.36 kg. There are five main raw materials inputted to produce the pool cover material: LDPE (56.5%), LLDE (10%), Masterbatch MB014 (1.5%) which constitutes additives encapsulated in an LDPE carrier containing UV stabiliser, Coloured Masterbatch MB150 (2%) which constitutes of additives encapsulated in an LDPE carrier containing coloured pigments and UV stabiliser and Regrind (30%) which constitutes of GeoBubble ™ offcuts from the manufacturing process at Plastipack manufacturing site.
The F400 pool cover weight and composition are summarised in Table 5.

Table 5: Composition of 1 m^2 of the FB400 pool cover

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.203	56.5
LLDPE	0.0360	10
Coloured Masterbatch MB150	0.00540	2
Masterbatch MB014	0.0072	1.5
Regrind (internal process waste)	0.108	30
Total	0.36	100

At Assembly 1 (Plastipack), the pool cover material goes through an extrusion process which incurs some raw material waste. At Assembly 2 (Customer) the welding process produces offcuts. Valpak calculations account for the offcuts/waste to obtain the full weight of raw materials inputted at each stage of the manufacturing stages (i.e. weight of amount input = weight of output + weight of offcuts/waste during the process). Data on the offcuts at each stage have been provided by Plastipack. Table 6 shows the results of the calculations, for example the total inputted weight of raw materials is 0.385 kg per 1 m^2 of FB400.

Table 6: The calculation conducted to determine the initial weight of raw materials inputted per 1 m^2 of FB400

Calculation Breakdown	**Unit**	**Value**
Raw material weight per m^2 prior to Assembly 1	Kg/m^2	0.385
Assembly 1 offcuts and wastage	Kg/m^2	0.00213
Offcuts and wastage (% of raw materials)	%	0.6%
Unit weight output at assembly 1	Kg/m^2	0.383
Assembly 2 offcuts and Wastage	Kg/m^2	0.0225
Offcuts and Wastage (% of the product of Assembly 1)	%	5.88%
Product after Assembly 2	Kg/m^2	0.360

Table 7 shows the weight of each component of the raw materials inputted at Assembly 1 (Plastipack).

Table 7: Composition and weight of 1 m^2 of FB400 inputted at Assembly 1

Material	**Total (in Kg)**
LDPE	0.218
LLDPE	0.0385
Coloured Masterbatch MB150	0.00770
Masterbatch MB014	0.00578
Regrind (internal process waste)	0.116
Total	0.385

4.2.2 CGU

The materials data used at the Assembly 1 stage are supplied by Plastipack for the year 2022. This information includes the percentage of each raw material used per 1 m^2. 1 m^2 of pool cover made from CGU GeoBubble™ material weighs 0.46 kg. There are four main raw materials inputted to produce the pool cover material: LDPE (82%), LLDE (10%), Masterbatch MB014 (3%) which constitutes of additives encapsulated in an LDPE carrier containing UV stabiliser and Coloured Masterbatch MB038 (5%) which constitutes of additives encapsulated in an LDPE carrier containing coloured pigments and UV stabiliser.
The end-product unit weight is summarised below.

Table 8: Composition of 1 m^2 of final product of CGU pool cover

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.377	82
LLDPE	0.0460	10
Coloured Masterbatch MB038	0.023	5
Masterbatch MB014	0.0138	3
Regrind (internal process waste)	0	0
Total	0.460	100

A similar calculation to FB400 is conducted to determine the total inputted weight of raw materials at Assembly 1 for CGU. The result of the calculations indicate that the total inputted weight of raw materials is 0.491 kg per 1 m^2 of CGU. The table below showcases the calculations conducted to obtain this result.

Table 9: The calculation conducted to determine the initial weight of raw materials inputted per 1 m^2 of CGU

Calculation Breakdown	Unit	Value
Raw material weight per m^2	Kg/m^2	0.491
Assembly 1 offcuts and wastage	Kg/m^2	0.00257
Offcuts and Wastage (% of raw materials)	%	0.5
Unit weight after Assembly 1	Kg/m^2	0.489
Assembly 2 Offcuts and Wastage	Kg/m^2	0.0288
Offcuts and Wastage (% of the product of Assembly 1)	%	5.88
Product after Assembly 2	Kg/m^2	0.46

The table below shows the weight of each component of the raw materials inputted at the initial stage of manufacturing.

Table 10: Composition and weight of 1 m^2 of CGU at initial stage of manufacturing

Material	Total (in Kg)
LDPE	0.403
LLDPE	0.0491
Coloured Masterbatch MB038	0.0246
Masterbatch MB014	0.0147
Regrind (internal process loss)	0
Total	0.491

4.2.3 S+G

The materials data used at the Assembly 1 stage are supplied by Plastipack for the year 2022. This information includes the percentage of each raw material used per 1 m^2. 1 m^2 of pool cover made from S+G GeoBubble™ material weighs 0.46 kg. There are five main raw materials inputted to produce the pool cover material: LDPE (82.84%), LLDE (10%), Masterbatch MB014 (3.82%) and Masterbatch MB030 (2%) which constitute of additives encapsulated in an LDPE carrier containing UV stabiliser and Coloured Masterbatch MB028 (1.34%) which constitutes of additives encapsulated in an LDPE carrier containing coloured pigments and UV stabiliser. The end-product unit weight is summarised in Table 11.

Table 11: Composition of 1 m^2 of final product of S+G

Material	Total (in Kg)	Proportion of total (%)
LDPE	0.381	82.84

LLDPE	0.0460	10
Coloured Masterbatch MB028	0.00616	1.34
Masterbatch MB014	0.0176	3.82
Masterbatch MB030	0.0092	2
Regrind (internal process loss)	0	0
Total	0.460	100

A similar calculation to FB400 is conducted to determine the total inputted weight of raw materials at Assembly 1 for S+G. The result of the calculations indicate that the total inputted weight of raw materials is 0.491 kg per 1 m^2 of S+G. The table below showcases the calculations conducted to obtain this result.

Table 12: The calculation conducted to determine the initial weight of raw materials inputted per 1 m^2 of S+G

Calculation Breakdown	**Unit**	**Value**
Raw material weight per m^2	Kg/m^2	0.491
Assembly 1 offcuts and wastage	Kg/m^2	0.00257
Offcuts and Wastage (% of raw materials)	%	0.5
Unit weight after Assembly 1	Kg/m^2	0.489
Assembly 2 Offcuts and Wastage	Kg/m^2	0.0288
Offcuts and Wastage (% of the product of Assembly 1)	%	5.88
Product after Assembly 2	Kg/m^2	0.46

The table below showcases the weight of each component of the raw materials inputted at the initial stage of manufacturing.

Table 13: Composition and weight of 1 m^2 of S+G at initial stage of manufacturing

Material	**Total (in Kg)**	**Proportion of total (%)**
LDPE	0.407	82.84
LLDPE	0.0491	10
Coloured Masterbatch MB028	0.0658	1.34
Masterbatch MB014	0.0188	3.82
Masterbatch MB030	0.00983	2

Regrind (internal process loss)	0	0
Total	0.491	100

4.2.4 RG

The materials data used at the Assembly 1 stage are supplied by Plastipack for the year 2022. This information includes the percentage of each raw material used per 1 m^2. 1 m^2 of pool cover made from RG GeoBubble™ material weighs 0.46 kg. There are five main raw materials inputted to produce the GeoBubble™ material: LDPE (81.67%), LLDE (10%), Masterbatch MB014 (3%) which constitutes of additives encapsulated in an LDPE carrier containing UV stabiliser and Coloured Masterbatch MB040 (3.35%) and MB041 (1.98%) which constitute of additives encapsulated in an LDPE carrier containing coloured pigments and UV stabiliser.
The end-product unit weight is summarised below.

Table 14: Composition of 1 m^2 of final product of RG

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.376	81.67
LLDPE	0.0460	10
Masterbatch MB014	0.0138	3
Masterbatch MB040	0.0154	3.35
Coloured Masterbatch MB041	0.00911	1.98
Regrind (internal process loss)	0	0
Total	0.460	100

A similar calculation to FB400 is conducted to determine the total inputted weight of raw materials at Assembly 1 for RG. The result of the calculations indicate that the total inputted weight of raw materials is 0.491 kg per 1 m^2 of RG. The table below showcases the calculations conducted to obtain this result.

Table 15: The calculation conducted to determine the initial weight of raw materials inputted per 1 m^2 of RG

Calculation Breakdown	**Unit**	**Value**
Raw material weight per m^2	Kg/m^2	0.491
Assembly 1 offcuts and wastage	Kg/m^2	0.00257
Offcuts and Wastage (% of raw materials)	%	0.5%
Unit weight after Assembly 1	Kg/m^2	0.489
Assembly 2 proportion output/input	Kg/m^2	0.0588
Assembly 2 Offcuts and Wastage	%	0.0288

Offcuts and Wastage (% of the product of Assembly 1)	Kg/m^2	5.88%
Product after Assembly 2	Kg	0.46

The table below showcases the weight of each component of the raw materials inputted at the initial stage of manufacturing.

Table 16: Composition and weight of 1 m^2 of RG at initial stage of manufacturing

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.401	81.67
LLDPE	0.0491	10
Masterbatch MB014	0.0147	3
Coloured Masterbatch MB040	0.0165	3.35
Masterbatch MB041	0.00973	1.98
Regrind (internal process loss)	0	0
Total	0.491	100

4.2.5 EGST + weave

The materials data used at the Assembly 1 stage are supplied by Plastipack for the year 2022. This information includes the percentage of each raw material used per 1 m^2. 1 m^2 of pool cover made from EGST GeoBubble™ material weighs 0.46 kg. There are six main raw materials inputted to produce the pool cover material: LDPE (84.51%), LLDE (10%), Masterbatch MB014 (2.325%), MB035 (2.68%) and MB030 (0.495%) which constitute of additives encapsulated in an LDPE carrier containing coloured pigments and UV stabiliser and HDPE which is laminated to the surface of the bubbles of the pool cover material. The EGST pool cover material is first extruded using LDPE, LLDPE and masterbatches, and the HDPE weave is then laminated to the surface of the bubble of the pool cover material.
The end-product unit weight is summarised in Table 17.

Table 17: Composition and weight of 1 m^2 of final product of EGST + weave

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.389	84.51
LLDPE	0.0460	10
Masterbatch MB014	0.0107	2.325
Masterbatch MB035	0.0123	2.68
Masterbatch MB030	0.00228	0.495

Regrind (internal process loss)	0	0
Total EGST	**0.46**	**100**
EGST	0.46	71.875
HDPE weave	0.18	28.125
Total EGST + weave	**0.64**	**100**

A similar calculation to FB400 is conducted to determine the total inputted weight of raw materials at Assembly 1 for EGST. The result of the calculations indicate that the total inputted weight of raw materials is 0.491 kg per 1 m^2 of EGST. The table below showcases the calculations conducted to obtain this result.

Table 18: The calculation conducted to determine the initial weight of raw materials inputted per 1 m^2 of EGST

Calculation Breakdown	**Unit**	**Value**
Raw material weight per m^2	Kg/m^2	0.491
Assembly 1 offcuts and wastage	Kg/m^2	0.00213
Offcuts and Wastage (% of raw materials)	%	0.433
Unit weight after Assembly 1	Kg/m^2	0.489
Assembly 2 proportion offcuts/input	Kg/m^2	0.0588
Assembly 2 Offcuts and Wastage	%	0.0288
Offcuts and Wastage (% of the product of Assembly 1)	Kg/m^2	5.88
Product after Assembly 2	Kg	0.460

After the extrusion process, the HDPE weave is laminated onto the bubbles of the EGST material. The HDPE waste's contribution to polymer waste at Assembly 1 stage at Plastipack's manufacturing site is assumed to be negligeable as its use is closely monitored due to the material being of high value. The same Assembly 2 proportion offcuts to input used for the pool cover materials at Assembly 2 stage is applied to the HDPE weave. The table below showcases the calculations conducted to obtain the amount of HDPE inputted at the Assembly 1 stage to obtain 1 m^2 of EGST + weave after Assembly 2 stage.

Table 19: The calculation conducted to determine the initial weight of HDPE inputted per 1 m^2 of EGST + weave

Calculation Breakdown	**Unit**	**Value**
Raw material weight per m^2	Kg/m^2	0.191
Assembly 1 offcuts and wastage	Kg/m^2	0.00
Offcuts and Wastage (% of raw materials)	%	0%
Unit weight after Assembly 1	Kg/m^2	0.191

Assembly 2 proportion offcuts/input	Kg/m^2	0.0588
Assembly 2 Offcuts and Wastage	%	0.00113
Offcuts and Wastage (% of the product of Assembly 1)	Kg/m^2	5.88
Product after Assembly 2	Kg	0.18
Weight of 32 m^2 product	Kg	5.76

The table below showcases the weight of each component of the raw materials inputted at the initial stage of manufacturing.

Table 20: Composition and weight of 1 m^2 of EGST + weave at initial stage of manufacturing

Material	**Total (in Kg)**	**Proportion from total (%)**
LDPE	0.415	60.8
LLDPE	0.0491	7.19
Masterbatch MB014	0.0114	1.67
Masterbatch MB035	0.0132	1.92
Masterbatch MB030	0.00243	0.356
Regrind (internal process loss)	0	0
HDPE weave	0.191	28.1
Total	0.683	100

4.2.6 Masterbatches

Due to the commercial sensitivities, granular details of the composition of the masterbatches have not been fully disclosed by the masterbatch manufacturers to Plastipack or to Valpak. In addition, while the Ecoinvent database used for this LCA contains processes for basic chemicals, processes for more complex chemical structures (such as masterbatches) are not available. For the main constituents of the masterbatch materials the information provided by the masterbatch producer, supplemented with data obtained through secondary research and reasoned assumptions, enables the generic modelling of the masterbatch materials for the LCA.

MB035, MB038, MB040 and MB041 are the coloured masterbatches used to manufacture opaque pool covers. They are composed of an LDPE carrier containing inorganic pigments and a set level of UV stabilisers. In this LCA these masterbatches are assumed to be composed of mostly LDPE (~55%), with (30%) being attributed to inorganic chemicals, and a small proportion (~15%) attributed to organic chemicals.

MB028 and MB150 are coloured masterbatches used for translucent pool covers. They are composed of an LDPE carrier containing inorganic pigments and a set level of UV stabilisers. These masterbatches are assumed to be composed of mostly LDPE (~65%), with the rest (~30%) being attributed to organic chemicals, and a small proportion (~5%) attributed to inorganic chemicals.

MB030 and MB014 masterbatches consist of an LDPE carrier containing UV absorber and UV booster. It is assumed that, apart from the LDPE (~75%), the components in these masterbatches are mainly organic chemicals (~ 25%).

Research on masterbatches shows that masterbatch materials usually contain between 40% and 65% of additives[10], but this can range from 15% to 85%.

The LCA modelling of these materials uses Ecoinvent database processes for LDPE, organic chemical production and inorganic chemical production.

Table 21: Summary of Masterbatch models

MB014	LDPE	75%
	Organic chemical	25%
MB150	LDPE	65%
	Organic chemical	30%
	Inorganic chemical	5%
MB028	LDPE	65%
	Organic chemical	30%
	Inorganic chemical	5%
MB030	LDPE	75%
	Organic chemical	25%
MB035	LDPE	55%
	Organic chemical	15%
	Inorganic chemical	30%
MB038	LDPE	55%
	Organic chemical	15%
	Inorganic chemical	30%
MB040	LDPE	55%
	Organic chemical	15%
	Inorganic chemical	30%
MB041	LDPE	55%
	Organic chemical	15%

[10]https://www.google.co.uk/books/edition/Applied_Plastics_Engineering_Handbook/urctkFROYbkC?hl=en&gbpv=1&pg=PA439&printsec=frontcover

	Inorganic chemical	30%

4.3 Ancillary materials

The ancillary materials used at Assembly 1 are supplied by Plastipack using a 3-year average. The table below showcases the weight of ancillary materials used per 1 m^2 of pool cover material. The ancillary materials used are the same for 1 m^2 of FB400, CGU, S+G, RG and EGST + weave in this LCA.

Table 22: Ancillary materials used in the production of 1 m^2 of end-product of pool cover material

Component	Material	Unit	Total
Cleaning Rag	Mixed Recycled Fabric	kg	0.000113
Isopropyl Alcohol	Isopropyl Alcohol	m^3	0.0000483

4.4 Packaging

4.4.1 Inbound Packaging at Assembly 1

The packaging data used per 1 m^2 of FB400, CGU, S+G, RG, EGST + weave have been provided by Plastipack. The table below represents the weight of all inbound packaging used at Assembly 1 per 1 m^2 of end-product FB400, CGU, S+G, RG, EGST + weave. This also includes the inbound packaging of the ancillary materials. The weight of the inbound packaging is used to model and account for the production and transport of inbound packaging to Assembly 1 site as well as the fate of the inbound packaging at its end-of-life (transport and disposal/preparation for next life). The weight of the wooden pallets will only be used to account for its transport to Assembly 1 and its transport back to the manufacturers they are considered to be part of return schemes. This means that the production of the pallets is not included within this product system.

Table 23: Inbound packaging at Assembly 1 per 1 m^2 of end-product FB400, CGU, S+G, RG and EGST + weave

Component	Material	Unit	FB400	CGU	S+G	RG	EGST + weave
Wooden Pallet	Softwood	kg	0.00182	0.00248	0.0024	0.0024	0.00223
LDPE Bag	LDPE virgin	kg	0.000176	0.000335	0.000314	0.000343	0.000273
LDPE Bag	LDPE – 30% recycled content	kg	0.0000462	0.0000590	0.0000590	0.0000590	0.0000590
Cardboard Box	Cardboard 100% recycled	kg	0.00000294	0.00000294	0.00000294	0.00000294	0.00000294
Backing Paper	Paper	kg	0.0000588	0.0000588	0.0000588	0.0000588	0.0000588
HDPE Drum	HDPE	kg	0.00000295	0.00000295	0.00000295	0.00000295	0.00000295
Cardboard Core	Cardboard	kg	-	-	-	-	0.00204
Total		**kg**	**0.00211**	**0.00294**	**0.00283**	**0.00283**	**0.00467**

4.4.2 Outbound Packaging at Assembly 1

The packaging data used per 1 m^2 of pool cover material has been provided by Plastipack. The outbound packaging used at Assembly 1 is the same for 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover material. This is due to the fact that the outbound packaging carries the same area of product (2 m x 102 m) and the area determines the amount of outbound packaging used. The table below summarises the materials used for packaging the pool cover materials to customers and the weight used per 1 m^2 of end-product. This information is used to account for the production of the outbound materials, the transport from manufacturers to Assembly 1 site, the transport to Assembly 2 site and the fate of the packaging at the Assembly 2 site (transport and disposal/preparation for recycling at next life).

Table 24: Outbound packaging at Assembly 1 for 1 m^2 of pool cover material

Component	Materials	Unit	Total
Cardboard Core	Cardboard - 100% recycled content	kg	0.00343
Double Sided tape	Polypropylene	kg	0.0000490
Polybag	LDPE - 30% recycled content	kg	0.00392
Zip Tie	Nylon 6-6	kg	0.00000980
Labels	Polypropylene	kg	0.0000245
Tape	Polypropylene	kg	0.0000490
Total	**-**	**kg**	0.00749

4.4.3 Packaging at Assembly 2

The materials data used at the Assembly 2 stage have been determined through assumptions conducted by Plastipack and the associated inbound packaging materials have been determined by Valpak assumptions.

4.4.3.1 Inbound Assembly 2

Valpak considered packaging similar to that used at in Assembly stage 1, to determine the inbound packaging. A Valpak packaging expert deemed that the stage 2 inbound packaging for filled cardboard boxes would likely include pallets and shrink wrap. It is assumed that the pallet (Assembly 1) can carry the weight of the filled cardboard boxes. The shrink wrap weight per pallet is assumed at 500 grams.[11] The inbound packaging used at Assembly 2 is the same for 1 m^2 of any pool cover material. The materials and transport impacts of the inbound packaging around the pool cover materials at Assembly stage 2 is already accounted for in assembly stage 1 but, once removed, is managed as a waste in Assembly stage 2. The weight of the inbound packaging used per 1 m^2 of pool cover at Assembly 2 is summarised in Table 25. The inbound packaging applies to the five pool covers FB400, CGU, S+G, RG and EGST + weave.

[11] https://www.melbpack.com.au/blog/how-calculate-cost-wrapping-pallet/#:~:text=First%2C%20we%20wrap%20a%20pallet,material%20used%20for%20the%20load.

Table 25: Inbound packaging at Assembly 2 for 1 m^2 of pool cover

Component	Materials	Unit	Total
Wooden Pallet	Softwood	kg	0.01677
Shrink wrap	LDPE	kg	0.000208
Cardboard Box	Cardboard – 100% recycled content	kg	0.0000298
Backing paper	Paper	kg	0.000313
Total	**-**	**kg**	0.0177

4.4.3.2 Outbound Assembly 2

The materials data used at the Assembly 2 stage have been determined through assumptions conducted by Plastipack. The outbound packaging used at Assembly 2 from customer to end user is the same for 1 m^2 FB400, CGU, S+G, RG and EGST + weave. This data is used to account for the production, transport from manufacturer to customer, transport to end user, and fate (transport and disposal/preparation for recycling at next life) of outbound packaging per 1 m^2 of pool cover. The weight of the outbound packaging used per 1 m^2 of pool cover at Assembly 2 is summarised in Table 26.

Table 26: Inbound packaging at Assembly 2 for 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Material	Materials	Unit	Total
Vinyl label	Polypropylene	kg	0.000313
Cardboard box	Cardboard – 100% recycled content	kg	0.0625
Tape	Polypropylene	kg	0.000625
Total	-	kg	0.0634

4.5 Transport of Materials and packaging

Table 27summarises the raw material transport journeys by supplier location to Plastipack for the production of the 5 pool cover materials. The journey distances between the suppliers and Assembly site 1 are sourced by Plastipack.

Table 27: Transport journeys of materials and packaging

Supplier	Material	Transport distance from supplier in km	Mode of Transport
Supplier 1	LDPE	313	Lorry
Supplier 2	LLDPE, Wooden Pallet, LDPE Bags	504	Lorry
Supplier 3	Masterbatches, Wooden Pallet, LDPE Bags	29	Lorry

Supplier 4 - 1	HDPE weave, Cardboard Core	86	Lorry
Supplier 4 - 2		20021	Ship
Supplier 5	Cardboard Core, Wooden Pallet	66	Lorry
Supplier 6	Double Sided Tape, Cardboard Box, Backing Paper, Tape, Cardboard Box.	77	Van
Supplier 7	Polybags, Wooden Pallet	79	Lorry
Supplier 8	Zip Ties, LDPE Bags, LDPE Bags, Cardboard Box	3	Van
Supplier 9	Labels, Backing Paper, Cardboard Box	184	Van
Supplier 10	Cleaning Rags, LDPE Bags	7	Van
Supplier 11	Isopropyl Alcohol, HDPE Drums	279	Van

There is no available information on the transport of packaging from supplier to customer in Assembly 2. The production of the packaging has been allocated market activity processes on the LCA database to account for the transport journeys.

