WHITEPAPER

SUSTAINABILITY EVALUATION OF PLASTIC VS STAINLESS STEEL INTERMEDIATE BULK CONTAINERS (IBCS)

THIELMANN
THE CONTAINER COMPANY

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EXECUTIVE SUMMARY

This whitepaper examines the environmental performance of a stainless steel IBC vs. a composite plastic IBC. This analysis was executed via a Life Cycle Assessment (LCA) in partnership with LEITAT technological center. This method provides a **scientifically sound quantification of the environmental impact throughout the product's life cycle**.

To assess the impact of each life cycle stage, an identification and quantification of all inputs and outputs was performed, with a total of 16 environmental factors taken into account. Researchers reached the following conclusions about the environmental impact of each product, depending on the length of its life cycle.

- When **ONE SINGLE USE** is considered, the environmental profile of the stainless steel tank is higher than the plastic tank for most of the impact categories. The reason for this is clearly raw material consumption.
- When **TWO YEARS OF LIFESPAN** are considered (ten uses), environmental impacts of the plastic IBC increase over the impact of the stainless steel IBC in most of the impact categories.
- For **FIVE, TEN, and 20 YEARS OF LIFESPAN** there are clear benefits of using stainless steel containers. From ten years onwards, the use of the stainless steel IBC is more environmentally friendly than the use of plastic IBCs for all the scenarios analyzed in the study.

In summary, **after two years (or ten rotations), the environmental impact of the plastic IBC increases over the impact of the stainless steel IBC** in most of the impact categories, with the environmental advantages of stainless steel growing exponentially with the number of uses.

Although on average, a stainless steel IBC costs ten times more than plastic, the initial investment is paid off after less than two years (ten rotations), considering an average use of five rotations/year and the fact that 25.5% of the plastic IBCs are discarded after washing, because they are damaged or cannot be sufficiently cleaned.

As a result, **stainless steel is by far the superior choice in regard to sustainability and return on investment**.

For this project, THIELMANN collaborated with LEITAT to analyze samples and calculate results.

LEITAT is a private technical institute with more than 110 years of experience in industrial innovation processes. LEITAT develops R&D activities in the areas of materials science, circular economy, energy and engineering, and biomedicine with deep knowledge and experience in technological transfers to several industrial sectors.

The study and minimization of the environmental impact fostering a circular economy is one of the main points of study of LEITAT. The Sustainability Area is part of the Circular Economy Department of the center and is formed by an interdisciplinary team capable of efficiently assess the demand of organizations on sustainability-related issues. The area deals with Sustainable Consumption & Production, Life Cycle Assessment & Eco-design, Environmental Communication, Governance and, Social Innovation.

The center takes part each year in many projects financed by the regional and national governments, participates in projects co-funded by the European Commission, and develops private R&D projects funded by industrial partners[1].

INTRODUCTION

In general terms, 'intermediate bulk container' (IBC) is defined as a rigid or flexible portable packaging that:

(i) has a capacity of more than 0.45 m3 but up to 3 m3;
(ii) is designed for mechanical handling; and
(iii) is resistant to the stress produced in certain handling and transport conditions.

IBCs are commonly reusable and can be manufactured with different materials. The following are the two most common designs:

- 'Composite IBC with plastic inner receptacle', which refers to an IBC comprising a rigid outer casing that envelopes a plastic inner receptacle, together with any service or other structural element. Once the inner receptacle and outer casing are assembled, they form an integrated single unit to be filled, stored, transported and emptied as such;

- 'Metal IBC', which generally refers to a stainless steel body together with appropriate service and structural elements[2].

1 https://projects.leitat.org/

2 https://unece.org/transportdangerous-goods/adr-2021-files

1000L Stainless steel IBC

1000L Plastic IBC

The design of these containers permits an efficient space utilization during their transportation and storage, which consequently reduces associated costs.

Many factors are taken into consideration when selecting the material of an IBC (price, compatibility, etc.). Now, the environmental impact of the IBC throughout its life cycle is becoming of particular concern, changing the way these decisions are approached.

This is the case across industries; in 2015, all United Nations Member States adopted the 2030 Agenda for Sustainable Development. At its heart are the 17 Sustainable Development Goals (SDGs)[3] , which are an urgent call for environmental, social, and economic action globally.

(THIELMANN supports the Sustainable Development Goals)

Particularly significant for industry is Goal 12, responsible consumption and production. This can be achieved via various strategies, such as the circular economy. The transition towards a circular economy, where the value of products, materials and resources is maintained for as long as possible, is an essential to nurturing a sustainable economy. The re-use of packaging items plays a key role in the achievement of this goal[4].

In this whitepaper, the environmental performance of a stainless steel IBC and a composite IBC has been assessed by means of a Life Cycle Assessment (LCA), which provides a scientifically sound quantification of the environmental impact throughout the product's life cycle[5].