4.6 Energy and Water

The site-specific production data such as energy (electricity and gas) and water used at Plastipack's production site (Assembly 1) is supplied by Plastipack as three-year (2020-2022) average data. Site-specific energy and water usage data at Assembly site 2 is assumed and supplied by Plastipack using information on welder power rating, expected output in one hour to calculate energy used per 1 m^2 of pool cover material.

Table 28 summarises the energy and water used per 1 m^2 of GeoBubble™ material. Per 1 m^2, the energy and water usage are the same for all of the 5 types of pool cover material.

Table 28: Fuels and water used per 1 m^2 of pool cover material

Assembly 1	**Unit**	**Total**
Electricity	kWh	0.261
Gas	kWh	0.00141
Water	kg	0.134
Assembly 2	-	-
Electricity	kWh	0.000434

4.7 Assembly Wastes

4.7.1 Assembly 1 Waste

The waste data from inbound packaging is supplied by Plastipack for the year 2022, whereas the polymer waste and ancillary material waste is supplied by Plastipack using a 3-year average. The waste produced from Assembly 1 as well as any transport distance to waste facilities provided are summarised below. The waste of isopropyl alcohol and the transport of this waste are not considered as this solvent is assumed to evaporate completely at room temperature[12]. The waste of the LDPE bags used as the inbound packaging for cleaning rags and its transport are not included as the bags are re-used on site. The weight of the offcuts in the table below only includes the weights of those that are transported and recycled off-site. The weight of the rest of the offcut is re-used on site and included in other pool cover products and for this reason the fate of this waste is perceived as out of scope.

Table 29: Assembly 1 waste, fate of waste, and transport distance to waste site for FB400, CGU, S+G, RG and EGST + weave

Component-Material	Recycled content (%)	Unit	FB400	CGU	S + G	RG	EGST + weave	Fate of waste
Polymer offcuts – PE and masterbatch additives	0%	Kg/m²	0.00195	0.00236	0.00236	0.00236	0.00236	Recycling – known manufacturer – 363 km
Cleaning Rag - Mixed Recycled Fabric	100%	kg/m²	0.000113	0.000113	0.000113	0.000113	0.000113	General waste[13] [14]
Isopropyl Alcohol	N/A	kg/m²	0.0000483	0.0000483	0.0000483	0.0000483	0.0000483	Evaporates[14]
LDPE Bag – virgin LDPE[15]	0%	kg/m²	0.0000673	0.000197	0.000176	0.000205	0.000135	Recycling[14]
LDPE Bag – recycled content LDPE[16]	100%	kg/m²	0.000154	0.000197	0.000197	0.000197	0.000197	Recycling[14]
Cardboard Box - Cardboard	100%	kg/m²	0.00000294	0.00000294	0.00000294	0.00000294	0.00000294	Recycling[14]
Backing Paper - Paper	0%	kg/m²	0.0000588	0.0000588	0.0000588	0.0000588	0.0000588	General waste [14]
HDPE Drum - HDPE	0%	kg/m²	0.00000295	0.00000295	0.00000295	0.00000295	0.00000295	Recycling[14]
Wooden Pallets - Softwood	Unknown	kg/m²	0.000513	0.000655	0.000655	0.000655	0.000655	Return scheme – 504 km
Wooden Pallets - Softwood	Unknown	kg/m²	0.000269	0.000786	0.000704	0.000673	0.00054	Return scheme – 29 km
Wooden Pallets - Softwood	Unknown	kg/m²	0.00343	0.000915	0.000915	0.000915	0.000915	Return scheme – 66 km

12 https://www.researchgate.net/publication/328783685_Evaluating_the_vapour_evaporation_from_the_surface_of_pure_organic_solvents_and_their_mixtures
13 A combination of landfill and incineration
14 Known waste service provider
15 Amount of virgin LDPE for recycling
16 Amount of recycled LDPE for recycling

Wooden Pallets - Softwood	Unknown	kg/m²	0.000123	0.000123	0.000123	0.000123	0.000123	Return scheme – 79 km
Water	N/A	Kg/m²	0.134	0.134	0.134	0.134	0.134	Waste water treatment

Plastipack confirmed that their pallets are part of a return scheme, and therefore only the environmental impact of their transport, and not production, has been included in this analysis The transport data of polymer offcuts waste to external manufacturers has been sourced by Plastipack. Plastipack has shared the company that they have employed for waste management services. This information is used by Valpak to find the closest of the waste management services' location to Plastipack to determine the transport distance of waste from Assembly 1 to general waste/recycling facilities. The distance from Plastipack to the waste/recycling facilities is provided through the use of google maps and comes to 2 km.

4.7.2 Assembly 2 Waste

The waste data has been sourced by Plastipack with the additional assumption that the inbound packaging determined by Valpak becomes waste at the end of the Assembly 2 stage. The waste produced at Assembly 2 is summarised as well as the fate of the waste. There is no information on the transport distances between the assembly site 2 and waste treatment facilities. The disposal and preparation for treatment of waste have been allocated market activity processes on the LCA database to account for the transport journeys.

Table 30: Assembly 2 waste and fate of waste for FB400, CGU, S+G, RG and EGST+ weave materials

Component - Material	**Recycled content (%)**	**Unit**	**FB400**	**CGU**	**S+G**	**RG**	**EGST + weave**	**Fate of waste**
GeoBubble™ - PE and masterbatch additives	0%	kg/m²	0.0225	0.0288	0.0288	0.0288	0.04	Recycling
Cardboard Core – Cardboard	100%	kg/m²	0.00343	0.00343	0.00343	0.00343	0.00343	Recycling
Double Sided tape - PP	0%	kg/m²	0.000049	0.000049	0.000049	0.000049	0.000049	General waste
Polybag - LDPE	30%	kg/m²	0.00392	0.00392	0.00392	0.00392	0.00392	Recycling
Zip Tie – Nylon 6-6	0%	kg/m²	0.0000098	0.0000098	0.0000098	0.0000098	0.0000098	General waste
Labels - PP	0%	kg/m²	0.0000245	0.0000245	0.0000245	0.0000245	0.0000245	General waste
Tape - PP	0%	kg/m²	0.000049	0.000049	0.000049	0.000049	0.000049	General waste
Wooden Pallet - Softwood	Unknown	kg/m²	0.0171	0.0171	0.0171	0.0171	0.0171	No information available

Cardboard Box - Cardboard	100%	kg/m^2	0.0000298	0.0000298	0.0000298	0.0000298	0.0000298	Recycling
Backing paper - Paper	0%	kg/m^2	0.000313	0.000313	0.000313	0.000313	0.000313	General waste
Shrink wrap - LDPE	0%	kg/m^2	0.000214	0.000214	0.000214	0.000214	0.000214	Recycling

It is assumed that the wooden pallet is reused on site.

4.8 Distribution to customer

The information on destination countries of all GeoBubble™ material has been provided by Valpak using a 3-year average. Table 96 in Appendix I summarises the transport journeys from Plastipack to the customers by country, such that each country presented contributes to the purchase of at least 1% of total GeoBubble™ units produced by Plastipack. This table summarises 96% of all transport journeys between Plastipack and customers. The final 4% represents destination countries which contribute to less than 1% of purchase volume each and with no specific transport distances available, and have been excluded from the average in order to prevent the overcomplication of analysis.

The transport journeys of the distribution to customers have been summarised through these four main processes.

Table 31: Transport routes of all GeoBubble™ materials to customers

Destination	Proportion of purchases to total	Lorry	Road-Train	Ferry	Sea container	Lorry	Road train
Route 1: UK	9%	31 km	-	-	-	-	-
Route 2: Continental Europe excluding France and Spain	18%	70 km	-	50 km	-	1065 km	-
Route 3: France and Spain	62%	-	70 km	50 km	-	-	965 km
Route 4: Rest of World	7%	70 km	-	-	14936 km	362 km	-

The information available on transport destination to customers covers 96% of total transport destinations – the final 4% being for known countries to which less than 1% of purchase volume was sold each and without available journey distances.

Table 32: Scaling of weight of 1 m^2 of GeoBubble™ material and associated packaging by proportion of GeoBubble™ material that gets transported to destination country

Destination	Percentage of total m^2 3-year average	Scaling transport distances to cover 100%	Weight of 1 m^2 of FB400 pool cover and associated packaging	Weight of 1 m^2 of CGU, RG, S+G pool cover and associated packaging	Weight of 1 m^2 of EGST + weave pool cover and associated packaging
Route 1: UK	9%	9%	0.0367	0.0467	0.0646
Route 2: Continental Europe excluding France and Spain	18%	19%	0.0738	0.0940	0.130
Route 3: France and Spain	62%	65%	0.252	0.320	0.444
Route 4: Rest of World	7%	7%	0.0278	0.0354	0.0490
Total	**96%**	**100%**	**0.390**	**0.496**	**0.688**

The proportions of purchase volumes by destination have been scaled to 96% to account for 100% of purchase volumes. The weight of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave materials and associated packaging is multiplied by the scaled proportions of purchased volumes by destination, and then multiplied by the leg distances of each route, to provide a proportionate impact assessment of the transport to customers of on 1 m^2 of FB400, CGU, S+G, RG and EGST + weave material whilst accounting for the variety in destination.

The materials transport weight by distance for each route is as follows.

Table 33: Weight by transport distance of GeoBubble™ material per leg per transport route

	Destination	**Lorry kg.km**	**Road-Train kg.km**	**Ferry kg.km**	**Sea container kg.km**	**Lorry kg.km**	**Road train kg.km**
FB400	Route 1: UK	1.14	-	-	-	-	-
	Route 2: Continental Europe excluding France and Spain	5.17	-	3.69	-	78.6	-
	Route 3: France and Spain	-	17.6	12.6	-	-	243
	Route 4: Rest of World	1.95	-	-	416	10.1	-

CGU, RG, S+G	Route 1: UK	1.45	-	-	-	-	-
	Route 2: Continental Europe excluding France and Spain	6.58	-	4.70	-	100.1	-
	Route 3: France and Spain	-	22.4	16.0	-	-	309
	Route 4: Rest of World	2.48	-	-	529	12.8	-
EGST + Weave	Route 1: UK	2.00	-	-	-	-	-
	Route 2: Continental Europe excluding France and Spain	9.11	-	6.51	-	129	-
	Route 3: France and Spain	-	31.1	22.2	-	-	428
	Route 4: Rest of World	3.43	-	-	733	17.8	-

4.9 Distribution to end user

The transport to end user is stated by Plastipack to be by van, the journey distance estimated at 250 km, on average.

4.10 Maintenance

The data for the maintenance of pool covers has been provided by Plastipack. The maintenance of a pool cover occurs twice a year and consists of 10 minutes of water passing through a hosepipe used to clean the pool cover. 15 litres of water used per minute for 10 minutes per cleaning cycle. This means that 150 l of water is used to clean 32 m^2 of pool cover, and 150 l/32 m^2 = 4.69 l used per m^2 of pool cover.

The average lifespan (provided by Plastipack) of the FB400 GeoBubble™ material is 4 years and that of CGU, S+G, RG and EGST + weave is 8 years. This information is used to calculate the water used for the maintenance of the pool covers throughout their lifespan. The maintenance of the pool cover includes the use of water and the treatment of this waste water once used.

Table 34: Water used for the maintenance of pool covers Fb400, CGU, S+G, RG and EGST + weave during their lifespans

	FB400	CGU, S+G, RG, EGST + weave
Lifespan	4	8
In Litres	37.5	75.0
In Kg	37.4	74.8

4.11 End-of-Life

It is assumed there are no environmental impacts associated with the removal of the pool cover material at EoL.

The pool cover consists mostly of LDPE which is considered as a material that is widely recyclable. The EoL is modelled to take place in France geographically, as 52% of total GeoBubble™ material is sold to customers based in France. It is assumed that the pool cover will be transported to the household waste recycling centre by the end user and accepted for recycling by the recycling centre in France as the bulky nature of the material would not be collected by kerbside household waste collection services. It is important to note that the complexity of the composition of the pool covers may limit their use as recyclates, in the case of EGST + weave, the incorporation of HDPE in its composition may further limit its use as a recyclate.

4.11.1 Fate

The cardboard box is assumed to be recycled through household packaging collection services. For the cardboard box, the recovery rate of cardboard is applied for France, which is 81.6% as of 2021[17], which is the most recent year for which data is available. The tape and the label are assumed to be collected by household general waste services as general waste and go to disposal (a mix of incineration and landfill).

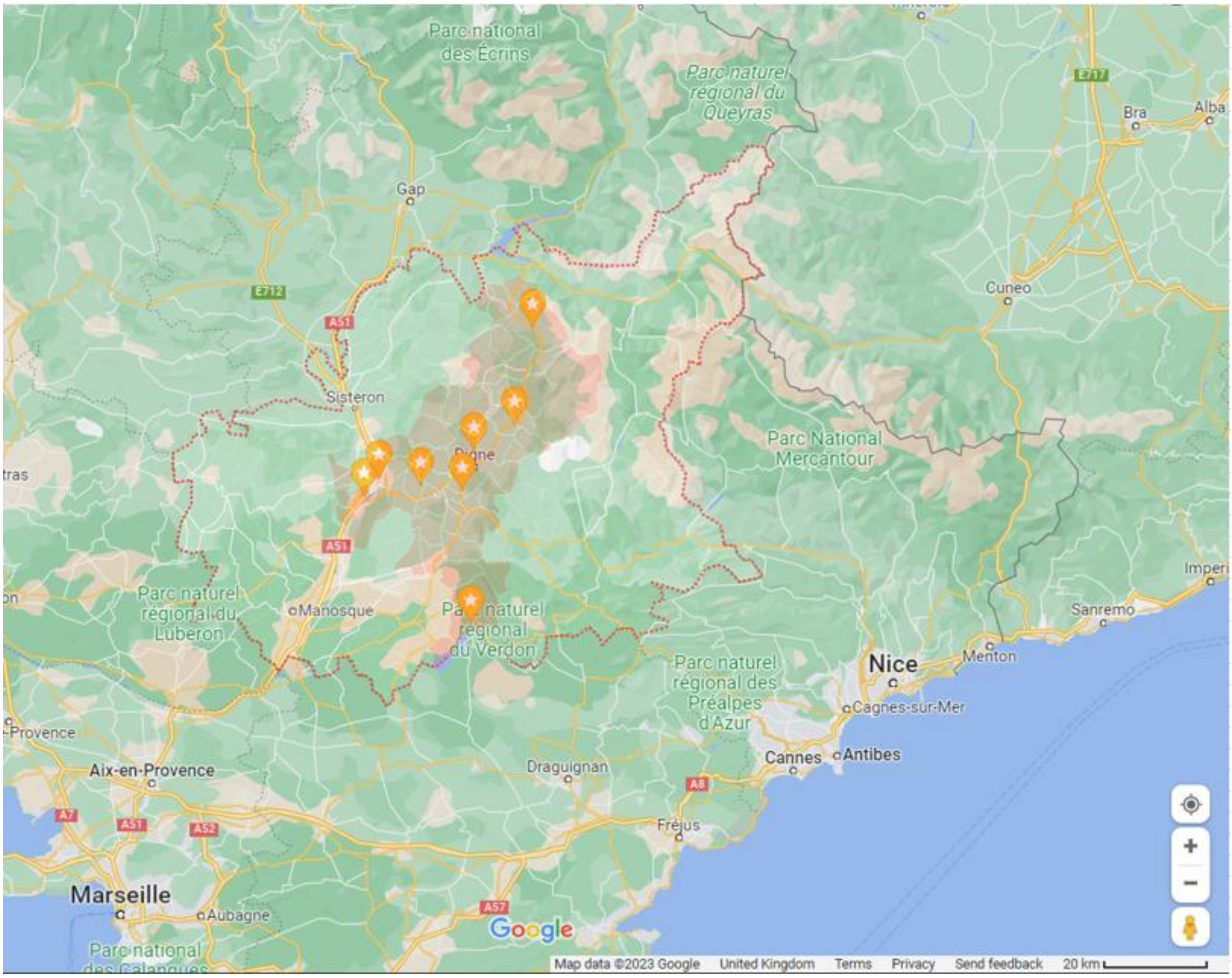
4.11.2 Transport

There is no available information on journey distances from end user to household waste recycling centre for the pool cover material. Assumptions for the journey distance from end user to household waste recycling centre for the pool covers in France are as follows.

Online research revealed no available information on the average distance from households to household waste recycling centres in France. To create an informed assumption on the transport distance between household and household waste recycling centres in France, an urban agglomeration has been chosen to map out the average distance. The mapping process utilises Google Maps. The South-east of France has been chosen as the region to map on as it is the region with the highest concentration (39%) of private pools in France[18]. From this, Alpes de Haute Provence is chosen randomly within that area to focus on. This province's geographical borders are dotted in red in the image of the map presented. The Provence-Alpes agglomeration, shaded in red, has been chosen from this Provence to simplify the mapping process. This agglomeration has been chosen within that area due to the availability of information on tips within that agglomeration on the internet. Information on the tips that accept all bulky items has been researched and presented on the map with yellow pins[19]. It is assumed that these tips accept pool covers for recovery. The maximum distance from a household within that agglomeration to a household waste recycling centre within that agglomeration has been approximated at 16.7 km. The average distance has been calculated to be 8.35 km. This average distance has been used as the distance from the end user to the nearest household waste recycling centre to dispose of the pool cover for recycling.

[17] https://www.statista.com/statistics/769494/pcr-recovery-rate-france/#:~:text=In%202021%2C%20the%20recovery%20rate,to%20less%20than%2080%20percent.
[18] https://www.propiscines.fr/piscine-actualite/la-france-compte-pres-de-25-millions-de-piscines-privees#:~:text=Sud%2DEst%20%3A%20la%20plus%20forte%20concentration%20r%C3%A9gionale%20de%20piscines&text=Le%20Nord%2DOuest%20(avec%20le,hors%2Dsol%20(56%25).
[19] https://www.provencealpesagglo.fr/decheteries/

Figure 7: Map showing the Alpes de Haute Provence region, the Provence-Alpes agglomeration and sampling points



4.12 Life Cycle Impact Factors

Environmental impact factors for the energy, water, fuels, materials, and waste used to manufacture the pool covers are sourced from a modified version of the Ecoinvent 3.8 database, based on the impact assessment method EN15804+A2:2019 for construction products. OpenLCA Nexus[20] provides version 2 of its EN15804 add-on using modified Ecoinvent 3.8 data for producing Environmental Product Declarations (EPDs) compliant with the EN15804+A2:2019 standard for construction products.

The data within the EN15804 add-on has been critically reviewed and verified by experts to be compliant with EN15804+A2:2019[21]. For the carbon footprints the environmental indicator used is total global warming potential, GWP Total, measured as kg CO_2eq.

Table 35 shows the Ecoinvent LCA datapoints used for materials, fuels, water, transport and waste to model the environmental impacts of the production of the pool covers FB400, CGU, S+G, RG and EGST + weave.

[20] https://nexus.openlca.org/
[21] https://nexus.openlca.org/ws/files/23889.

Table 35: Processes used for materials, fuels, water, transport and waste used in the production of pool covers FB400, CGU, S+G, RG and EGST + weave and the associated processes (including Module D)

Component	Processes used in the LCA modelling of GeoBubble™ materials
Masterbatch	Chemical production, inorganic | chemical, inorganic | EN15804 - GLO
Masterbatch	Chemical production, organic | chemical, organic | EN15804 - GLO
Cardboard	core board production | core board | EN15804 - RoW
Electricity, low voltage	Market for electricity, low voltage | electricity, low voltage | EN15804 - GB
Electricity, low voltage	Market for electricity, low voltage | electricity, low voltage | EN15804 - FR
Wooden pallet	EUR-flat pallet production | EUR-flat pallet | EN15804 - RER
Extrusion of plastic	Extrusion, co-extrusion of plastic sheets | extrusion, co-extrusion | EN15804 - RoW
Extrusion of plastic	Extrusion, plastic film | extrusion, plastic film | EN15804 - RER
Extrusion of plastic	Market for extrusion, plastic film | extrusion, plastic film | EN15804 - GLO
Cleaning Rag	Fibre and fabric waste, polyester, Recycled Content cut-off | fibre and fabric waste, polyester | EN15804 - GLO
Heat, central or small-scale, natural gas	Market for heat, central or small-scale, natural gas | heat, central or small-scale, natural gas | EN15804 - Europe without Switzerland
Rigid Plastic Injection moulding	Injection moulding | injection moulding | EN15804 - RER
Isopropanol	Isopropanol production | isopropanol | EN15804 - RER
Nylon	Nylon 6-6 production | nylon 6-6 | EN15804 - RER
Packaging film, low density polyethylene	Packaging film production, low density polyethylene | packaging film, low density polyethylene | EN15804 - RER
Packaging film, low density polyethylene	Market for packaging film, low density polyethylene | packaging film, low density polyethylene | EN15804 - GLO
Paper	Paper production, woodfree, coated, at integrated mill | paper, woodfree, coated | EN15804 - RER
Paper	Market for paper, woodfree, coated | paper, woodfree, coated | EN15804 - RER
Polyethylene, high density, granulate	Polyethylene production, high density, granulate | polyethylene, high density, granulate | EN15804 - RER
Polyethylene, linear low density, granulate	Polyethylene production, linear low density, granulate | polyethylene, linear low density, granulate | EN15804 - RER
Polyethylene, low density, granulate	Polyethylene production, low density, granulate | polyethylene, low density, granulate | EN15804 - RER
Polypropylene, granulate	Polypropylene production, granulate | polypropylene, granulate | EN15804 - RER

Polypropylene, granulate	Market for polypropylene, granulate | polypropylene, granulate | EN15804 - GLO
Tap water	Market for tap water | tap water | EN15804 - Europe without Switzerland
Road, lorry	Transport, freight, lorry >32 metric ton, EURO6 | transport, freight, lorry >32 metric ton, EURO6 | EN15804 - RER
Road, Lorry Rest of Europe	Transport, freight, lorry 16-32 metric ton, EURO6 | transport, freight, lorry 16-32 metric ton, EURO6 | EN15804 – RER
Road, Lorry Rest of World	Transport, freight, lorry 16-32 metric ton, EURO6 | transport, freight, lorry 16-32 metric ton, EURO6 | EN15804 - RoW
Road, Van Rest of Europe	Transport, freight, lorry 3.5-7.5 metric ton, EURO6 | transport, freight, lorry 3.5-7.5 metric ton, EURO6 | EN15804 - RER
Sea, container ship	Transport, freight, sea, container ship | transport, freight, sea, container ship | EN15804 - GLO
Ferry	Transport, freight, sea, ferry | transport, freight, sea, ferry | EN15804 - GLO
Passenger car	Transport, passenger car | transport, passenger car | EN15804 - RER
Waste paper, GB	Market for waste graphical paper | waste graphical paper | EN15804 - GB
Waste paper, FR	Market for waste graphical paper | waste graphical paper | EN15804 - FR
Waste cardboard, FR	Market for waste paperboard | waste paperboard | EN15804 - FR
Cardboard, recycled content	Waste paperboard, sorted, Recycled Content cut-off | waste paperboard, sorted | EN15804 - GLO
Waste cardboard	Treatment of waste paperboard, unsorted, sorting | waste paperboard, sorted | EN15804 - Europe without Switzerland
Waste cardboard, sorted	Market for waste paperboard, sorted | waste paperboard, sorted | EN15804 - GLO
Waste cardboard, unsorted	Market for waste paperboard, unsorted | waste paperboard, unsorted | EN15804 - Europe without Switzerland
Waste plastic, mixture	Market for waste plastic, mixture | waste plastic, mixture | EN15804 - FR
Waste polyethylene	Market for waste polyethylene | waste polyethylene | EN15804 - FR
Waste polyethylene, for recycling, sorted	Waste polyethylene, for recycling, sorted, Recycled Content cut-off | waste polyethylene, for recycling, sorted | EN15804 - GLO
Waste polyethylene, for recycling, sorted	Treatment of waste polyethylene, for recycling, unsorted, sorting | waste polyethylene, for recycling, sorted | EN15804 - Europe without Switzerland
Waste polyethylene, for recycling, unsorted	Market for waste polyethylene, for recycling, unsorted | waste polyethylene, for recycling, unsorted | EN15804 - Europe without Switzerland
Waste polypropylene	Market for waste polypropylene | waste polypropylene | EN15804 - FR

Waste textile, soiled	Treatment of waste textile, soiled, municipal incineration | waste textile, soiled | EN15804 - RoW
Waste water maintenance	Treatment of wastewater, from residence, capacity 1.1E10l/year | wastewater, from residence | EN15804 - RoW

5. Data Validation

This section describes the quality of the data used, and the steps taken to increase the accuracy and validity of data used in this study.

5.1 Quality of Data

In general, the quality of data used is judged based on the principle that primary process specific data used to model the manufacture of the pool cover materials FB400, CGU, S+G, RG and EGST + weave at the production site must be of higher quality than background data processes (the latter are provided by the Ecoinvent 3.8 datasets used, they are processes upstream in the supply chain of Plastipack's main specific production processes and are not readily influenceable by Plastipack).

5.1.1 Temporal Representativeness

Comprehensive process specific input data of high quality, granularity and temporal representativeness has been provided by Plastipack regarding the Assembly 1 manufacturing processes for the pool cover materials CGU, S+G, FB400, RG and EGST + weave and the supply chains for materials and fuels at the production site. The datasets for the raw material processes are for 2022, and a 3-year average is used for fuels, water and GeoBubble™ material offcuts and are therefore very recent and highly representative of actual processes used at Assembly 1. Comprehensive process specific input data of high quality and granularity has been provided by Plastipack regarding the transport to customers of the pool cover materials, including 3-year average of the proportion of pool cover materials sold by destination country and descriptions of transport journeys. For the Assembly 2 process-specific inputs, the data on electricity used has been provided by Plastipack, based on a 3-year usage average that has been allocated to a unit of analysis using data on total production of pool cover materials per annum.

5.1.2 Geographical representativeness

Environmental impact factors used are representative of the location of the production sites, and supplier locations in the supply chains for materials used to produce the Plastipack pool cover materials.

Comprehensive process specific input data of high quality, granularity and geographical representativeness has been provided by Plastipack regarding the Assembly 1 manufacturing processes for the pool cover materials CGU, S+G, FB400, RG and EGST + weave and the supply chains for materials and fuels at the production site. Processes from EN15804 add-on database of geographical representativeness have been applied to every stage of the life cycle of the pool covers. The production of raw materials and use of water, fuels and waste treatment service (including transport) which are mostly based in the UK, have been modelled using UK/GB specific processes when possible (there are just 2 instances of GB specific processes), where not an option, Europe (excluding Switzerland), Europe average processes, Rest of World average processes and Global average processes are used (see table 35). The transport to customers to Assembly 2 uses high-level data encompassing 96% of transport journeys to customers, which account for destination countries with greater than 1% of purchase volumes, and with known transport distances. For transport journeys to customers in Europe, Europe average processes are used and when not an option, Global average processes are used. For transport journeys to customers outside of Europe, Rest of World average processes are used. Assembly 2 activities, maintenance and end-of-life of the pool covers are modelled to be based in France, as 52% of total purchasing volumes are destined to France. Processes representative of France from EN15804 add-on database are used for Assembly 2 activities, maintenance and end-of-life of the pool covers when possible and when not an option are replaced by Europe excluding Switzerland, Europe average processes, or Global processes.

5.1.3 Technological representativeness

Environmental impact factors used are representative of the current technological developments. The modelling of the masterbatches, the extrusion of plastic packaging, the maintenance stage and transport processes are represented by processes in line with the current technologies. The end-of-life scenario for the pool cover accounts for the current technological abilities of recycling 'LDPE rich' plastic materials, however it assumes well-established systems for the recycling of bulky LDPE rich plastic in France. Disposal technologies and methods are considered representative of current practices.

5.2 Data limitations and Assumptions

The composition of masterbatches was assumed using generic components (LDPE, organic chemical, inorganic chemical). This is due to the fact that there was limited available information on the proportions of the composition of masterbatches coupled with the lack of specific processes to model the components available on the EN15804 add-on database.

Distances from Assembly 1 stage to waste treatment facility are sourced from Google maps. These journey distances are approximations because the specific routes actually taken on delivery journeys between production site and waste site, in 2022 is not available. There is no information available on Google maps on the nature of the site (whether it is an office-site or a waste facilities site) for the recycling company used, therefore the closest site has been chosen as the destination.

Comprehensive process specific input data of high quality and granularity has been provided by Plastipack regarding the transport to customers of the pool cover materials, including 3-year average of the proportion of all GeoBubble™ materials sold by destination country and descriptions of transport journeys. This high-level data is provided to 96% of transport journeys to customers, which account for destination countries with greater than 1% of purchase volumes, and with known transport distances. VSC scales this dataset to be representative of 100% of transport journeys to customers and adds on environmental impact factors and methods from the EN15804 add-on database. The transport to customers specific input data provided by Plastipack is regarded as high quality and high accuracy.

Assumptions have been used to model for the Assembly 2 processes. The data on packaging is provided by Plastipack using sector-specific knowledge. Inbound packaging for the cardboard box, in lieu of measured weights, has been determined by VSC through discussion with a Valpak packaging expert combined with research to determine the appropriate weights of the packaging. To this dataset, VSC added data environmental impact factors and methods from the EN15804 add-on database. Representative environmental impacts factors are used that include market activity of the processes to account for the lack of information available on distances from supplier to Assembly 2 and Assembly 2 to waste disposal/treatment site. The Assembly 2 specific input data provided by Plastipack is regarded as adequate.

The distribution to end user and the maintenance of pool covers FB400, CGU, S+G, RG and EGST + weave are calculated based on assumptions provided by Plastipack using sector-specific knowledge. The distribution to end user and the pool cover maintenance specific input data provided by Plastipack is regarded as adequate.

For the End-of-Life of product, it is known that the processes providing the environmental impacts are calculated based on assumptions and theoretical models, therefore the quality of the data should be regarded as poor. As such, it is acknowledged here that the impacts are uncertain.

In summary, the data is judged overall to be of high quality and an accurate representation (in terms of timeliness, geography, and technology) for all processes used in manufacture of the pool covers CGU, S+G, FB400, RG and EGST + weave.

5.3 Completeness of Environmental Impacts

All process flows have been quantified in terms of their environmental impacts. Environmental impact factors are sourced from the Ecoinvent 3.8 database, as modified for compliance with the EN15804+A2:2019 standard for producing Environmental Product Declarations (EPDs). The data within it has been critically reviewed and verified to be compliant with EN15804[22]. Carbon emissions from all sources (fuels, materials, production, transport, water and waste) are quantified in terms of their environmental impacts.

[22] https://nexus.openlca.org/ws/files/23889.

6. Discussion of results

The environmental impacts and other impacts of 1 m^2 of pool covers FB400, CGU, S+G, RG and EGST + weave from cradle-to-grave are presented below.

Table 36: Environmental impacts of 1 m^2 of FB400, CGU. S+G, RG and EGST + weave

Indicator	FB400	CGU	S+G	RG	EGST + weave	Unit
Environmental Impacts						
EI acidification	4.50E-03	5.83E-03	5.76E-03	5.74E-03	9.57E-03	molc H+ eq
EI climate change, GWP biogenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg CO_2 eq
EI climate change, GWP fossil	1.19E+00	1.49E+00	1.49E+00	1.48E+00	2.17E+00	kg CO_2 eq
EI climate change, GWP land transformation	9.02E-04	8.78E-04	8.65E-04	8.66E-04	1.36E-03	kg CO_2eq
EI climate change, GWP total	1.19E+00	1.49E+00	1.49E+00	1.48E+00	2.17E+00	kg CO_2 eq
EI depletion of abiotic resources - ADPE elements	8.38E-06	1.07E-05	1.03E-05	1.03E-05	1.37E-05	kg Sb-Eq
EI depletion of abiotic resources - ADPF fossil fuels	3.29E+00	4.33E+00	4.27E+00	4.28E+00	7.50E+00	MJ
EI eutrophication, freshwater	2.70E-04	3.77E-04	3.74E-04	3.73E-04	5.11E-04	kg P eq
EI eutrophication, marine	1.69E-03	2.71E-03	2.70E-03	2.69E-03	3.52E-03	kg N eq
EI eutrophication, terrestrial	9.38E-03	1.21E-02	1.20E-02	1.20E-02	2.05E-02	molc N eq
EI ozone depletion	6.47E-08	8.03E-08	7.92E-08	7.97E-08	1.12E-07	kg CFC11 eq
EI photochemical ozone formation	4.37E-03	5.29E-03	5.54E-03	5.49E-03	8.35E-03	kg NMVOC eq
EI water use, AWARE	8.24E-01	1.18E+00	1.18E+00	1.17E+00	1.42E+00	m^3

A comparison of environmental impacts of 1 m^2 of pool covers FB400, CGU, S+G, RG and EGST + weave shows that CGU, S+G and RG have similar values for the environmental impact indicators presented, due to similarities in product weight (and therefore raw materials inputted) and lifecycle models.

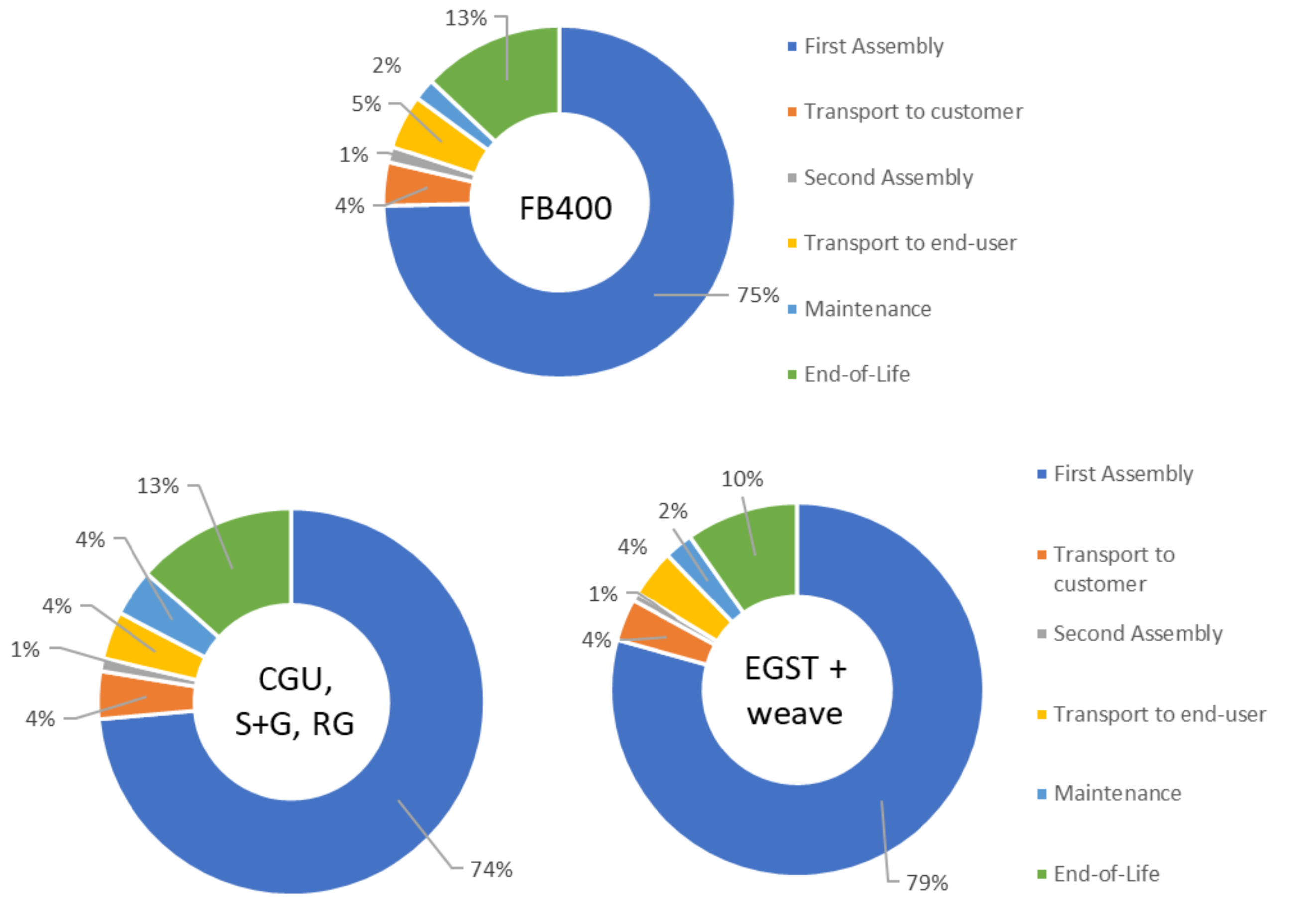
The LCA results show that for the majority of the impacts presented, a significant proportion can be attributed to the production of LDPE, which is the main raw material in the pool cover materials' compositions. For example, for FB400, CGU, S+G, RG and EGST + weave, the production of LDPE contributed to 37-57% of freshwater eutrophication from the pool covers' lifecycles. Similarly, for the five pool covers, the production of LDPE contributed to 34-56% of acidification from the pool covers' lifecycles. For the five pool covers, the production of LDPE contributed to 39-55% of carbon footprint from the pool covers' lifecycles. In the case for water deprivation potential for the five pool covers, the production of LDPE contributed to 39% to 50% of this impact.

6.1 Carbon Footprint

This section reports the quantified carbon footprints for the pool covers FB400, CGU, S+G, RG and EGST + weave. The carbon footprints reported are inclusive of the carbon emissions caused by End-of-Life processes of product at the End-of-Life. The carbon footprints of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers are 1.19 kg CO_2eq, 1.49 kg CO_2, 1.49 kg CO_2eq, 1.48 kg CO_2eq and 2.17 kg CO_2eq respectively. The carbon footprints of a standard 32 m^2 pool cover of FB400, CGU, S+G, RG and EGST + weave are 38.2 kg CO_2eq, 47.8 kg CO_2eq, 47.8 kg CO_2eq, 47.4 kg CO_2eq and 69.4 kg CO_2eq respectively.

The figure below shows the contribution of each lifecycle stage to the overall carbon footprint for FB400, CGU, S+G, RG and EGST + weave.

Figure 8: Contribution of each of the life cycle stages to the overall carbon footprint by pool cover material



For FB400, CGU, S+G, RG and EGST + weave pool covers, the Assembly 1 stage contributes to most to the carbon footprint of the life cycle per 1 m^2, ranging from 74% to 79%. The second biggest contributor to the overall carbon footprint of the pool covers is the End-of-Life stage, which contributes between 10% and 13% of overall footprint. The model for the End-of-Life of the pool covers assumes that the end user drives to the household waste recycling centre to recycle the pool cover.

Figure 9: Contribution of each of the life cycle stages by EPD module to the overall carbon footprint per 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers

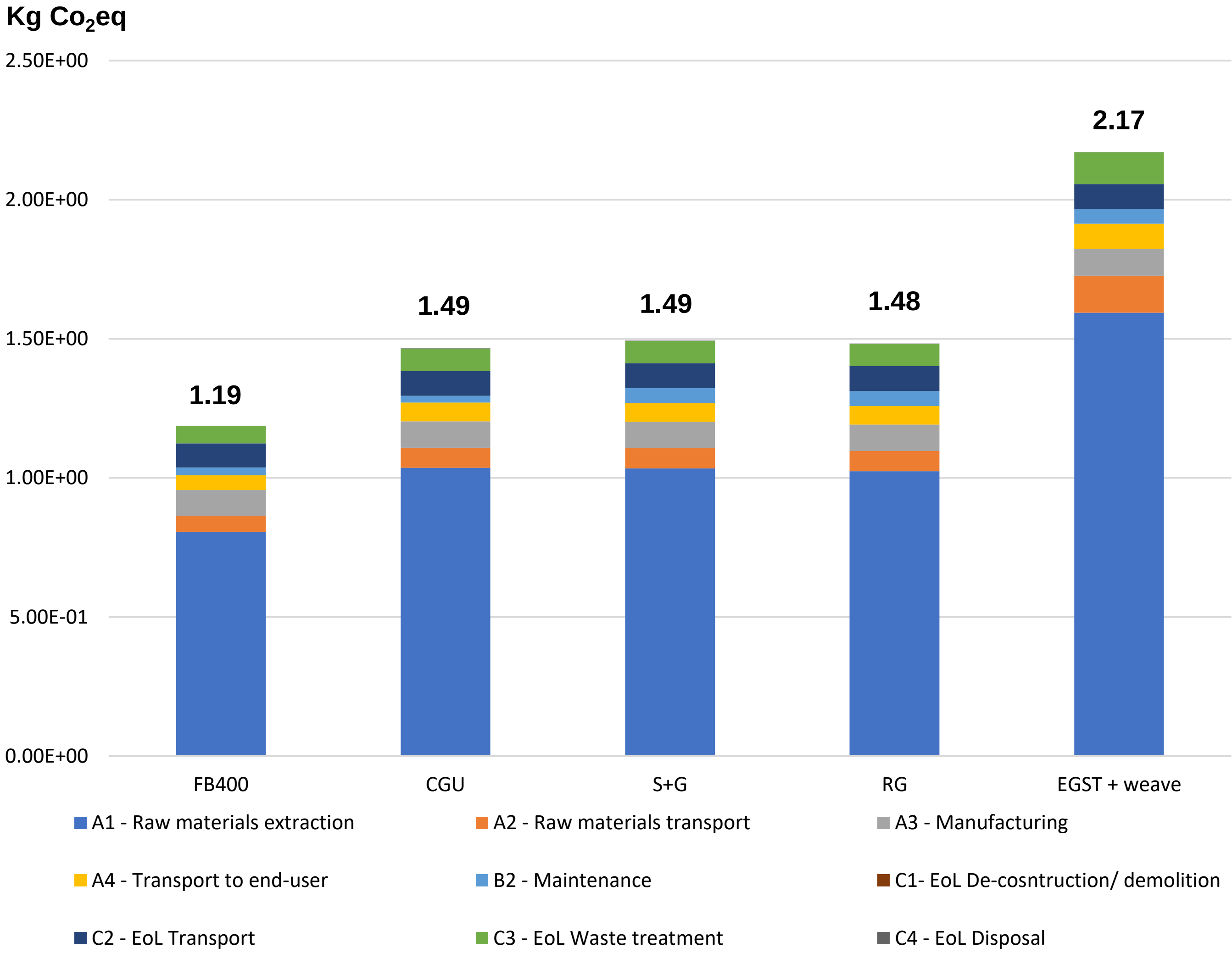


Figure 9 shows the overall carbon footprint of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers broken down by lifecycle module. The lifecycle module A1 which represents raw materials extraction contributes the most to the overall carbon footprint, ranging between 67% and 73% for all five pool covers. This can mostly be attributed to the carbon footprint of the raw materials of the pool covers. The carbon footprint for FB400 pool cover is the lowest of all five pool covers considered mostly due to the weight of the pool cover weighing less than the other pool covers considered per 1 m^2, therefore using less raw material. Similarly, the carbon footprint of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material.

Table 37 shows the carbon footprint used per functional unit of FB400, CGU, S+G, RG and EGST + weave pool covers in one life cycle.

Table 37: Contribution of each of the life cycle stages by EPD module to the overall carbon footprint per 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers

EPD module	**FB400** (kg CO_2eq)	**CGU** (kg CO_2eq)	**S+G** (kg CO_2eq)	**RG** (kg CO_2eq)	**EGST + weave** (kg CO_2eq)
A1 Raw materials extraction	8.06E-01	1.04E+00	1.03E+00	1.02E+00	1.59E+00
A2 Raw materials transport	5.73E-02	7.25E-02	7.25E-02	7.24E-02	1.34E-01
A3 Manufacturing	9.31E-02	9.52E-02	9.53E-02	9.53E-02	9.62E-02
A4 Distribution to end user	5.41E-02	6.68E-02	6.68E-02	6.68E-02	8.97E-02
B2 Maintenance	2.68E-02	5.36E-02	5.36E-02	5.36E-02	5.36E-02
C1 EoL De-construction/ demolition	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C2 EoL transport	8.94E-02	8.94E-02	8.94E-02	8.94E-02	8.94E-02
C3 Waste treatment	6.17E-02	8.02E-02	8.02E-02	8.02E-02	1.13E-01
C4 Disposal	6.63E-04	6.63E-04	6.63E-04	6.63E-04	6.63E-04

Figure 10: The contribution of materials, transport and manufacturing process to carbon footprint of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover in Assembly 1

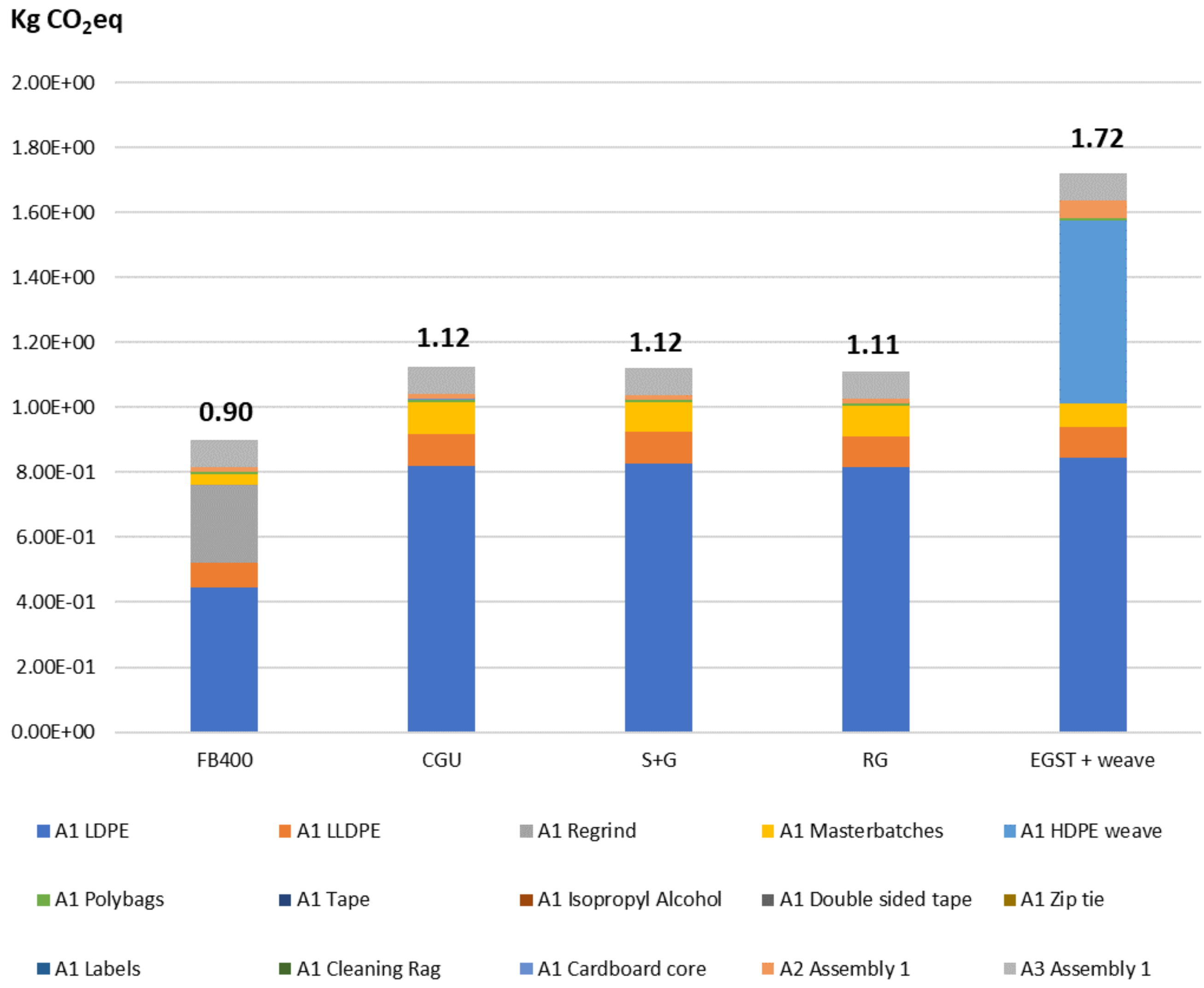


Figure 10 shows the contribution of materials, transport and manufacturing process to Assembly 1 carbon footprint for FB400, CGU, S+G, RG and EGST + weave pool covers. For S+G and RG pool covers, the main contributors to Assembly 1 carbon footprint are the LDPE, LLDPE and Masterbatches in descending order. For the CGU pool cover, the main contributors to Assembly 1 carbon footprint are the LDPE, Masterbatches and LLDPE in descending order. For the FB400 pool cover, the main contributors to Assembly 1 carbon footprint are LDPE, the raw materials of the regrind and the manufacturing process (A3 Assembly 1) in descending order. For the EGST + weave pool cover, the main contributors to Assembly 1 carbon footprint are LDPE, HDPE weave and LLDPE in descending order.

Table 38 shows the carbon footprint of materials, transport and manufacturing process at Assembly 1 for FB400, CGU, S+G, RG and EGST + weave pool covers.

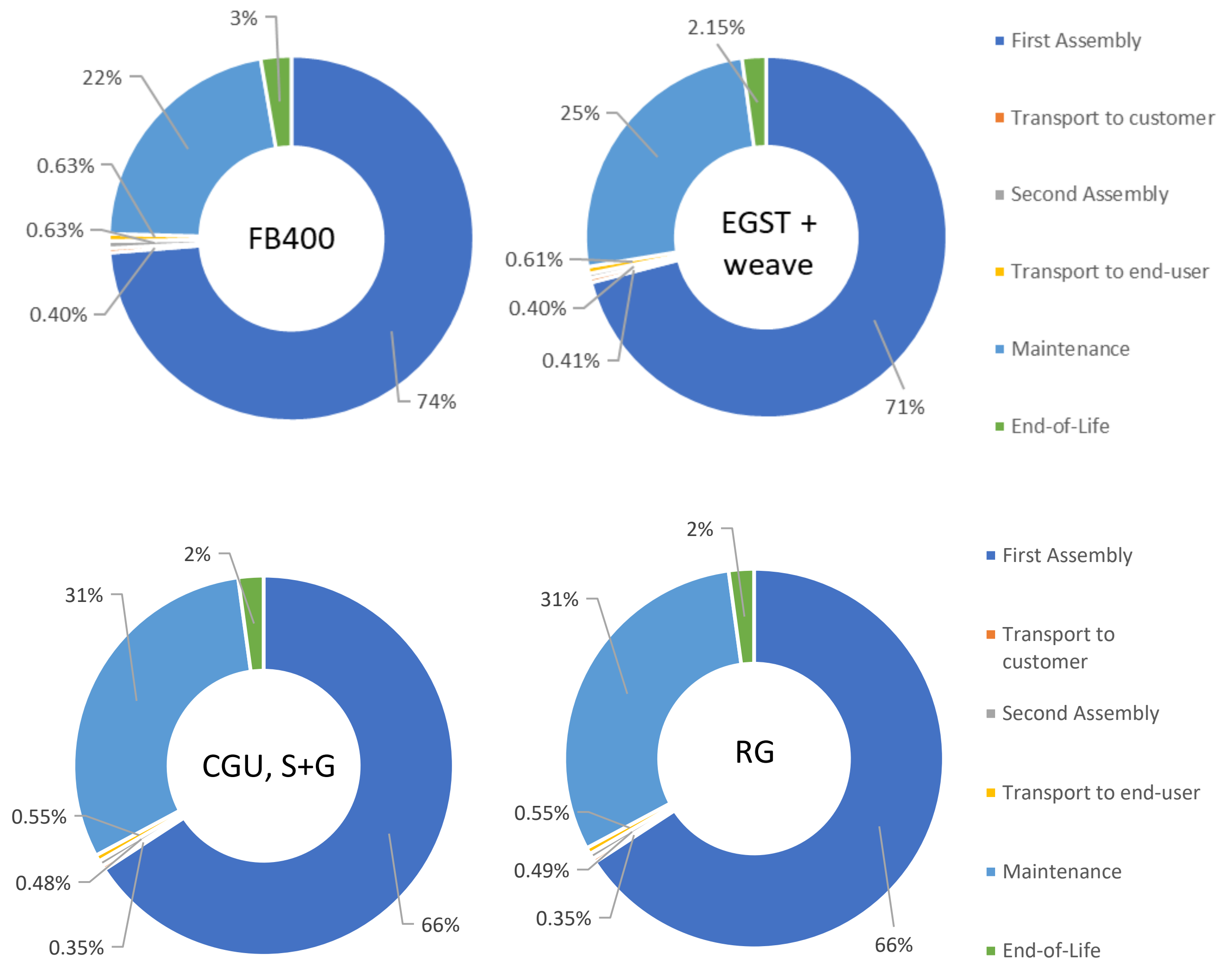
Table 38: The contribution of materials, transport and manufacturing process to carbon footprint of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover in Assembly 1

Component	**FB400** (kg CO_2eq)	**CGU** (kg CO_2eq)	**S+G** (kg CO_2eq)	**RG** (kg CO_2eq)	**EGST + weave** (kg CO_2eq)
A1 LDPE	4.47E-01	8.19E-01	8.27E-01	8.15E-01	8.43E-01
A1 LLDPE	7.65E-02	9.76E-02	9.76E-02	9.76E-02	9.76E-02
A1 Regrind	2.37E-01	N/A	N/A	N/A	N/A
A1 Masterbatches	3.49E-02	1.01E-01	9.14E-02	9.30E-02	6.97E-02
A1 HDPE weave	N/A	N/A	N/A	N/A	5.64E-01
A1 Polybags	7.11E-03	7.11E-03	7.11E-03	7.11E-03	7.11E-03
A1 Tape	1.16E-04	1.16E-04	1.16E-04	1.16E-04	1.16E-04
A1 Isopropyl Alcohol	1.05E-04	1.05E-04	1.05E-04	1.05E-04	1.05E-04
A1 Double sided tape	1.67E-04	1.67E-04	1.67E-04	1.67E-04	1.67E-04
A1 Zip tie	9.33E-05	9.33E-05	9.33E-05	9.33E-05	9.33E-05
A1 Labels	7.26E-05	7.26E-05	7.26E-05	7.26E-05	7.26E-05
A1 Cleaning Rag	1.36E-06	1.36E-06	1.36E-06	1.36E-06	1.36E-06
A1 Cardboard core	-4.14E-04	-4.14E-04	-4.14E-04	-4.14E-04	-4.14E-04
A2 Assembly 1	1.24E-02	1.54E-02	1.55E-02	1.53E-02	5.48E-02
A3 Assembly 1	8.32E-02	8.31E-02	8.31E-02	8.31E-02	8.41E-02

6.2 Water Deprivation Potential

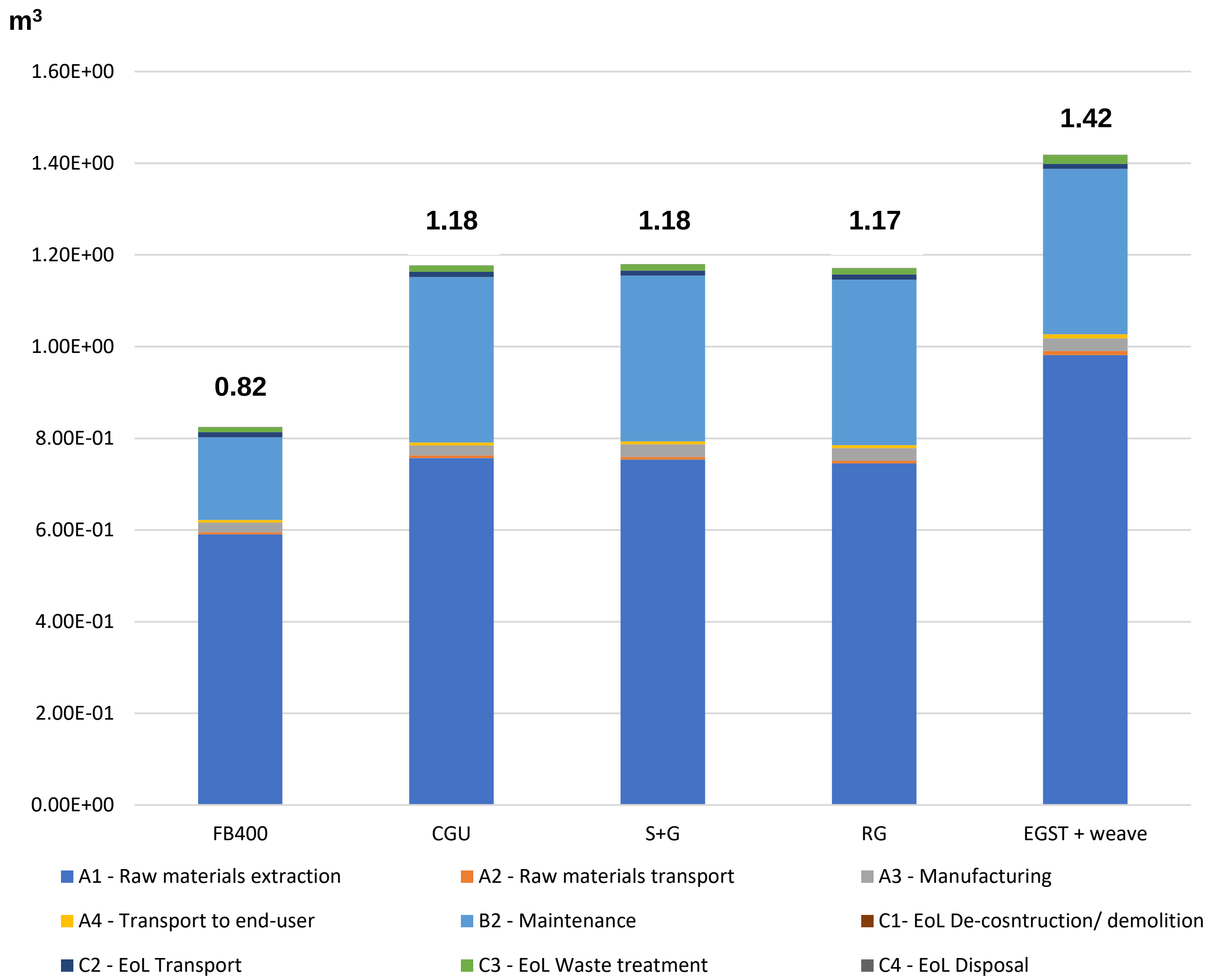
This section reports the quantified water deprivation potential for the pool covers FB400, CGU, S+G, RG and EGST + weave. The water deprivation potential of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers are 0.82 m^3 and 1.18 m^3, 1.18 m^3, 1.17 m^3 and 1.42 m^3 respectively. The water deprivation potential of a standard 32 m^2 pool cover of FB400, CGU, S+G, RG and EGST + weave pool covers are 26.4 m^3, 37.7 m^3, 37.8 m^3 37.4 m^3 and 45.4 m^3 respectively. The figure below shows the contribution of each lifecycle stage to the overall water deprivation potential for FB400, CGU, S+G, RG and EGST + weave pool covers.

Figure 11: Contribution of each of the life cycle stages to the overall water deprivation potential for pool covers FB400, CGU, S+G, RG and EGST + weave



For the GeoBubble™ materials FB400, CGU, S+G, RG and EGST + weave, the main stage that contribute to the majority of water deprivation potential in their life cycle is Assembly 1. Assembly 1 accounts for 74% of the overall water deprivation potential for the FB400 pool cover, 66% for pool covers CGU, S+G and RG, and 71% for pool cover EGST + weave. The maintenance of the pool cover accounts for 22% of the overall water deprivation potential for the FB400 pool cover, 31% for pool covers CGU, S+G and RG, and 25% for pool cover EGST + weave.   For pool covers FB400, CGU, S+G, RG and EGST + weave, the water deprivation potential in the Assembly 2 stage, transport to customer,transport to end user and End-of-Life stage make up 4.36%, 3.54%, 3.53% , 3.55% and 3.57% respectively of the overall water deprivation potential in their life cycles.

Figure 12: Contribution of each of the life cycle stages by EPD module to the overall water deprivation potential per 1 m² of FB400, CGU, S+G, RG and EGST + weave pool covers



The figure shows the overall water deprivation potential of one functional unit of GeoBubble™ FB400, CGU, S+G, RG and EGST + weave broken down by LCA information modules. Module A1 which represents raw materials extraction, contributes the most to the overall water deprivation potential, ranging between 64% and 72% of the overall water deprivation potential of the life cycles of the five pool covers. The maintenance of the pool covers is the second biggest contributor to the overall water deprivation potential of the pool covers.

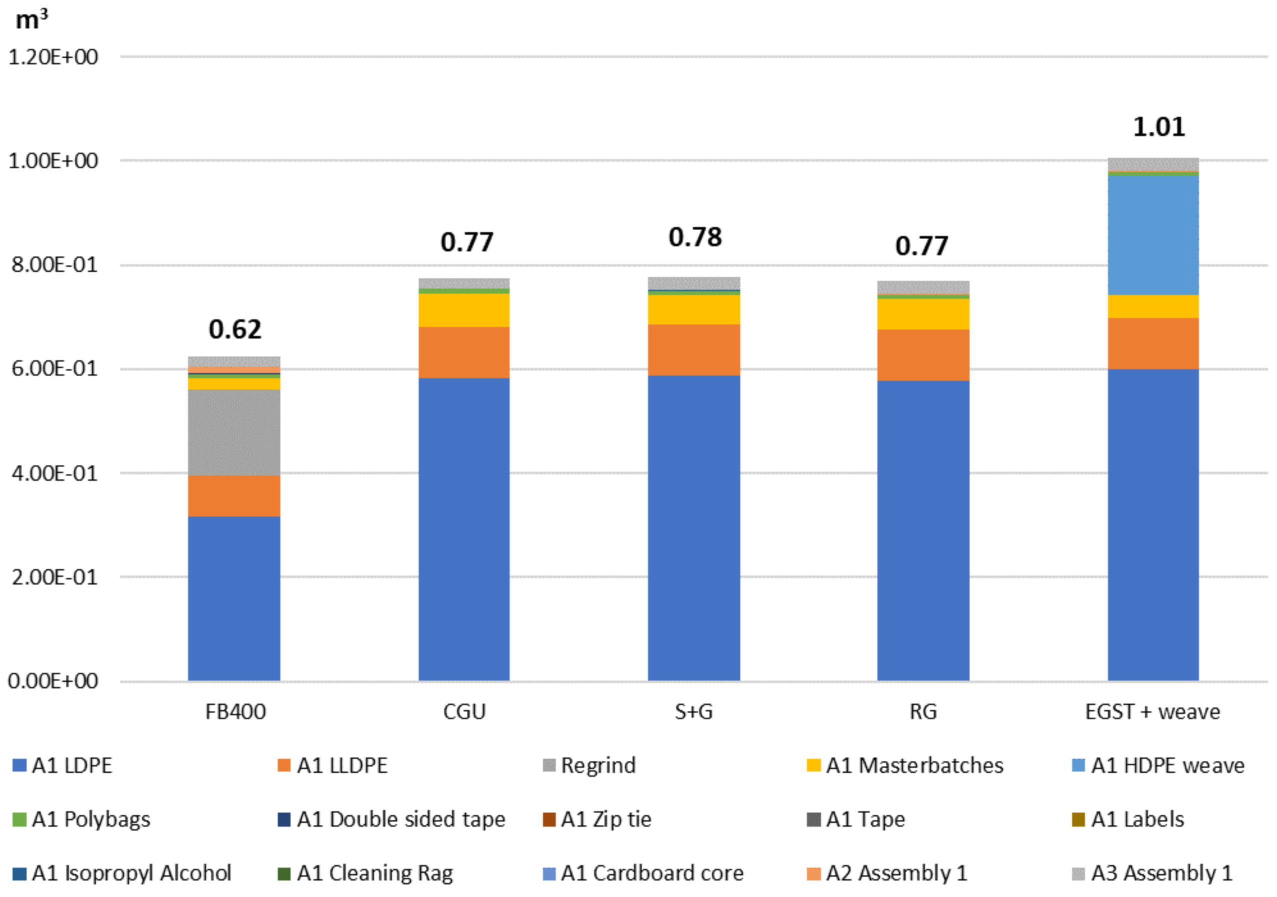
The water deprivation potential for FB400 is the lowest out of all five pool covers considered due to the weight of this GeoBubble™ material weighing less than the other GeoBubble™ materials considered per 1 m^2, therefore using less LDPE as a raw material. The water deprivation potential of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material. The model for the maintenance stage of the pool covers consists of rinsing the pool cover twice a year, and is for the duration of their expected lifespans, this is 4 years for FB400 and 8 years for CGU, S+G, RG and EGST + weave.

Table 39 below shows the amount of water deprivation potential per 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers in one life cycle.

Table 39: Contribution of each of the life cycle stages by EPD module to the overall water deprivation potential per 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers

LCA/EPD module	**FB400** (m^3)	**CGU** (m^3)	**S+G** (m^3)	**RG** (m^3)	**EGST + weave** (m^3)
A1 Raw materials extraction	5.90E-01	7.57E-01	7.54E-01	7.45E-01	9.82E-01
A2 Raw materials transport	4.49E-03	5.40E-03	5.41E-03	5.40E-03	8.39E-03
A3 Manufacturing	2.16E-02	2.21E-02	2.79E-02	2.79E-02	2.80E-02
A4 Distribution to end user	5.22E-03	6.45E-03	6.45E-03	6.45E-03	8.67E-03
B2 Maintenance	1.81E-01	3.61E-01	3.61E-01	3.61E-01	3.61E-01
C1 EoL De-construction/ demolition	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C2 EoL transport	1.10E-02	1.11E-02	1.11E-02	1.11E-02	1.11E-02
C3 Waste treatment	1.08E-02	1.37E-02	1.37E-02	1.37E-02	1.90E-02
C4 Disposal	4.51E-04	4.51E-04	4.51E-04	4.51E-04	4.51E-04

Figure 13: The contribution of materials, transport and manufacturing process to the water deprivation potential of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover in Assembly 1



The figure shows that for pool covers FB400, CGU, S+G and RG, LDPE and LLDPE contribute the most to water deprivation potential in Assembly 1, whereas for pool covers EGST+ weave LDPE and HDPE weave are the top contributors to water deprivation potential.

The table below breaks down the water deprivation potential contributions from materials, materials transport, and manufacturing process in Assembly 1 for 1 m^2 pool covers FB400, CGU, S+G and RG, EGST + weave.

Table 40: The contribution of materials, transport and manufacturing process to the water deprivation potential of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover in Assembly 1

Components	**FB400** (m^3)	**CGU** (m^3)	**S+G** (m^3)	**RG** (m^3)	**EGST + weave** (m^3)
A1 LDPE	3.17E-01	5.81E-01	5.87E-01	5.78E-01	5.99E-01
A1 LLDPE	7.74E-02	9.87E-02	9.87E-02	9.87E-02	9.87E-02
A1 Masterbatches	2.19E-02	6.60E-02	5.71E-02	5.74E-02	4.50E-02
A1 Regrind	1.66E-01	N/A	N/A	N/A	N/A
A1 HDPE weave	N/A	N/A	N/A	N/A	2.28E-01
A1 Polybags	7.77E-03	7.77E-03	7.77E-03	7.77E-03	7.77E-03
A1 Double-sided tape	1.96E-04	1.96E-04	1.96E-04	1.96E-04	1.96E-04
A1 Zip tie	1.02E-04	1.02E-04	1.02E-04	1.02E-04	1.02E-04
A1 Tape	9.13E-05	9.13E-05	9.13E-05	9.13E-05	9.13E-05
A1 Labels	6.66E-05	6.66E-05	6.66E-05	6.66E-05	6.66E-05
A1 Isopropyl Alcohol	3.95E-05	3.95E-05	3.95E-05	3.95E-05	3.95E-05
A1 Cleaning Rag	1.08E-06	1.08E-06	1.08E-06	1.08E-06	1.08E-06
A1 Cardboard core	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A2 Assembly 1	1.24E-02	1.24E-03	1.24E-03	1.23E-03	2.62E-03
A3 Assembly 1	1.93E-02	1.93E-02	2.50E-02	2.50E-02	2.52E-02

6.3 Biogenic carbon in GeoBubble™ material and Packaging

The following table showcases the biogenic carbon present in the 1 m^2 of FB400, CGU, S+G, RG, EGST + weave pool cover and its packaging (after Assembly 2).

Table 41: Biogenic carbon in 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover and its packaging (after Assembly 2)

	Biogenic carbon kg C				
Material	**FB400**	**CGU**	**S+G**	**RG**	**EGST + weave**
LDPE	0.00	0.00	0.00	0.00	0.00
LLDPE	0.00	0.00	0.00	0.00	0.00
Regrind	0.00	N/A	N/A	N/A	N/A
Masterbatch MB150	0.00	N/A	N/A	N/A	N/A
Masterbatch MB014	0.00	0.00	0.00	0.00	0.00
Masterbatch MB038	N/A	0.00	N/A	N/A	N/A
Masterbatch MB030	N/A	N/A	0.00	N/A	0.00
Masterbatch MB028	N/A	N/A	0.00	N/A	N/A
Masterbatch MB040	N/A	N/A	N/A	0.00	N/A
Masterbatch MB041	N/A	N/A	N/A	0.00	N/A
Masterbatch MB035	N/A	N/A	N/A	N/A	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Packaging Material	**FB400**	**CGU**	**S+G**	**RG**	**EGST + weave**
Polypropylene	0.00	0.00	0.00	0.00	0.00
Cardboard	0.00753	0.00753	0.00753	0.00753	0.00753
Polypropylene	0.00	0.00	0.00	0.00	0.00
Total	**0.00753**	**0.00753**	**0.00753**	**0.00753**	**0.00753**

6.4 Mandatory and voluntary impacts according to EN15804

6.4.1 FB400

Table 42: Results of the mandatory environmental impact category indicators according to EN 15804 for the life cycle of 1 m^2 of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP biogenic	kg CO_2 eq.	-2.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-02	5.11E-03
GWP-fossil	kg CO_2 eq.	9.48E-01	8.34E-02	1.33E-01	0.00E+00	2.24E-01	1.19E-01	1.18E-03
GWP-LULUC	kg CO_2 eq.	7.58E-04	3.21E-05	2.76E-05	0.00E+00	4.23E-05	4.13E-05	2.33E-07
GWP-Total	kg CO_2 eq.	1.00E+00	5.41E-02	2.68E-02	0.00E+00	8.94E-02	6.17E-02	6.63E-04
ODP	kg CFC11 eq.	3.36E-08	1.18E-08	1.66E-09	0.00E+00	1.62E-08	1.39E-09	3.73E-11
AP	molc H^+ eq.	3.65E-03	1.55E-04	2.21E-04	0.00E+00	3.57E-04	1.13E-04	3.54E-06
EP – freshwater	kg P eq.	1.97E-04	5.04E-06	4.75E-05	0.00E+00	1.22E-05	7.96E-06	5.66E-08
EP – marine	kg N eq.	7.12E-04	2.88E-05	7.92E-04	0.00E+00	8.21E-05	6.94E-05	9.53E-06
EP – terrestrial	molc N eq.	7.29E-03	3.12E-04	5.42E-04	0.00E+00	8.87E-04	3.40E-04	1.32E-05
POCP	kg NMVOC eq.	3.75E-03	1.17E-04	1.06E-04	0.00E+00	2.97E-04	9.80E-05	5.80E-06
ADP – minerals and metals*	kg Sb eq.	6.30E-06	3.22E-07	2.95E-07	0.00E+00	1.09E-06	3.81E-07	1.15E-09
ADP – fossil*	MJ	2.69E+00	8.34E-02	1.74E-01	0.00E+00	2.24E-01	1.19E-01	1.18E-03
WDP*	m^3	6.16E-01	5.22E-03	1.81E-01	0.00E+00	1.10E-02	1.08E-02	4.51E-04

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP – Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP – minerals and metals = Abiotic depletion potential for non-fossil resources, ADP – fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential. * *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 43: Results of the mandatory indicator on resource use according to EN15804 for the lifecycle of 1 m² of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
PENRT	MJ	3.29E+01	8.19E-01	4.22E-01	0.00E+00	1.26E+00	2.51E-01	3.98E-03
PENRE	MJ	5.79E+00	1.09E-01	2.85E-01	0.00E+00	2.55E-01	1.54E-01	1.35E-03
PENRM	MJ	2.71E+01	7.10E-01	1.37E-01	0.00E+00	1.00E+00	9.72E-02	2.63E-03
PERE	MJ	8.28E-01	1.26E-02	2.44E-02	0.00E+00	2.11E-02	1.73E-02	1.20E-04
PERM	MJ	3.62E-01	4.42E-03	7.28E-03	0.00E+00	7.85E-03	7.41E-03	3.59E-05
PERT	MJ	1.19E+00	1.70E-02	6.55E-02	0.00E+00	2.90E-02	2.47E-02	1.56E-04
FW	m^3	1.44E-02	1.24E-04	9.75E-03	0.00E+00	2.71E-04	2.56E-04	1.06E-05
SM	kg	1.09E-01	1.25E-03	9.68E-03	0.00E+00	2.39E-03	4.52E-01	1.38E-05
NRSF	MJ	2.04E-02	1.79E-03	4.61E-03	0.00E+00	5.02E-04	5.38E-04	2.48E-06
RSF	MJ	2.36E-02	3.91E-04	2.01E-03	0.00E+00	2.63E-04	5.08E-04	1.44E-06

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 44: Results of the mandatory indicators on waste according to EN15804 for the lifecycle of 1 m² of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
HW	kg	1.00E+00	2.65E-02	6.12E-02	0.00E+00	6.54E-02	4.09E-02	3.43E-04
NHW	kg	9.87E-02	2.58E-02	9.31E-03	0.00E+00	3.11E-02	3.99E-02	1.25E-02
RW	kg	1.55E-03	2.11E-05	6.79E-05	0.00E+00	2.53E-05	2.17E-05	1.18E-07

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 45: Results of other mandatory indicator according to EN15804 for the lifecycle of 1 m^2 of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP-GHG[23]	kg CO_2 eq.	8.86E-01	5.35E-02	2.66E-02	0.00E+00	8.60E-02	6.70E-02	6.76E-03

Table 46: Results of additional voluntary output flow indicator for the lifecycle of 1 m^2 of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	4.09E-02	1.08E-03	4.11E-03	0.00E+00	4.17E-03	1.77E-03	5.33E-06

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 47: Results of other voluntary indicator for the lifecycle of 1 m^2 of FB400 pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
Ionising radiation, HH	kBq U-235 eq	1.67E-01	1.41E-01	6.76E-03	0.00E+00	4.41E-03	5.81E-03	2.25E-03
Land use	Pt	1.43E+00	4.38E-01	4.69E-02	0.00E+00	1.89E-02	5.16E-01	5.08E-02
Human toxicity, non-cancer effects	CTUh	2.31E-08	1.80E-08	4.45E-09	0.00E+00	1.27E-09	2.97E-09	2.04E-09
Ecotoxicity, freshwater	CTUe	1.27E-01	9.92E-02	5.05E-02	0.00E+00	2.82E-03	5.85E-02	2.05E-02
Particulate matter, HH	Disease inc.	2.96E-08	2.27E-08	1.81E-09	0.00E+00	5.96E-10	4.36E-09	2.78E-09
Human toxicity, cancer effects	CTUh	2.65E-10	2.09E-10	1.05E-10	0.00E+00	3.79E-11	6.86E-11	7.31E-11

[23] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

6.4.2 CGU

Table 48: Results of the mandatory environmental impact category indicators according to EN 15804 for the life cycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP biogenic	kg CO_2 eq.	-2.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-02	5.11E-03
GWP-fossil	kg CO_2 eq.	1.20E+00	1.03E-01	2.65E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
GWP-LULUC	kg CO_2 eq.	6.87E-04	3.97E-05	5.51E-05	0.00E+00	4.28E-05	5.25E-05	2.33E-07
GWP-Total	kg CO_2 eq.	1.20E+00	6.68E-02	5.36E-02	0.00E+00	8.94E-02	8.02E-02	6.63E-04
ODP	kg CFC11 eq.	4.39E-08	1.46E-08	3.32E-09	0.00E+00	1.67E-08	1.76E-09	3.73E-11
AP	molc H^+ eq.	4.68E-03	1.92E-04	4.41E-04	0.00E+00	3.70E-04	1.43E-04	3.54E-06
EP – freshwater	kg P eq.	2.54E-04	6.23E-06	9.49E-05	0.00E+00	1.23E-05	1.01E-05	5.66E-08
EP – marine	kg N eq.	9.02E-04	3.56E-05	1.58E-03	0.00E+00	8.72E-05	8.82E-05	9.53E-06
EP – terrestrial	molc N eq.	9.26E-03	3.85E-04	1.08E-03	0.00E+00	9.43E-04	4.32E-04	1.32E-05
POCP	kg NMVOC eq.	4.73E-03	1.45E-04	2.12E-04	0.00E+00	7.68E-05	1.24E-04	5.80E-06
ADP – minerals and metals*	kg Sb eq.	8.12E-06	3.98E-07	5.90E-07	0.00E+00	1.09E-06	4.82E-07	1.15E-09
ADP – fossil*	MJ	3.50E+00	1.03E-01	3.49E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
WDP*	m^3	7.84E-01	6.45E-03	3.61E-01	0.00E+00	1.11E-02	1.37E-02	4.51E-04

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP – Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP – minerals and metals = Abiotic depletion potential for non-fossil resources, ADP – fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential. * *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 49: Results of the mandatory indicator on resource use according to EN15804 for the lifecycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
PENRT	MJ	4.10E+01	1.01E+00	8.43E-01	0.00E+00	1.29E+00	3.18E-01	3.98E-03
PENRE	MJ	7.17E+00	1.35E-01	5.70E-01	0.00E+00	2.57E-01	1.95E-01	1.35E-03
PENRM	MJ	3.39E+01	8.77E-01	2.74E-01	0.00E+00	1.03E+00	1.23E-01	2.63E-03
PERE	MJ	9.86E-01	1.56E-02	4.88E-02	0.00E+00	2.13E-02	2.18E-02	1.20E-04
PERM	MJ	4.08E-01	5.46E-03	1.46E-02	0.00E+00	7.90E-03	9.38E-03	3.59E-05
PERT	MJ	1.39E+00	2.10E-02	1.31E-01	0.00E+00	2.92E-02	3.12E-02	1.56E-04
FW	m^3	1.83E-02	1.54E-04	1.95E-02	0.00E+00	2.73E-04	3.25E-04	1.06E-05
SM	kg	1.33E-01	1.55E-03	1.94E-02	0.00E+00	2.40E-03	5.63E-01	1.38E-05
NRSF	MJ	2.56E-02	2.22E-03	9.23E-03	0.00E+00	5.12E-04	6.80E-04	2.48E-06
RSF	MJ	2.97E-02	4.83E-04	4.03E-03	0.00E+00	2.67E-04	6.33E-04	1.44E-06

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 50: Results of the mandatory indicators on waste according to EN15804 for the lifecycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
HW	kg	1.30E+00	3.27E-02	1.22E-01	0.00E+00	6.58E-02	5.17E-02	3.43E-04
NHW	kg	1.25E-01	3.18E-02	1.86E-02	0.00E+00	3.16E-02	5.06E-02	1.25E-02
RW	kg	1.81E-03	2.60E-05	1.36E-04	0.00E+00	2.57E-05	2.73E-05	1.18E-07

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 51:Results of other mandatory indicator according to EN15804 for the lifecycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP-GHG[24]	kg CO_2 eq.	1.12E+00	6.61E-02	5.31E-02	0.00E+00	8.81E-02	8.51E-02	6.76E-03

Table 52: Results of additional voluntary output flow indicator for the lifecycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	5.15E-02	1.34E-03	8.21E-03	0.00E+00	4.18E-03	2.23E-03	5.33E-06

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 53: Results of other voluntary indicator for the lifecycle of 1 m^2 of CGU pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
Ionising radiation, HH	kBq U-235 eq	1.92E-01	5.54E-03	1.35E-02	0.00E+00	5.95E-03	2.84E-03	1.69E-05
Land use	Pt	1.86E+00	5.28E-01	9.39E-02	0.00E+00	5.25E-01	6.43E-02	4.77E-03
Human toxicity, non-cancer effects	CTUh	2.97E-08	1.61E-09	8.89E-09	0.00E+00	2.99E-09	2.59E-09	2.06E-10
Ecotoxicity, freshwater	CTUe	1.61E-01	2.36E-02	1.01E-01	0.00E+00	5.88E-02	2.61E-02	2.65E-04
Particulate matter, HH	Disease inc.	3.84E-08	3.12E-09	3.62E-09	0.00E+00	4.62E-09	3.54E-09	6.95E-11
Human toxicity, cancer effects	CTUh	3.48E-10	3.00E-11	2.11E-10	0.00E+00	6.90E-11	9.28E-11	1.54E-12

[24] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

6.4.3 S+G

Table 54: Results of the mandatory environmental impact category indicators according to EN 15804 for the life cycle of 1 m^2 of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP biogenic	kg CO_2 eq.	-2.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-02	5.11E-03
GWP-fossil	kg CO_2 eq.	1.19E+00	1.03E-01	2.65E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
GWP-LULUC	kg CO_2 eq.	6.75E-04	3.97E-05	5.51E-05	0.00E+00	4.27E-05	5.25E-05	2.33E-07
GWP-Total	kg CO_2 eq.	1.20E+00	6.68E-02	5.36E-02	0.00E+00	8.94E-02	8.02E-02	6.63E-04
ODP	kg CFC11 eq.	4.28E-08	1.46E-08	3.32E-09	0.00E+00	1.67E-08	1.76E-09	3.73E-11
AP	molc H^+ eq.	4.62E-03	1.92E-04	4.41E-04	0.00E+00	3.70E-04	1.43E-04	3.54E-06
EP – freshwater	kg P eq.	2.51E-04	6.23E-06	9.49E-05	0.00E+00	1.23E-05	1.01E-05	5.66E-08
EP – marine	kg N eq.	8.96E-04	3.56E-05	1.58E-03	0.00E+00	8.72E-05	8.82E-05	9.53E-06
EP – terrestrial	molc N eq.	9.17E-03	3.85E-04	1.08E-03	0.00E+00	9.43E-04	4.32E-04	1.32E-05
POCP	kg NMVOC eq.	4.74E-03	1.45E-04	2.12E-04	0.00E+00	3.16E-04	1.24E-04	5.80E-06
ADP – minerals and metals*	kg Sb eq.	7.78E-06	3.98E-07	5.90E-07	0.00E+00	1.09E-06	4.82E-07	1.15E-09
ADP – fossil*	MJ	3.44E+00	1.03E-01	3.49E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
WDP*	m^3	7.87E-01	6.45E-03	3.61E-01	0.00E+00	1.11E-02	1.37E-02	4.51E-04

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP – Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP – minerals and metals = Abiotic depletion potential for non-fossil resources, ADP – fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential. * *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 55: Results of the mandatory indicator on resource use according to EN15804 for the lifecycle of 1 m² of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
PENRT	MJ	4.13E+01	1.01E+00	8.43E-01	0.00E+00	1.29E+00	3.18E-01	3.98E-03
PENRE	MJ	7.13E+00	1.35E-01	5.70E-01	0.00E+00	2.57E-01	1.95E-01	1.35E-03
PENRM	MJ	3.42E+01	8.77E-01	2.74E-01	0.00E+00	1.03E+00	1.23E-01	2.63E-03
PERE	MJ	9.84E-01	1.56E-02	4.88E-02	0.00E+00	2.13E-02	2.18E-02	1.20E-04
PERM	MJ	4.06E-01	5.46E-03	1.46E-02	0.00E+00	7.90E-03	9.38E-03	3.59E-05
PERT	MJ	1.39E+00	1.35E-02	1.31E-01	0.00E+00	2.92E-02	3.12E-02	1.56E-04
FW	m^3	1.84E-02	1.54E-04	1.95E-02	0.00E+00	2.73E-04	3.25E-04	1.06E-05
SM	kg	1.34E-01	1.55E-03	1.94E-02	0.00E+00	2.40E-03	5.63E-01	1.38E-05
NRSF	MJ	2.52E-02	2.22E-03	9.23E-03	0.00E+00	5.12E-04	6.80E-04	2.48E-06
RSF	MJ	2.99E-02	4.83E-04	4.03E-03	0.00E+00	2.67E-04	6.33E-04	1.44E-06

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 56: Results of the mandatory indicators on waste according to EN15804 for the lifecycle of 1 m² of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
HW	kg	1.27E+00	3.27E-02	1.22E-01	0.00E+00	6.58E-02	5.17E-02	3.43E-04
NHW	kg	1.24E-01	3.18E-02	1.86E-02	0.00E+00	3.16E-02	5.06E-02	1.25E-02
RW	kg	1.81E-03	2.60E-05	1.36E-04	0.00E+00	2.57E-05	2.73E-05	1.18E-07

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 57:Results of other mandatory indicator according to EN15804 for the lifecycle of 1 m^2 of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP-GHG[25]	kg CO_2 eq.	1.11E+00	6.61E-02	5.31E-02	0.00E+00	8.81E-02	8.51E-02	6.76E-03

Table 58: Results of additional voluntary output flow indicator for the lifecycle of 1 m^2 of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	5.17E-02	1.34E-03	8.21E-03	0.00E+00	4.18E-03	2.23E-03	5.33E-06

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 59: Results of other voluntary indicator for the lifecycle of 1 m^2 of S+G pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
Ionising radiation, HH	kBq U-235 eq	1.92E-01	5.54E-03	1.35E-02	0.00E+00	5.95E-03	2.84E-03	1.69E-05
Land use	Pt	1.79E+00	5.28E-01	9.39E-02	0.00E+00	5.25E-01	6.43E-02	4.77E-03
Human toxicity, non-cancer effects	CTUh	2.87E-08	1.61E-09	8.89E-09	0.00E+00	2.99E-09	2.59E-09	2.06E-10
Ecotoxicity, freshwater	CTUe	1.53E-01	2.36E-02	1.01E-01	0.00E+00	5.88E-02	2.61E-02	2.65E-04
Particulate matter, HH	Disease inc.	3.79E-08	3.12E-09	3.62E-09	0.00E+00	4.62E-09	3.54E-09	6.95E-11
Human toxicity, cancer effects	CTUh	3.40E-10	3.00E-11	2.11E-10	0.00E+00	6.90E-11	9.28E-11	1.54E-12

[25] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

6.4.4 RG

Table 60: Results of the mandatory environmental impact category indicators according to EN 15804 for the life cycle of 1 m^2 of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP biogenic	kg CO_2 eq.	-2.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-02	5.11E-03
GWP-fossil	kg CO_2 eq.	1.18E+00	1.03E-01	2.65E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
GWP-LULUC	kg CO_2 eq.	6.75E-04	3.97E-05	5.51E-05	0.00E+00	4.27E-05	5.25E-05	2.33E-07
GWP-Total	kg CO_2 eq.	1.19E+00	6.68E-02	5.36E-02	0.00E+00	8.94E-02	8.02E-02	6.63E-04
ODP	kg CFC11 eq.	4.33E-08	1.46E-08	3.32E-09	0.00E+00	1.67E-08	1.76E-09	3.73E-11
AP	molc H^+ eq.	4.59E-03	1.92E-04	4.41E-04	0.00E+00	3.70E-04	1.43E-04	3.54E-06
EP – freshwater	kg P eq.	2.49E-04	6.23E-06	9.49E-05	0.00E+00	1.23E-05	1.01E-05	5.66E-08
EP – marine	kg N eq.	8.91E-04	3.56E-05	1.58E-03	0.00E+00	8.72E-05	8.82E-05	9.53E-06
EP – terrestrial	molc N eq.	9.12E-03	3.85E-04	1.08E-03	0.00E+00	9.43E-04	4.32E-04	1.32E-05
POCP	kg NMVOC eq.	4.68E-03	1.45E-04	2.12E-04	0.00E+00	3.16E-04	1.24E-04	5.80E-06
ADP – minerals and metals*	kg Sb eq.	7.74E-06	3.98E-07	5.90E-07	0.00E+00	1.09E-06	4.82E-07	1.15E-09
ADP – fossil*	MJ	3.46E+00	1.03E-01	3.49E-01	0.00E+00	2.25E-01	1.51E-01	1.18E-03
WDP*	m^3	7.79E-01	6.45E-03	3.61E-01	0.00E+00	1.11E-02	1.37E-02	4.51E-04

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP – Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP – minerals and metals = Abiotic depletion potential for non-fossil resources, ADP – fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential. * *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 61: Results of the mandatory indicator on resource use according to EN15804 for the lifecycle of 1 m² of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
PENRT	MJ	4.08E+01	1.01E+00	8.43E-01	0.00E+00	1.29E+00	3.18E-01	3.98E-03
PENRE	MJ	7.09E+00	1.35E-01	5.70E-01	0.00E+00	2.57E-01	1.95E-01	1.35E-03
PENRM	MJ	3.37E+01	8.77E-01	1.17E+00	0.00E+00	1.23E-01	1.23E-01	2.63E-03
PERE	MJ	9.76E-01	1.56E-02	4.88E-02	0.00E+00	2.13E-02	2.18E-02	1.20E-04
PERM	MJ	4.03E-01	5.46E-03	1.46E-02	0.00E+00	7.90E-03	9.38E-03	3.59E-05
PERT	MJ	1.38E+00	2.10E-02	1.31E-01	0.00E+00	2.92E-02	3.12E-02	1.56E-04
FW	m^3	1.82E-02	1.54E-04	1.95E-02	0.00E+00	2.73E-04	3.25E-04	1.06E-05
SM	kg	1.33E-01	1.55E-03	1.94E-02	0.00E+00	2.40E-03	5.63E-01	1.38E-05
NRSF	MJ	2.50E-02	2.22E-03	9.23E-03	0.00E+00	5.12E-04	6.80E-04	2.48E-06
RSF	MJ	2.93E-02	4.83E-04	4.03E-03	0.00E+00	2.67E-04	6.33E-04	1.44E-06

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 62: Results of the mandatory indicators on waste according to EN15804 for the lifecycle of 1 m² of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
HW	kg	1.26E+00	3.27E-02	1.22E-01	0.00E+00	6.58E-02	5.17E-02	3.43E-04
NHW	kg	1.24E-01	3.18E-02	1.86E-02	0.00E+00	3.16E-02	5.06E-02	1.25E-02
RW	kg	1.79E-03	2.60E-05	1.36E-04	0.00E+00	2.57E-05	2.73E-05	1.18E-07

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 63: Results of other mandatory indicator according to EN15804 for the lifecycle of 1 m^2 of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
GWP-GHG[26]	kg CO_2 eq.	1.10E+00	6.61E-02	5.31E-02	0.00E+00	8.81E-02	8.51E-02	6.76E-03

Table 64: Results of additional voluntary output flow indicator for the lifecycle of 1 m^2 of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	5.08E-02	1.34E-03	8.21E-03	0.00E+00	4.18E-03	2.23E-03	5.33E-06

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 65: Results of other voluntary indicator for the lifecycle of 1 m^2 of RG pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
Ionising radiation, HH	kBq U-235 eq	1.91E-01	5.54E-03	1.35E-02	0.00E+00	5.95E-03	2.84E-03	1.69E-05
Land use	Pt	1.80E+00	5.28E-01	9.39E-02	0.00E+00	5.25E-01	6.43E-02	4.77E-03
Human toxicity, non-cancer effects	CTUh	2.86E-08	1.61E-09	8.89E-09	0.00E+00	2.99E-09	2.59E-09	2.06E-10
Ecotoxicity, freshwater	CTUe	1.56E-01	2.36E-02	1.01E-01	0.00E+00	5.88E-02	2.61E-02	2.65E-04
Particulate matter, HH	Disease inc.	3.78E-08	3.12E-09	3.62E-09	0.00E+00	4.62E-09	3.54E-09	6.95E-11
Human toxicity, cancer effects	CTUh	3.44E-10	3.00E-11	2.11E-10	0.00E+00	6.90E-11	9.28E-11	1.54E-12

[26] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

6.4.5 EGST + weave

Table 66: Results of the mandatory environmental impact category indicators according to EN 15804 for the lifecycle of 1 m^2 of EGST + weave pool cover

Indicators	Unit	A1 – A3	A4	B2	C1	C2	C3	C4
GWP biogenic	kg CO_2 eq.	-2.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-02	5.11E-03
GWP-fossil	kg CO_2 eq.	1.81E+00	1.38E-01	2.65E-01	0.00E+00	2.25E-01	2.08E-01	1.18E-03
GWP-LULUC	kg CO_2 eq.	1.13E-03	5.33E-05	5.51E-05	0.00E+00	4.27E-05	7.27E-05	2.33E-07
GWP-Total	kg CO_2 eq.	1.82E+00	8.97E-02	5.36E-02	0.00E+00	8.94E-02	1.13E-01	6.63E-04
ODP	kg CFC11 eq.	7.01E-08	1.96E-08	3.32E-09	0.00E+00	1.67E-08	2.44E-09	3.73E-11
AP	molc H^+ eq.	8.30E-03	2.58E-04	4.41E-04	0.00E+00	3.70E-04	1.97E-04	3.54E-06
EP - freshwater	kg P eq.	3.82E-04	8.37E-06	9.49E-05	0.00E+00	1.23E-05	1.39E-05	5.65E-08
EP - marine	kg N eq.	1.67E-03	4.78E-05	1.58E-03	0.00E+00	8.72E-05	1.22E-04	9.53E-06
EP - terrestrial	molc N eq.	1.74E-02	5.18E-04	1.08E-03	0.00E+00	9.43E-04	5.97E-04	1.32E-05
POCP	kg NMVOC eq.	7.45E-03	1.94E-04	2.12E-04	0.00E+00	3.16E-04	1.72E-04	5.80E-06
ADP - minerals and metals*	kg Sb eq.	1.09E-05	5.35E-07	5.90E-07	0.00E+00	1.09E-06	6.64E-07	1.15E-09
ADP – fossil*	MJ	6.58E+00	1.38E-01	3.49E-01	0.00E+00	2.25E-01	2.08E-01	1.18E-03
WDP*	m^3	1.02E+00	8.67E-03	3.61E-01	0.00E+00	1.11E-02	1.90E-02	4.51E-04

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP - Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP - minerals and metals = Abiotic depletion potential for non-fossil resources, ADP - fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential.
**Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 67: Results of the mandatory indicators on resource use according to EN15804 for the lifecycle of 1 m² of EGST + weave pool cover

Indicators	Unit	A1 – A3	A4	B2	C1	C2	C3	C4
PENRT	MJ	5.87E+01	1.36E+00	8.43E-01	0.00E+00	1.29E+00	4.38E-01	3.98E-03
PENRE	MJ	1.09E+01	1.81E-01	5.70E-01	0.00E+00	2.57E-01	2.68E-01	1.35E-03
PENRM	MJ	4.78E+01	1.18E+00	2.74E-01	0.00E+00	1.03E+00	1.70E-01	2.63E-03
PERE	MJ	1.24E+00	2.09E-02	4.88E-02	0.00E+00	2.13E-02	3.01E-02	1.20E-04
PERM	MJ	5.02E-01	7.34E-03	1.46E-02	0.00E+00	7.90E-03	1.29E-02	3.59E-05
PERT	MJ	1.74E+00	2.83E-02	1.31E-01	0.00E+00	2.92E-02	4.30E-02	1.56E-04
FW	m^3	2.39E-02	2.06E-04	1.95E-02	0.00E+00	2.73E-04	4.49E-04	1.06E-05
SM	kg	1.49E-01	2.08E-03	1.94E-02	0.00E+00	2.40E-03	7.64E-01	1.38E-05
NRSF	MJ	3.04E-02	2.98E-03	9.23E-03	0.00E+00	5.12E-04	9.37E-04	2.48E-06
RSF	MJ	3.25E-02	6.49E-04	4.03E-03	0.00E+00	2.67E-04	8.57E-04	1.44E-06

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 68: Results of the mandatory indicators on waste according to EN15804 for the lifecycle of 1 m² of EGST + weave pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
HW	kg	1.94E+00	4.39E-02	1.22E-01	0.00E+00	6.58E-02	7.12E-02	3.43E-04
NHW	kg	1.72E-01	4.28E-02	1.86E-02	0.00E+00	3.16E-02	6.98E-02	1.25E-02
RW	kg	2.03E-03	3.50E-05	1.36E-04	0.00E+00	2.57E-05	3.75E-05	1.18E-07

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 69: Results of the other mandatory indicators according to EN15804 for the lifecycle of 1 m^2 of EGST + weave pool cover

Indicators	Unit	A1- A3	A4	B2	C1	C2	C3	C4
GWP-GHG[27]	kg CO_2 eq.	1.70E+00	8.88E-02	5.31E-02	0.00E+00	8.81E-02	1.18E-01	6.76E-03

Table 70: Results of the additional voluntary output flow indicator for the lifecycle of 1 m^2 of EGST + weave pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	5.77E-02	1.80E-03	8.21E-03	0.00E+00	4.18E-03	3.06E-03	5.33E-06

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 71: Other voluntary indicator results for 1 m^2 of EGST + weave pool cover

Indicators	Unit	A1-A3	A4	B2	C1	C2	C3	C4
Ionising radiation, HH	kBq U-235 eq	2.20E-01	7.44E-03	1.35E-02	0.00E+00	5.95E-03	3.90E-03	1.69E-05
Land use	Pt	2.67E+00	7.10E-01	9.39E-02	0.00E+00	5.25E-01	8.86E-02	4.77E-03
Human toxicity, non-cancer effects	CTUh	4.77E-08	2.16E-09	8.89E-09	0.00E+00	2.99E-09	3.58E-09	2.06E-10
Ecotoxicity, freshwater	CTUe	2.56E-01	3.17E-02	1.01E-01	0.00E+00	5.88E-02	3.62E-02	2.65E-04
Particulate matter, HH	Disease inc.	6.25E-08	4.19E-09	3.62E-09	0.00E+00	4.62E-09	2.00E-09	6.95E-11
Human toxicity, cancer effects	CTUh	5.34E-10	4.03E-11	2.11E-10	0.00E+00	6.90E-11	1.28E-10	1.54E-12

[27] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

6.5 Benefits and Loads Beyond the System Boundary

Module D encompasses the savings from the recycling of the pool cover which assumes the avoided production of virgin LDPE.

The benefits and loads beyond the system boundary use processes from the eco-invent 3.8 EN15804 add-on to translate the savings from the avoided production of virgin LDPE into measurable environmental impacts avoided and other impacts avoided.

Table 72: Results of the mandatory environmental impact category indicators according to EN for the benefits and loads beyond the system boundary of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
GWP biogenic	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWP-fossil	kg CO_2 eq.	-7.31E-01	-9.34E-01	-9.34E-01	-9.34E-01	-1.30E+00
GWP-LULUC	kg CO_2 eq.	-3.62E-04	-4.62E-04	-4.62E-04	-4.62E-04	-6.43E-04
GWP-Total	kg CO_2 eq.	-7.31E-01	-9.34E-01	-9.34E-01	-9.34E-01	-1.30E+00
ODP	kg CFC11 eq.	-1.14E-08	-1.46E-08	-1.46E-08	-1.46E-08	-2.03E-08
AP	molc H^+ eq.	-2.73E-03	-3.49E-03	-3.49E-03	-3.49E-03	-4.85E-03
EP - freshwater	kg P eq.	-1.65E-04	-2.11E-04	-2.11E-04	-2.11E-04	-2.94E-04
EP - marine	kg N eq.	-5.08E-04	-6.49E-04	-6.49E-04	-6.49E-04	-9.03E-04
EP - terrestrial	molc N eq.	-5.11E-03	-6.52E-03	-6.52E-03	-6.52E-03	-9.08E-03
POCP	kg NMVOC eq.	-3.10E-03	-3.96E-03	-3.96E-03	-3.96E-03	-5.51E-03
ADP - minerals and metals*	kg Sb eq.	-4.74E-06	-6.06E-06	-6.06E-06	-6.06E-06	-8.43E-06
ADP – fossil*	MJ	-2.03E+00	-2.59E+00	-2.59E+00	-2.59E+00	-3.61E+00
WDP*	m^3	-5.19E-01	-6.63E-01	-6.63E-01	-6.63E-01	-9.23E-01

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP - Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP - minerals and metals = Abiotic depletion potential for non-fossil resources, ADP - fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential.

* *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 73: Results of the mandatory indicator results on resource use according to for the benefits and loads beyond the system boundary of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
PENRT	MJ	-2.73E+01	-3.49E+01	-3.49E+01	-3.49E+01	-4.86E+01
PENRE	MJ	-4.04E+00	-5.16E+00	-5.16E+00	-5.16E+00	-7.18E+00
PENRM	MJ	-2.33E+01	-2.98E+01	-2.98E+01	-2.98E+01	-4.14E+01
PERE	MJ	-5.05E-01	-6.45E-01	-6.45E-01	-6.45E-01	-8.98E-01
PERM	MJ	-1.50E-01	-1.91E-01	-1.91E-01	-1.91E-01	-2.66E-01
PERT	MJ	-6.54E-01	-8.36E-01	-8.36E-01	-8.36E-01	-1.16E+00
FW	m^3	-1.21E-02	-1.55E-02	-1.55E-02	-1.55E-02	-2.15E-02
SM	kg	-4.34E-02	-5.55E-02	-5.55E-02	-5.55E-02	-7.72E-02
NRSF	MJ	-1.60E-02	-2.05E-02	-2.05E-02	-2.05E-02	-2.85E-02
RSF	MJ	-2.23E-02	-2.85E-02	-2.85E-02	-2.85E-02	-3.96E-02

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 74: Results of the mandatory indicator results on waste according to EN15804 for the benefits and loads beyond the system boundary of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
HW	kg	-8.30E-01	-1.06E+00	-1.06E+00	-1.06E+00	-1.48E+00
NHW	kg	-2.07E-02	-2.65E-02	-2.65E-02	-2.65E-02	-3.68E-02
RW	kg	-8.91E-04	-1.14E-03	-1.14E-03	-1.14E-03	-1.58E-03

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 75: Results of the other mandatory indicators according to EN15804 for the benefits and loads beyond the system boundary of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
GWP-GHG[28]	kg CO_2 eq.	-6.75E-01	-8.63E-01	-8.63E-01	-8.63E-01	-1.20E+00

Table 76:Results of additional voluntary output flow indicator for the benefits and loads beyond the system boundary of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	-3.79E-02	-4.84E-02	-4.84E-02	-4.84E-02	-6.73E-02

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 77:Results of other voluntary indicator for the benefits and loads beyond the system boundary of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover

Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
Ionising radiation, HH	kBq U-235 eq	-8.33E-02	-1.06E-01	-1.06E-01	-1.06E-01	-1.48E-01
Land use	Pt	-2.33E-01	-2.97E-01	-2.97E-01	-2.97E-01	-4.14E-01
Human toxicity, non-cancer effects	CTUh	-1.61E-08	-2.05E-08	-2.05E-08	-2.05E-08	-2.86E-08
Ecotoxicity, freshwater	CTUe	-5.83E-02	-7.44E-02	-7.44E-02	-7.44E-02	-1.04E-01
Particulate matter, HH	Disease inc.	-2.10E-08	-2.69E-08	-2.69E-08	-2.69E-08	-3.74E-08
Human toxicity, cancer effects	CTUh	-1.73E-10	-2.21E-10	-2.21E-10	-2.21E-10	-3.07E-10

[28] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

The avoided production of virgin LDPE based on the scenario that the pool cover is recycled, represents a carbon footprint saving per 1 m^2 of GeoBubble ™ material, of 0.731 kg CO_2eq for FB400, 0.934 kg CO_2eq for CGU, 0.934 kg CO_2eq for S+G, 0.934 kg CO_2eq for RG and 1.30 kg CO_2eq for EGST + weave.

The resulting carbon footprint saving per standard pool cover (32 m^2) is 23.4 kg CO_2eq for FB400, 29.9 kg CO_2eq for CGU, 29.9 kg CO_2eq for S+G, 29.9 kg CO_2eq for RG and 41.6 kg CO_2eq for EGST + weave.

The avoided production of virgin LDPE based on the scenario that the pool cover is recycled represents a water deprivation potential saving, per 1 m^2 of GeoBubble ™ material, of 0.519 m^3 for FB400, 0.663 m3 for CGU, 0.663 m^3 for S+G, 0.663 m^3 for RG and 0.923 m^3 for EGST + weave.

The resulting water deprivation potential saving per standard pool cover (32 m^2) is 16.6 m^3 for FB400, 21.2 m^3 for CGU, 21.2 m^3 for S+G, 21.2 m^3 for RG and 29.5 m^3 for EGST + weave.

7. Potential resource savings through the use of GeoBubble™ pool covers

This section discusses the potential environmental impact savings associated with the use of GeoBubble™ materials.

The use phase of the GeoBubble™ pool cover materials reduces water, energy and chlorine used for a pool. As discussed in the product description, the pool covers are designed to save resources, particularly through energy, water and chlorine savings. This is done through properties that maximise the transfer of solar energy into the pool for FB400, S+G, RG, EGST + weave, properties that reflect solar energy to maintain a cooler pool for CGU, and properties preventing evaporation and the breakdown of chlorine for all five GeoBubble™ materials.

This section first quantifies the energy, water and chlorine savings per unit of FB400, CGU, S+G, RG and EGST + weave based on the frequency at which the pool cover is used during pool season. Then, processes from the eco-invent 3.8 EN15804 add-on are used to translate these savings into measurable environmental impacts avoided and other impacts avoided.

7.1 Energy Savings

The following section details energy use avoided (and the carbon footprint reduction associated with this) from the use of RG, S+G, FB400 and EGST + weave in a heated pool when the pool is not in use during daytime pool season, and energy use avoided from the use of CGU in a cooled pool when the pool is not in use during daytime during pool season.

EGST + weave:

Plastipack' s case study[29] tests two identical outdoor pools for 17 days at Plastipack's in-house testing facility, with one covered with EGST pool cover fabricated in-house and the other uncovered. Each pool is serviced by its own 0.75kW filtration pump and heated using identical 12.5kW heat pumps, which were on timers and set to 28°C. The filtration pumps were also set by timers to be running continuously between 07:00hr and 21:00hr, whist the heat pumps ran between 08:00hr and 20:00hr. This filtration and heating pattern was selected as it most efficient for heating purposes.

The case study reveals that the EGST material helps preserve and increase the temperature of the water within the pool leading to a reduction of energy consumption by 85%. The study also showed that the uncovered pool used 193 kWh for the 17 days, which equates to an average power usage of 1.42 kW.

It is assumed that the EGST + weave material has the same energy consumption as EGST, as its energy saving potential is determined by the pool cover's ability to retain heat. There is no information indicating that

[29] Plastipack ltd, 2022. "EnergyGuard™ Selective Transmission".

the HDPE weave would reduce the EGST + weave's potential to retain heat (logically the opposite might occur so this is a cautious assumption).

FB400:

A case study conducted by Plastipack on FB400[30] shows that the use of the pool cover can increase water temperature by 2 to 3 degrees Celsius compared to an uncovered pool. A case study on EGST by Plastipack reveals that the use of the pool cover can increase water temperature by 5 to 7 degrees Celsius compared to an uncovered pool. Using the following information, Plastipack assumes that FB400 is about half as much as energy efficient as EGST, therefore the energy saving rate of FB400 is 40%.

S+G:

A case study by Plastipack tests two identical outdoor pools for 30 days at Plastipack's in-house testing facilities. One pool is covered with an S+G pool cover fabricated in-house and the other is uncovered. Each pool is serviced by its own 0.75kW filtration pump and heated using identical 12.5kW heat pumps, which were on timers and set to 28°C. The filtration pumps were also set by timers to be running continuously between 07:00hr and 21:00hr, whist the heat pumps ran between 08:00hr and 20:00hr. This filtration and heating pattern was selected as it most efficient for heating purposes. The case study reveals that the S+G material helps preserve and increase the temperature of the water within the pool leading to a reduction of energy consumption by 87%[31].

RG:

Similar to the EGST and S+G case studies to calculate energy use reduction, tests by Plastipack were conducted on two identical pools at Plastipack's in-house testing facility using the same standard servicing for the EGST and S+G case studies, comparing an uncovered pool's energy use during heating to a pool covered with RG pool cover for 14 days. Results reveal that the use of the RG cover reduced energy use for pool heating by 98% compared to heating an uncovered pool[32]. Plastipack cautiously estimate that RG reduces energy use for pool heating by 85% to account for less favourable weather conditions likely to occur throughout the remainder of a pool season.

CGU:

Unlike the other pool covers discussed above, the CGU pool cover is designed for warmer climates, and is designed to reduce solar energy entering the pool, thereby maintaining a cooler pool. The energy savings observed from the use of CGU are from less energy needed to cool the pool down. Plastipack explain that testing CGU's energy savings has been proven difficult in the UK, as it is rarely warm enough to monitor energy savings from cooling a pool. The CGU's temperature gain inhibition was tested at Plastipack's in-house testing facility using two identical pools, with one being uncovered and the other being covered by CGU pool cover. This test shows that for the duration of the 24 hours, CGU reduced temperature gains in the day by 55%[33]. Testimonials from the USA stated that "with full sun and temperature peaks well in excess of 110F (43°C) for weeks at a time, the water temp never got to 95°F (35°C), which is the setting of my Nocturnal cooling, which greatly reduces my electrical cost…". Plastipack estimate that the CGU cover leads to an energy saving of around 60% by keeping pools cool with less frequent use of water-cooling systems. The average power usage for to cool a pool is estimated to be the same as the average power usage for a heat pump to heat a pool.

Plastipack estimates that a standard 4mx8m pool is used 8 hours per day for 182 days a year in a pool season. A summary of information relating to the energy efficiency of FB400, CGU, S+G, RG and EGST + weave materials and the assumptions on the energy efficiency of an uncovered pool are shown below.

[30] Plastipack ltd, 2019. "GeoBubble™ Light Blue"
[31] Plastipack ltd, 2023. "Sol+ Guard™ Heat Pump Study".
[32] Plastipack ltd, 2023. " RaeGuard"™: The best cover for cost effective heat retention.
[33] Plastipack ltd, 2018. "CoolGuard™ Ultra"

Table 78: Energy efficiency of uncovered pool and energy saving rate of FB400, CGU, S+G, RG and EGST + weave materials

Pool Cover Material	Days per pool season	Hours per day heat pump is active	Average power usage for a heat pump/cooler for 8x4 pool per hour	Uncovered pool kWh consumption per year	Energy Saving rate	Lifespan of GeoBubble™ material in years
FB400	182	8	1.42	1,820	40%	4
RG	182	8	1.42	1,820	85%	8
S + G	182	8	1.42	1,820	87%	8
CGU	182	8	1.42	1,820	60%	8
EGST + weave	182	8	1.42	1,820	85%	8

Table 79 shows the energy savings for pool cover materials FB400, S+G, RG and EGST + weave per pool cover for use on a heated pool and pool cover material materials CGU per pool cover for use on a cooled pool based on the frequency at which a pool cover is used for the daytime during a pool season. The energy savings through the use of 1 m^2 of pool covers FB400, CGU, S+G, RG and EGST + weave 100% of the daytime during pool season are used as a baseline to show the energy savings as a result of the use of 1 m^2 of pool covers FB400, CGU, S+G, RG and EGST + weave 50%, 25% and 10% of the daytime during pool season as continuous use of the pool cover is not a realistic use scenario, and levels of pool cover usage will vary. These percentages have been selected to show the sensitivity of savings from variant assumptions on pool cover usage Table 79 also shows the kWh energy saving for using a pool cover for one hour in a heated pool, during the daytime of pool season.

Table 79: Summary of energy saved by 1 m^2 of pool cover based on frequency of pool cover usage over the lifetime of the pool cover materials

Pool Cover Material	kW saver	kWh saver 1 m^2 of pool cover when used **100%** of the time	kWh saver 1 m^2 of pool cover when used **50%** of the time	kWh 1 m^2 of pool cover when used **25%** of the time	kWh saver 1 m^2 of pool cover when used **10%** of the time
FB400	0.0178	103	51.7	25.8	10.3
CGU	0.0266	310	155	78	31.0
S+G	0.0386	450	225	112	45.0
RG	0.0377	439	220	110	43.9
EGST + weave	0.0377	439	220	110	43.9

The energy savings from the use of 1 m^2 of GeoBubble™ pool cover in a heated pool are 51.7, 225, 220 and 220 kWh in the lifespan of FB400, S+G, RG and EGST + weave respectively when the pool cover is used 50% of the daytime during pool season. The energy savings from the use of 1 m^2 of GeoBubble™ pool cover for its lifespan are 25.8 kWh, 112 kWh, 110 kWh, 110 kWh for FB400, S+G, RG and EGST + weave respectively when the pool cover is used 25% of the daytime during pool season, and 10.3 kWh, 45.0 kWh, 43.9 kWh and 43.9 kWh for FB400, S+G, RG and EGST + weave respectively when the pool cover is used 10% of the daytime during pool season.

The energy savings from the use of 1 m^2 GeoBubble™ CGU pool cover in a cooled pool is 115 kWh in its lifespan when the pool cover is used 50% of the daytime during pool season. The energy savings from the use of 1 m^2 of CGU GeoBubble™ pool cover for its lifespan is 77.5 kWh when the pool cover is used 25% of the daytime during pool season, and 31.0 kWh when the pool cover is used 10% of the daytime during pool season.

The energy savings from the use of a 32 m^2 GeoBubble™ standard pool cover in a heated pool are 1654, 7195 kWh, 7027 kWh and 7030 kWh in the lifespan of FB400, S+G, RG and EGST + weave respectively when the pool cover is used 50% of the daytime during pool season. The energy savings from the use of a standard GeoBubble™ pool cover for its lifespan are 827 kWh, 3598 kWh, 3515 kWh and 3515 kWh for FB400, S+G, RG and EGST + weave respectively when the pool cover is used 25% of the daytime during pool season, and 331 kWh, 1439 kWh, 1406 kWh and 1406 kWh for FB400, S+G, RG and EGST + weave respectively when pool cover is used 10% of the daytime during pool season.

The energy savings from the use of a 32 m^2 standard CGU GeoBubble™ pool cover in a cooled pool is 4962 kWh in its lifespan when the pool cover is used 50% of the daytime during pool season. The energy savings from the use of a standard CGU GeoBubble™ pool cover for its lifespan is 2481 kWh when the pool cover is used 25% of the daytime during pool season, and 992 kWh when pool cover is used 10% of the daytime during pool season.

7.2 Water savings

The following section covers water savings as a result of the use of pool cover materials FB400, CGU, S+G, RG and EGST + weave when the pool is not in use during daytime pool season, which decreases the rate of evaporation of water in a pool. A case study conducted by Plastipack on the standard GeoBubble™ pool cover materials shows that the material acts as a barrier against evaporation, reducing evaporation rate by 98%. Plastipack estimates that the evaporation rates per one square metre of pool is 1.5 metres of depth per year. This means that the daily evaporation rate is 8 mm. This is supported by secondary research that shows that evaporation rates can range between 5 mm per day[34] and 11.4 mm per day (3.5 inches per week[35]). The calculations in Table 80 summarise the water savings caused by GeoBubble™ materials.

Table 80: Water savings by pool cover materials based on frequency of pool cover usage over the lifetime of the pool cover material

Pool Cover Material	Evaporation rates per 1 m^2 per year in metres	Evaporation reduction rate	Water saving per 1 m^2 per year when the pool cover is used **100%** of the time	Lifespan of GeoBubble™ materials in years
FB400	1.5	98%	1.47	4
CGU, S+G, RG, EGST + weave	1.5	98%	1.47	8

Table 81 shows the water savings from the use of 1m^2 of FB400, CGU, S+G, RG and EGST + weave pool cover materials based on the frequency at which the pool covers are used for the daytime during pool season. The water savings from the use of 1 m^2 of the pool cover 100% of the daytime during pool season is used as a baseline to show the water savings as a result of the use of the GeoBubble™ pool covers 50%, 25% and 10% of the daytime during pool season. Table 81 also shows the water savings for using a unit of pool cover for one hour during the daytime of pool season.

[34] https://www.compass-pools.co.uk/wp-content/uploads/2022/08/Compass-Pools-Water-Efficency-2022-3-1_compressed-1.pdf
[35] https://www.flower-mound.com/1998/Pool-Evaporation#:~:text=How%20much%20water%20does%20my,that's%203.5%20inches%20per%20week.

Table 81: Summary of water savings by per 1 m^2 of pool cover based on frequency of pool cover usage over the lifetime of the pool cover materials

Pool Cover Material	Water savings m^3 per hour per 1 m^2 of pool cover	Water saving per 1 m^2 of pool cover when used **100%** of the time m^3	Water saving m^3 per 1 m^2 of pool cover when used **50%** of the time	Water saving m^3 per 1 m^2 of pool cover when used **25%** of the time	Water saving m^3 per 1 m^2 of pool cover when used **10%** of the time
FB400	3.22E-05	5.88	2.94	1.47	0.588
CGU, S+G, RG, EGST + weave	3.22E-05	11.8	5.88	2.94	1.18

The water savings from the use of 1 m^2 of the GeoBubble™ pool covers in their lifespan when used 50% of daytime during pool season are 2.94 m^3 for FB400 and 5.88 m^3 for CGU, S+G, RG and EGST + weave, equivalent to 2931 l and 5862 l respectively. The water saving for the GeoBubble™ materials in their lifespan per standard pool cover when used 25% of daytime during pool season are 1.47 m^3 for FB400 and 2.94 m^3 for CGU, S+G, RG and EGST + weave, equivalent to 1465.59 l and 2931.18 l respectively. The water saving from the use of 1 m^2 of the GeoBubble™ pool covers in their lifespan when used 10% of daytime during pool season are 0.588 m^3 for FB400 and 1.176 m^3 for CGU, S+G, RG and EGST + weave, equivalent to 586 and 1172 l respectively.

The water savings from the use of 1 m^2 of the GeoBubble™ pool covers in their lifespan when used 50% of daytime during pool season are 94.08 m^3 of FB400 and 188.16m^3 of CGU, S+G, RG and EGST + weave, equivalent to 94,080 l and 188,160 l respectively. The water savings f from the use of 1 m^2 of the GeoBubble™ pool covers in their lifespan when used 25% of daytime during pool season are 47.04 m^3 for FB400 and 94.08 m^3 for CGU, S+G, RG and EGST + weave, equivalent to 47,040 l and 94,080 l respectively. The water savings from the use of 1 m^2 of the GeoBubble™ pool covers in their lifespan when used 10% of daytime during pool season are 18.82 m^3 for FB400 and 37.63 m^3 for CGU, S+G, RG and EGST + weave, equivalent to 18,820 l and 37,630 l respectively.

7.3 Chlorine savings

The following section covers the chlorine savings that occur through the use of the pool cover materials FB400, CGU, S+G, RG and EGST + weave when the pool is not in use during daytime pool season. Covering the pool when it is not in use decreases the rate at which chlorine is broken down and so the rate at which the pool will need to be replenished with chlorine. The chlorine savings reported in kg represent the savings in stabilised chlorine in its granular form.

The use of the GeoBubble™ material also offers chlorine savings. Chlorine consumption for pools refers to the use of stabilised chlorine to inhibit algae growth in the pool.

The use of GeoBubble™ pool covers act as a physical barrier from the sun, which reduces the chlorine in the pool from easily being consumed/degraded.

FB400:

The case study on FB400 conducted by Plastipack showcases that the use of the pool cover, reduced chlorine consumption by 37%[36] compared to an uncovered pool.

EGST +weave:

The case study on EGST[37] conducted by Plastipack showcases that the use of the pool cover reduced chlorine consumption by 39% compared to an uncovered pool. This chlorine savings figure is used to calculate the environmental impacts saved when the EGST + weave pool cover is used in section **Error! Reference source not found.**. It is assumed that EGST + weave's chlorine savings are the same as that of EGST. The pool cover

[36] Plastipack ltd, 2019. "GeoBubble™ Light Blue"
[37] Plastipack ltd, 2022. "EnergyGuard™ Selective Transmission."

saves chlorine by acting as a barrier from UV rays which break chlorine down. There is no evidence to suggest that the HDPE weave reduces chlorine saving potential of the EGST + weave pool cover.

S+G:

The case study on S+G conducted by Plastipack showcases that the use of the pool cover, reduces chlorine consumption by 24% compared to an uncovered pool[38].

RG:

There are no tests on the chlorine consumption of an uncovered pool compared to a pool covered by RG. Tests on standard GeoBubble pool cover materials found that typically this material can reduce chlorine consumption between 30% and 40%[39]. Pool covers that are opaque observed greater chlorine consumption reduction, as they prevent light entering the pool and helps inhibit algae growth. For this reason, it is assumed that RG reduces chlorine consumption by 40%.

CGU:

Tests conducted on identical pools for two weeks, with one pool being uncovered and another covered with CGU, showed that the use of CGU can reduce chlorine consumption by 75%[40]. Plastipack adjusted this number to account for the regular treatment of the pool for algae prevention that did not occur during the testing duration. Plastipack expect that a CGU cover would provide savings of up to 50% in standard domestic pool conditions.

The EGST case study compares chlorine consumption of an uncovered standard (32 square meters) pool and a pool covered with EGST over a 17-day period. The water concentration of free chlorine was kept at 4 ppm to account for the heat wave that was occurring during the test period. This is due to the fact that warmer water will significantly increase the rate at which free chlorine is depleted from a pool. Stabilised chlorine was added when free chlorine dropped below 4 ppm. The uncovered pool used 1528 grams of stabilised chlorine during the 17-day test period. The findings from this scenario are used to calculate the chlorine savings from the GeoBubble™ materials FB400, CGU, S+G, RG and EGST + weave.

The table below summarises chlorine consumption by an uncovered pool during the 17-day test period. It is assumed that the pool day hours are 8 a day and the pool season is of 182 days. From this, we can calculate daily savings and savings per pool season.

Table 82: Chlorine consumption of uncovered pool kept at 4 ppm

Days of Test	Uncovered pool chlorine consumption in 17 days (kg)	Uncovered pool chlorine consumption per day (kg)	Pool hours in a day (kg)	Uncovered pool chlorine consumption per hour (kg)	Pool season days	Uncovered pool chlorine consumption per pool season
17	1.53	0.09	8	0.01	182	16.36

The table below summarises the chlorine savings through the use of pool cover materials FB400, CGU, S+G, RG and EGST + weave 100% of the time in the lifespan of the materials based on the possible savings rates. This information will be used as a baseline to calculate the environmental impacts avoided through the chlorine savings based on how frequently the pool cover is used during pool season over the pool cover material's respective lifetimes. The chlorine savings in kg are shown based on available data on the range of the efficiency of the pool covers as calculated in FB400, CGU, S+G, RG and EGST case studies.

[38] Plastipack ltd, 2023. "Sol+ Guard™ Heat Pump Study".
[39] Plastipack ltd, 2019. "GeoBubble™ Light Blue"
[40] Plastipack ltd, 2018. "CoolGuard™ Ultra"

Table 83: Chlorine savings from the use of 1 m² of pool cover based on frequency of pool cover usage

Pool Cover Material	Saving rate of pool cover	Pool cover chlorine savings per hour per 1 m²	Lifetime per pool cover	Chlorine savings per 1 m² of pool cover (kg) when used **100%** of the time	Chlorine savings per 1 m² of pool cover (kg) when used **50%** of the time	Chlorine savings per 1 m² of pool cover (kg) when used **25%** of the time	Chlorine savings per 1 m² of pool cover (kg) when used **10%** of the time
FB400	37%	0.0000246	4	0.757	0.378	0.189	0.0757
CGU	50%	0.000176	8	2.05	1.02	0.511	0.205
S+G	24%	0.0000843	8	0.982	0.491	0.245	0.0982
RG	40%	0.000140	8	1.64	0.818	0.409	0.164
EGST + weave	39%	0.000137	8	1.59	0.797	0.399	0.159

The savings in stabilised chlorine through the use of FB400, CGU, S+G, RG, EGST + weave are presented in the table above.

The savings in stabilised chlorine for 1 m² of FB400, CGU, S+G, RG and EGST + weave are 0.378 kg, 1.02 kg, 0.491 kg, 0.818 kg and 0.797 kg of stabilised chlorine respectively when used 50% of the daytime during pool season during the material's lifetime.

The savings in stabilised chlorine from the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave are 0.189 kg, 0.511 kg, 0.245 kg, 0.409 kg and 0.399 kg of stabilised chlorine respectively when used 25% of the daytime during pool season during the material's lifetime.

The savings in stabilised chlorine from the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave are 0.0757 kg, 0.205 kg, 0.0982 kg, 0.164 kg and 0.797 kg of stabilised chlorine respectively when used 10% of the daytime during pool season during the material's lifetime.

The savings in stabilised chlorine from the use of a standard pool cover (32 m²) are 12.1 kg, 32.7 kg, 15.7 kg, 26.2 kg and 25.5 kg of stabilised chlorine for FB400, CGU, S+G, RG and EGST + weave respectively when used 50% of the daytime during pool season during the material's lifetime.

The savings in stabilised chlorine from the use of a standard pool cover (32 m²) are 6.05 kg, 16.4 kg, 7.85 kg, 13.1 kg and 12.8 kg of stabilised chlorine for FB400, CGU, S+G, RG and EGST + weave respectively when used 25% of the daytime during pool season during the material's lifetime.

The savings in stabilised chlorine from the use of a standard pool cover (32 m²) are 2.42 kg, 6.54 kg, 3.14 kg, 5.23 kg and 5.10 kg of stabilised chlorine for FB400, CGU, S+G, RG and EGST + weave respectively when used 50% of the daytime during pool season during the material's lifetime.

7.4 Environmental Impacts

7.4.1 Results

The energy, water and chlorine savings from the use of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave depending on the frequency at which the pool cover used, has been calculated. To translate the energy savings into measurable impacts, the process for heat, air-water heat pump 10 kW is used from the add-on database EN15804 used from Ecoinvent 3.8. To translate the water savings into measurable impacts, the process for market for tap water in Europe has been used from the add-on database EN15804 used from Ecoinvent 3.8. To translate the chlorine savings into measurable impacts, stabilised chlorine is modelled on the add-on database EN15804 used from Ecoinvent 3.8.

The chlorine savings refer to stabilised chlorine granule savings, particularly sodium dichloroisocyanurate dihydrate CAS No.51580-86-0. The add-on database EN15804 used from Ecoinvent 3.8 does not have sodium dichlorocyanurate dihydrate or anhydrite. For this reason, the production of stabilised chlorine has been modelled. A detailed explanation on the model of the production of stabilised chlorine can be found in Appendix II.

The table below shows the eco-invent processes used to calculate the savings in this section.

Table 84: Processes used in the modelling of resource savings by pool cover use

Component	Processes used in the modelling of resource savings by pool cover use
Stabilised Chlorine	market for chlorine, gaseous | chlorine, gaseous | EN15804 - RER
Stabilised Chlorine	Market group for electricity, medium voltage | electricity, medium voltage | EN15804 - RER
Stabilised Chlorine	kerosene production, petroleum refinery operation | kerosene | EN15804 - Europe without Switzerland
Stabilised Chlorine	market for sodium hydroxide, without water, in 50% solution state | sodium hydroxide, without water, in 50% solution state | EN15804 - GLO
Stabilised Chlorine	urea production | urea | EN15804 - RER
Stabilised Chlorine	market for water, ultrapure | water, ultrapure | EN15804 - RER
Heat Pump	heat production, air-water heat pump 10kW | heat, air-water heat pump 10kW | EN15804 - Europe without Switzerland
Water	market for tap water | tap water | EN15804 - Europe without Switzerland

The following tables showcase the environmental impacts and other impacts avoided from the energy, water and chlorine savings of a pool through to the use of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave when used 50% of the time during daytime pool season for the lifetime of the material. The tables below look at mandatory environmental, waste and resource use indictors and mandatory output flow results as well as other voluntary environmental indicators for this scenario.

Table 85: Results of the mandatory environmental impact category indicators according to EN 1580 for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
GWP biogenic	kg CO_2 eq.	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWP-fossil	kg CO_2 eq.	9.42E+00	2.81E+01	3.92E+01	3.88E+01	3.88E+01
GWP-LULUC	kg CO_2 eq.	1.84E-02	5.49E-02	7.72E-02	7.62E-02	7.62E-02
GWP-Total	kg CO_2 eq.	9.44E+00	2.81E+01	3.93E+01	3.89E+01	3.88E+01
ODP	kg CFC11 eq.	1.87E-06	5.50E-06	6.89E-06	7.10E-06	7.08E-06
AP	molc H^+ eq.	4.84E-02	1.44E-01	1.99E-01	1.98E-01	1.98E-01
EP - freshwater	kg P eq.	7.91E-03	2.36E-02	3.35E-02	3.30E-02	3.30E-02
EP - marine	kg N eq.	7.87E-03	2.34E-02	3.21E-02	3.20E-02	3.20E-02
EP - terrestrial	molc N eq.	7.05E-02	2.10E-01	2.86E-01	2.85E-01	2.85E-01
POCP	kg NMVOC eq.	1.93E-02	5.73E-02	7.81E-02	7.80E-02	7.79E-02
ADP - minerals and metals*	kg Sb eq.	1.35E-04	4.03E-04	5.53E-04	5.51E-04	5.50E-04
ADP – fossil*	MJ	7.94E+01	2.37E+02	3.32E+02	3.29E+02	3.28E+02
WDP*	m³	6.60E+00	1.95E+01	2.61E+01	2.63E+01	2.62E+01

GWP-biogenic = Global warming potential biogenic, GWP-fossil = Global warming potential fossil fuels, GWP-LULUC= Global warming potential land use and land use change, GWP - Total = Total global warming potential, ODP = Ozone layer depletion potential, AP = Acidification potential, EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment, EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment, EP-terrestrial = Eutrophication potential terrestrial, POCP = Formation potential of tropospheric ozone, ADP - minerals and metals = Abiotic depletion potential for non-fossil resources, ADP - fossil = Abiotic depletion for fossil resources potential, WDP = Water deprivation potential.

* *Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator*

Table 86: Results of the mandatory indicator results on resource use according to EN15804 for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
PENRT	MJ	2.06E+02	6.13E+02	8.40E+02	8.37E+02	8.36E+02
PENRE	MJ	1.55E+02	4.64E+02	6.56E+02	6.47E+02	6.46E+02
PENRM	MJ	5.08E+01	1.49E+02	1.83E+02	1.90E+02	1.90E+02
PERE	MJ	2.80E+01	8.38E+01	1.19E+02	1.17E+02	1.17E+02
PERM	MJ	4.29E+00	1.28E+01	1.81E+01	1.78E+01	1.78E+01
PERT	MJ	3.23E+01	9.66E+01	1.37E+02	1.35E+02	1.35E+02
FW	m³	1.54E-01	4.56E-01	6.10E-01	6.14E-01	6.13E-01
SM	kg	1.98E+00	5.92E+00	8.43E+00	8.29E+00	8.28E+00
NRSF	MJ	7.80E-01	2.33E+00	3.31E+00	3.26E+00	3.26E+00
RSF	MJ	1.12E+00	3.36E+00	4.80E+00	4.72E+00	4.72E+00

PENRT = Total use of non-renewable primary energy resources, PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRM = Use of non-renewable primary energy resources used as raw materials, PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERM = Use of renewable primary energy resources used as raw materials, PERT = Total use of renewable primary energy resources FW = Use of net fresh water, SM = Use of secondary materials, NRSF = Use of non-renewable secondary fuels, RSF = Use of renewable secondary fuels.

Table 87: Results of the mandatory indicator results on waste according to EN15804 for the for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
HW	kg	3.98E+01	1.19E+02	1.69E+02	1.66E+02	1.66E+02
NHW	kg	5.21E-01	1.55E+00	2.13E+00	2.12E+00	2.12E+00
RW	kg	4.69E-02	1.40E-01	2.00E-01	1.96E-01	1.96E-01

HW = Hazardous waste, NHW = Non-hazardous waste, RW = Radioactive waste.

Table 88: Results of the other mandatory indicators according to EN15804 for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
GWP-GHG[41]	kg CO_2 eq.	9.05E+00	2.70E+01	3.76E+01	3.73E+01	3.73E+01

Table 89:Results of additional voluntary output flow indicator for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EXE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFE	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.88E+00	5.61E+00	8.01E+00	7.87E+00	7.86E+00

CFR = Components for reuse. EXE = Exported energy, MFE = Materials for energy recovery, MFR=Materials for recycling.

Table 90:Results of other voluntary indicator for the potential resource savings through the use of 1 m² of FB400, CGU, S+G, RG and EGST + weave pool cover

		When 1 m² of pool cover is used throughout 50% of its lifespan				
Indicators	Unit	FB400	CGU	S+G	RG	EGST + weave
Ionising radiation, HH	kBq U-235 eq	4.38E+00	1.31E+01	1.86E+01	1.83E+01	1.83E+01
Land use	Pt	8.14E+00	2.41E+01	3.27E+01	3.27E+01	3.27E+01
Human toxicity, non-cancer effects	CTUh	6.25E-07	1.86E-06	2.61E-06	2.58E-06	2.58E-06
Ecotoxicity, freshwater	CTUe	1.62E+00	4.82E+00	6.67E+00	6.62E+00	6.62E+00

[41] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

Particulate matter, HH	Disease inc.	1.56E-07	4.61E-07	6.11E-07	6.17E-07	6.16E-07
Human toxicity, cancer effects	CTUh	4.01E-09	1.19E-08	1.64E-08	1.63E-08	1.63E-08

7.4.2 Interpretation

The avoided carbon footprint and water deprivation potential through the use of 1 m^2 of FB400, S+G, RG and EGST + weave for a heated pool kept at 4 ppm are presented for an hour of daytime during pool season as well as for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan.

The avoided carbon footprint and water deprivation potential through the use of 1 m^2 of CGU for a cooled pool kept at 4 ppm are presented for an hour of daytime during pool season as well as for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan.

The results are presented using these scenarios to show the avoided impacts depending on the variability of the frequency of the use of the GeoBubble™ materials. The results presented at a frequency of 10%, 25%, 50% and 75% include the energy, water and chlorine savings from the use of a pool cover compared to an uncovered pool. The results presented per hour only include the energy, water and chlorine savings from the use of a pool cover compared to an uncovered pool.

Table 91: Avoided carbon footprint through the use of 1 m^2 of FB400, CGU, S+G, RG and EGST + weave pool covers

	Avoided carbon footprint (kg CO_2eq)				
Pool cover	when 1 m^2 of pool cover is used for one hour	When 1 m^2 of pool cover is used throughout 10% of its lifespan	When 1 m^2 of pool cover is used throughout 25% of its lifespan	When 1 m^2 of pool cover is used throughout 50% of its lifespan	When 1 m^2 of pool cover is used throughout 75% of its lifespan
FB400	3.24E-03	1.89E+00	4.72E+00	9.44E+00	1.42E+01
CGU	4.83E-03	5.63E+00	1.41E+01	2.81E+01	4.22E+01
S+G	6.74E-03	7.85E+00	1.96E+01	3.93E+01	5.89E+01
RG	6.67E-03	7.78E+00	1.94E+01	3.89E+01	5.83E+01
EGST + weave	6.67E-03	7.77E+00	1.94E+01	3.88E+01	5.83E+01

The use of 1 m^2 of FB400 for an hour for a heated pool kept at 4ppm can lead to an avoided impact of 0.00324 kg CO_2eq, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.104 kg CO_2eq.

The use of 1 m^2 of FB400 on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan (4 years) can lead to an avoided impact of 1.89 kg CO_2eq, 4.72 kg CO_2eq, 9.44 kg CO_2eq and 14.2 kg CO_2eq respectively, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 60 kg CO_2eq, 151 kg CO_2eq, 302 kg CO_2eq, 453 kg CO_2eq respectively.

The use of 1 m^2 of CGU for an hour for a cooled pool kept at 4ppm can lead to an avoided impact of 0.00483 kg CO_2eq, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.155 kg CO_2eq.

The use of 1 m^2 of CGU on a cooled pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan (8 years) can lead to an avoided impact of 5.63 kg CO_2eq, 14.1 kg CO_2eq, 28.1 kg CO_2eq and 42.2 kg CO_2eq respectively, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 180 kg CO_2eq, 450 kg CO_2eq, 900 kg CO_2eq, 1350 kg CO_2eq respectively.

The use of 1 m^2 of S+G for an hour for a heated pool kept at 4ppm can lead to an avoided impact of 0.00674 kg CO_2eq, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.216 kg CO_2eq.

The use of 1 m^2 of S+G on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan (8 years) can lead to an avoided impact of 7.85 kg CO_2eq, 19.6 kg CO_2eq, 39.3 kg CO_2eq and 58.9 kg CO_2eq respectively, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 251 kg CO_2eq, 628 kg CO_2eq, 1256 kg CO_2eq, 1884 kg CO_2eq respectively.

The use of 1 m^2 of RG for an hour for a heated pool kept at 4ppm can lead to an avoided impact of 0.00667 kg CO_2eq, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.214 kg CO_2eq.

The use of 1 m^2 of RG on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan (8 years) can lead to an avoided impact of 7.78 kg CO_2eq, 19.4 kg CO_2eq, 38.9 kg CO_2eq and 58.3 kg CO_2eq respectively, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 249 kg CO_2eq, 622 kg CO_2eq, 1244 kg CO_2eq, 1866 kg CO_2eq respectively.

The use of 1 m^2 of EGST + weave for an hour for a heated pool kept at 4ppm can lead to an avoided impact of 0.00667 kg CO_2eq, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.213 kg CO_2eq.

The use of 1 m^2 of EGST + weave on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan (8 years) can lead to an avoided impact of 7.77 kg CO_2eq, 19.4 kg CO_2eq, 38.8 kg CO_2eq and 58.3 kg CO_2eq respectively, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 249 kg CO_2eq, 621 kg CO_2eq, 1243 kg CO_2eq, 1864 kg CO_2eq respectively.

Table 92: Avoided water deprivation potential through the use of FB400, CGU, S+G, RG and EGST + weave pool covers

	Avoided water deprivation potential (m^3)				
Pool cover	when 1 m^2 of pool cover is used for one hour	When 1 m^2 of pool cover is used throughout 10% of its lifespan	When 1 m^2 of pool cover is used throughout 25% of its lifespan	When 1 m^2 of pool cover is used throughout 50% of its lifespan	When 1 m^2 of pool cover is used throughout 75% of its lifespan
FB400	2.26E-03	1.32E+00	3.30E+00	6.60E+00	9.89E+00
CGU	3.35E-03	3.91E+00	9.77E+00	1.95E+01	2.93E+01
S+G	4.49E-03	5.23E+00	1.31E+01	2.61E+01	3.92E+01
RG	4.51E-03	5.26E+00	1.31E+01	2.63E+01	3.94E+01
EGST + weave	4.50E-03	5.25E+00	1.31E+01	2.62E+01	3.94E+01

The use of 1 m^2 of FB400 for an hour for a heated pool kept at 4 ppm can lead to an avoided impact of 0.00226 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.0725 m^3.

The use of 1 m^2 of FB400 on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan can lead to an avoided impact of 1.32 m^3 , 3.30 m^3, 6.60 m^3 and 9.89 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 42.2 m^3 , 106 m^3, 211 m^3, 317 m^3 respectively.

The use of 1 m^2 of CGU for an hour for a cooled pool kept at 4 ppm can lead to an avoided impact of 0.00335 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.107 m^3.

The use of 1 m^2 of CGU on a cooled pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan can lead to an avoided impact of 3.91 m^3 , 9.77 m^3, 19.5 m^3 and 29.3 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 125 m^3 , 313 m^3, 625 m^3, 938 m^3 respectively.

The use of 1 m^2 of S+G for an hour for an unheated pool kept at 4 ppm can lead to an avoided impact of 0.00449 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.144 m^3.

The use of 1 m^2 of S+G on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan can lead to an avoided impact of 5.23 m^3 , 13.1 m^3, 26.1 m^3 and 39.2 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 167 m^3 , 418 m^3, 836 m^3, 1250 m^3 respectively.

The use of 1 m^2 of RG for an hour for an unheated pool kept at 4 ppm can lead to an avoided impact of 0.00451 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.144 m^3.

The use of 1 m^2 of RG on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan can lead to an avoided impact of 5.26 m^3, 13.1 m^3, 26.3 m^3 and 39.4 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 168 m^3 , 420 m^3, 841 m^3, 1260 m^3 respectively.

The use of 1 m^2 of EGST + weave for an hour for an unheated pool kept at 4 ppm can lead to an avoided impact of 0.00450 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) can lead to an avoided impact of 0.144 m^3.

The use of 1 m^2 of EGST + weave on a heated pool kept at 4ppm for 10%, 25%, 50% and 75% of the daytime during pool season throughout its lifespan can lead to an avoided impact of 5.25 m^3 , 13.1 m^3, 26.2 m^3 and 39.4 m^3 in water deprivation potential, whereas the use of a standard pool cover (32 m^2) when used in these frequencies can lead to an avoided impact of 168 m^3 , 420 m^3, 840 m^3, 1260 m^3 respectively.

8. Conclusions

The key points to note are as follows:

The key points to note are as follows:

- The function unit is the manufacture of 1 m^2 of pool cover using GeoBubble™ material, its packaging and distribution to end users, maintenance during its expected lifespan, and EoL. The expected lifespan of FB400 is 4 years and that of CGU, S+G, RG and EGST + weave is 8 years.
- This life cycle assessment report studies 5 pool covers using FB400, CGU, S+G, RG, EGST + weave respectively, and their associated weights per 1 m^2 are:
-
    - 0.36 kg/m^2 for FB400,
    - 0.46 kg/m^2 for CGU, S+G and RG, and
    - 0.64 kg/m^2 for EGST + weave.

- The system boundary for this LCA study is cradle-to-grave and module D.
- The process specific input data provided by Plastipack is regarded as being of high quality and high accuracy, and an accurate representation (in terms of timeliness, geography and technology) for all processes used in manufacture and supply of the pool cover materials at the Plastipack production site in the UK. The production datasets at Assembly 1 site are a combination of 2022 data (for materials processes) and three-year average data (for water, fuels and off-cuts, as well as for the distribution to customers for welding). Assumptions and averages have been applied where necessary – methodologies for these is outlined in detail in this report in their respective Inventory section.

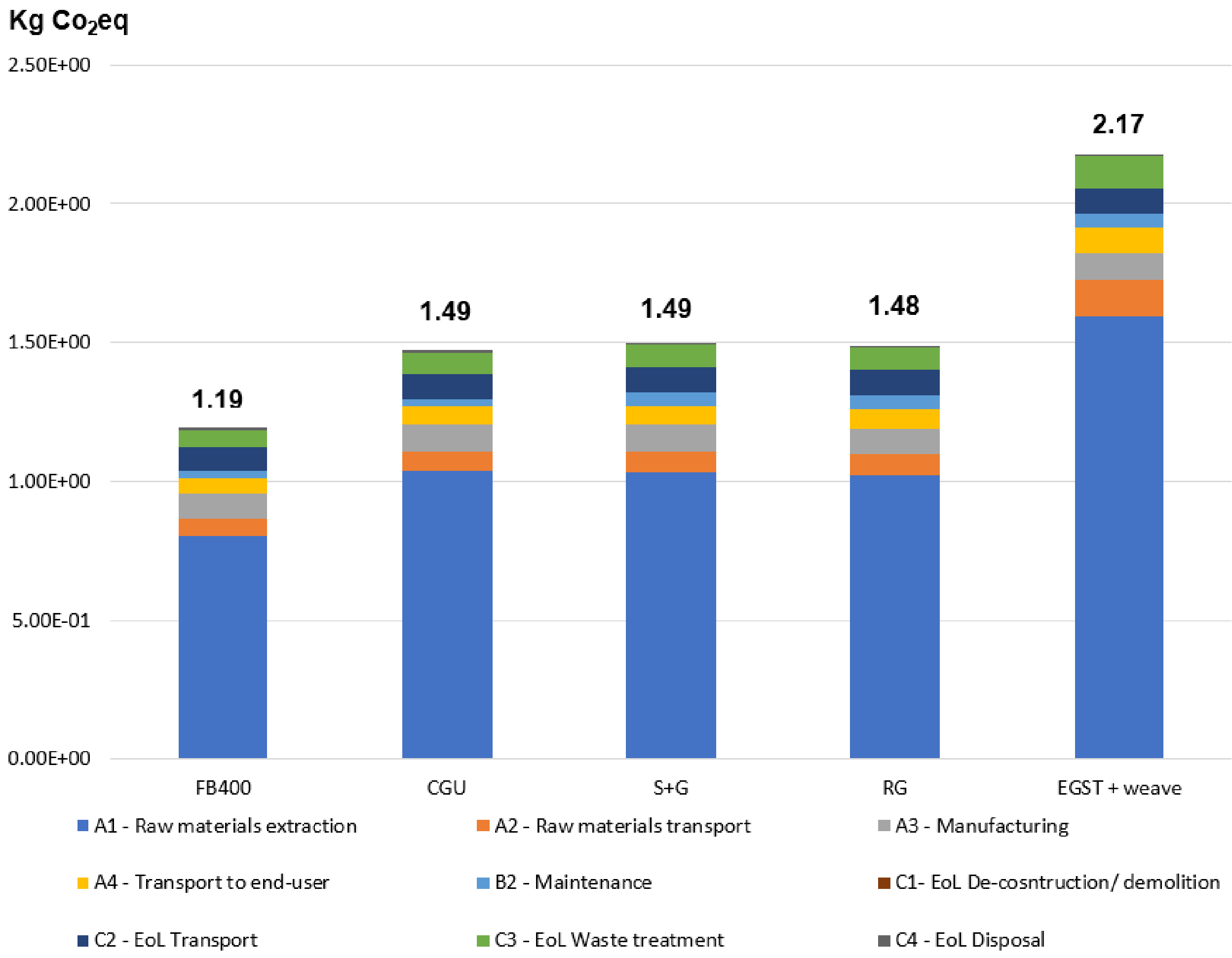
Table 93: The carbon footprints of the life cycles FB400, CGU, S+G, RG and EGST + weave pool covers

Pool cover materials	Unit	Per 1 m^2 of pool cover	Per standard 32 m^2 pool cover
FB400	kg CO_2eq	1.19	38.2
CGU	kg CO_2eq	1.49	47.8
S+G	kg CO_2eq	1.49	47.8
RG	kg CO_2eq	1.48	47.4
EGST + weave	kg CO_2eq	2.17	69.4

Table 94: The water deprivation potential of the life cycles of FB400 CGU, S+G, RG and EGST + weave pool covers

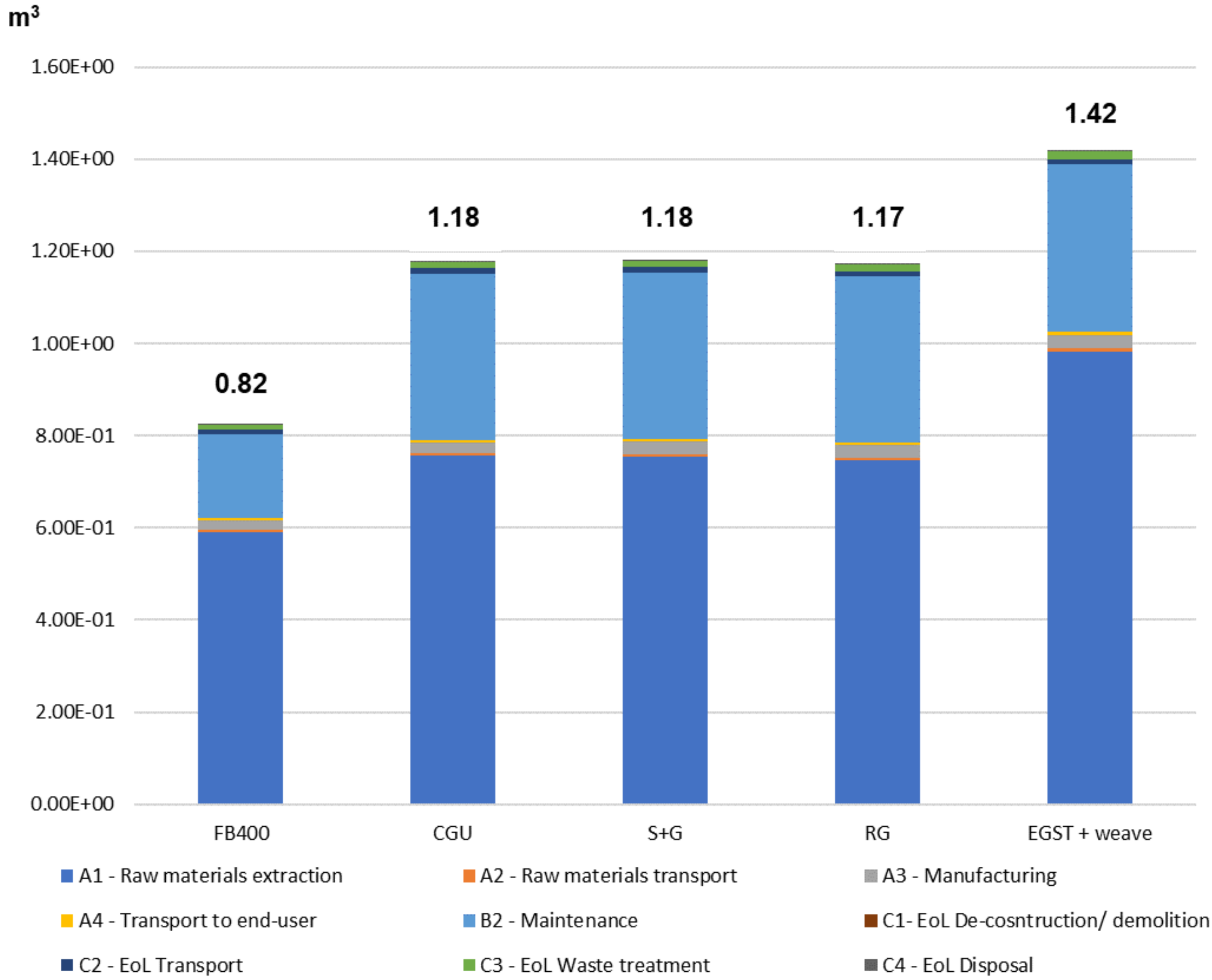
Pool cover materials	Unit	Per 1 m^2 of pool cover	Per standard 32 m^2 pool cover
FB400	m^3	0.82	26.4
CGU	m^3	1.18	37.7
S+G	m^3	1.18	37.8
RG	m^3	1.17	37.5
EGST + weave	m^3	1.42	45.4

Figure 14: Contribution of each of the life cycle stages to the overall carbon footprint, Kg CO2eq per 1 m² of pool cover



- The figure shows the overall carbon footprint of one functional unit of pool cover FB400, CGU, S+G, RG and EGST + weave broken down by lifecycle module. The lifecycle module A1 which represents raw materials extraction contributes the most to the overall carbon footprint, ranging between 74% and 79% for all five pool covers FB400, CGU, S+G, RG and EGST + weave. This can mostly be attributed to the carbon footprint of the raw materials of the pool covers. The carbon footprint for FB400 pool cover is the lowest of all five pool covers considered mostly due to the weight of the pool cover weighing less than the other pool covers considered per 1 m², therefore using less raw material. Similarly, the carbon footprint of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material.

Figure 15: Contribution of each of the life cycle stages by LCA module to the overall water deprivation potential, m^3 per 1 m^2 of pool cover



- Module A1 which represents raw materials extraction contributes the most to the overall water deprivation potential, ranging between 64% and 72% of the overall water deprivation potential of the five pool covers' lifecycles. The water deprivation potential for FB400 is the lowest out of all five pool covers considered due to the weight of the pool cover material weighing less than the other pool cover materials considered per 1 m^2, therefore using less LDPE as a raw material. The water deprivation potential of the EGST + weave has the highest value due to the weight of the pool cover weighing the most out of all 5 pool covers, therefore using the most raw material.

- Module D impacts are beyond the system boundary and arise from the avoided production of virgin LDPE from recycling the pool cover.

Table 95: Summary of carbon footprint and water deprivation potential avoided from recycling the pool covers and the avoided production of virgin LDPE

	Carbon footprint (kg CO_2eq)		Water Deprivation Potential (m^3)	
GeoBubble™ materials	Per 1 m^2 of pool cover	Per standard pool cover (32 m^2)	Per 1 m^2 of pool cover	Per standard pool cover (32 m^2)
FB400	0.731	23.4	0.519	16.6
CGU	0.934	29.9	0.663	21.2
S+G	0.934	29.9	0.663	21.2
RG	0.934	29.9	0.663	21.2
EGST + weave	1.30	41.6	0.923	29.5

9. Appendix I

9.1 Distribution to customer of GeoBubble ™ material

Table 96: Distribution to customer of GeoBubble material

Origin	Destination	Transport mode/type	% of total m^2 3-year average	Notes / Comments
Plastipack Limited	UK	Lorry	9%	Plastipack to Destination 31km
Plastipack Limited	France	Road Train + Ferry	52%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 790km
Plastipack Limited	Spain	Road Train + Ferry	10%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1842km
Plastipack Limited	Germany	Lorry + Ferry	7%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 668km
Plastipack Limited	Italy	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1050km
Plastipack Limited	Portugal	Lorry + Ferry	2%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 2004km
Plastipack Limited	Belgium	Lorry + Ferry	2%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 241km
Plastipack Limited	Austria	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1181km
Plastipack Limited	Sweden	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1926km
Plastipack Limited	Hungary	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1563km
Plastipack Limited	Poland	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1155km
Plastipack Limited	Czech Republic	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 1217km
Plastipack Limited	Bulgaria	Lorry + Ferry	1%	Plastipack to Dover 70km, Dover to Calais (Ferry) 50km, Calais to Destination 2423km
Plastipack Limited	South Africa - Cape Town	Container/ Cargo Ship	5%	By road 514m, By Cargo Ship 12,111km
Plastipack Limited	Australia	Container/ Cargo Ship	2%	By road 246km, By Cargo Ship 20,518km

Plastipack Limited	New Zealand	Container/ Cargo Ship	1%	By road 248km, By Cargo Ship 23,438km

10. Appendix II

10.1 Modelling Process for Stabilised Chlorine

Desk research was conducted to obtain information relating to the production of sodium dichloroisocyanurate dihydrate[42][43][44]. Limited information was available on the internet relating to the production of stabilised chlorine on a large scale. For this reason, it is important to note that the model used for the production of stabilised chlorine may not be representative of how it is produced on a large scale.

The production of sodium dichloroisocyanurate dihydrate occurs in a two step process. The first consists of combining chlorine, cyanuric acid and sodium hydroxide and producing dichloroisocyanuric acid. The Ecoinvent 3.8 database does not possess a process for cyanuric acid, for this reason, desk research has been conducted to model the production of cyanuric acid. Cyanuric acid is produced by using urea as a starting material as it is the most traditional, economical, and convenient and produces high quality and good yield. The model for the production of cyanuric acid uses urea and kerosene as it produces a high yield of cyanuric acid (88.7%)[45]. The ratio of kerosene and urea is 2:1, and is heated to 180 degrees Celsius to obtain cyanuric acid. Assuming that urea and kerosene are kept at room temperature of 20 degrees Celsius, these elements must be heated 160 degrees Celsius further. To find out the energy required to heat up the solution, the specific heat capacities of both elements are used. The specific heat capacities for urea and kerosene are 1.339 (J/(g C)) and 2.01 (kJ/(kg K)) respectively. It is assumed that 50% of energy used for heating the solution is lost. The first step which consists of producing dichloroisocyanuric acid uses the proportions of the three elements by molar mass due to the lack of information on actual yield. The molar mass of chlorine is about 35 g/mole, therefore 2 Cl_2 molar mass is 140 g/mol. That of cyanuric acid is 129 g/mol and that of sodium hydroxide is approximately 40 g/mol, therefore 2 NaOH is 70 g/mol. This produces 349 g/mol, which is broken down to 198 g/mol of dichloroisocyanuric, 2 molecules of water (38 g/mol) and 2 molecules of NaCl (116 g/mol). The aqueous slurry is then separated from the solid dichloroisocyanuric acid. The energy used for the first reaction including the separation process that may include the use of a centrifuge, is accounted for using an energy proxy. The energy proxy used is from Ecoinvent 3.8, specifically the energy used for liquifying gaseous chlorine in the process for liquid chlorine, equivalent to 0.07 kWh per kg of product. The dichloroisocyanuric acid is then stabilised with sodium hydroxide in the form of an aqueous solution, such that at least two molar equivalent of water is used based on the amount of dichloroisocyanuric acid is used. The reaction temperature should remain between 0 and 5 degrees Celsius. The second step which consists of using sodium dichloroisocyanurate dihydrate uses the proportions of the three elements by molar mass due to the lack of information on actual yield. For every 197 grams of dichloroisocyanuric acid, 36 grams of water and 40 grams of sodium hydroxide are used. This solution is then filtered again and the solid sodium dichloroisocyanurate dihydrate is dried (temperature of 25 – 30 degrees Celsius) to get rid of small amounts of free water. The energy in reaction two uses the same proxy as reaction one, such that 0.07 kWh of energy is used per kg. Inputting all of the relevant flows into add-on 15804 from Ecoivent 3.8 enables the calculation of the environmental impacts avoided through chlorine savings due to the use of GeoBubble™ which inhibits the degradation of chlorine.

[42] https://patents.google.com/patent/DE3227817A1/en
[43] https://patents.google.com/patent/US3803144A/en
[44] http://jchemindustry.tju.edu.cn/EN/abstract/abstract11318.shtml
[45]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6257242/#:~:text=There%20are%20two%20ways%20for,7%2C8%2C9%5D.