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3 https://sdgs.un.org/goals

4 https://www.sciencedirect.com/science/article/pii/S2212827117307771

5 https://ec.europa.eu/environment/waste/publications/pdf/Making_Sust_Consumption.pdf

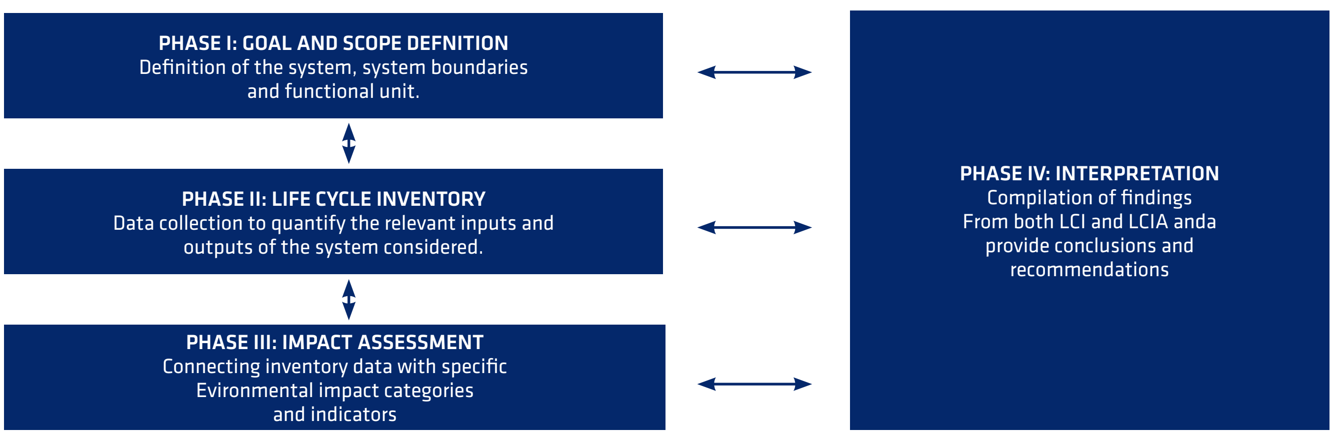
METHODOLOGY AND OBJECTIVE

LCA can be defined as a process to evaluate the environmental performance of a product, process, or activity along the entire life cycle of the system: extraction and processing of raw materials; manufacturing, transportation and distribution; use, re-use and maintenance; and recycling and final disposal.

To assess the environmental impact of the different life cycle stages, an identification and quantification of all inputs and outputs of the process is performed (energy, materials used, wastes released into the environment).

The technical framework of this methodology has been standardized in accordance with the International Standard Organization (ISO): ISO 14040[6] and ISO 14044[7]. Moreover, the LCA methodology also follows the International Reference Life Cycle Data System Handbook of European Platform on Life Cycle Assessment[8].

According to these standards, the LCA is implemented in four interrelated phases:
(1) goal and scope definition;
(2) life cycle inventory;
(3) impact assessment;
(4) and finally, interpretation of the results.



LCA framework, according to ISO 14044.

The aim of this report is to compare the environmental performance of two IBCs:

- A 1000L stainless steel IBC made by THIELMANN (https://thielmann.com/en/products/ibcs/ibcs-for-liquids/cubical-container-ltp);

- A 1000L composite IBC with plastics inner receptacle.

In order to do so, a quantification of the potential environmental impact of the whole life cycle of both containers has been performed via a LCA methodology.

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6 ISO 14040 - Environmental Management - Life cycle assessment - Principles and framework.
7 ISO 14044 - Environmental management- Life cycle assessment - Requirements and guidelines.
8 EC-JRC, 2011. ILCD Handbook: Recommendations for Life Cycle Impact Assessment in the European Context, Publications Office of the European Union. Luxembourg.

PHASE I: GOAL AND SCOPE DEFINITION

As previously indicated, the aim of this LCA is to evaluate the environmental performance of two IBCs: one made of stainless steel and another made of plastic.

FUNCTION AND FUNCTIONAL UNIT

These products have been designed to contain and transport 1000L of product. Considering this, the functional unit has been defined as: **transport and store 1000 liters of liquid.**

SYSTEM BOUNDARIES

The definition of the system boundaries is important to determine the life cycle phases included in the assessment; this decision will affect the final impact of the product. There are different LCA variants considering the limits of the system:

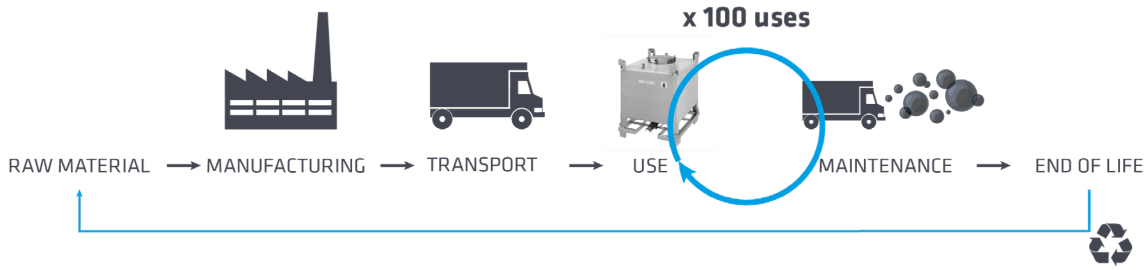
A) Cradle to grave: includes the full life cycle of the product, from resource extraction to use phase and disposal phase.
B) Cradle to gate: it only includes the resource extraction and the manufacturing process.
C) Cradle to cradle: similar to cradle to grave, this variation includes the impact associated with the recycling process.

In this study, **a cradle to grave approach has been considered**. The life cycle stages considered in the LCA are:

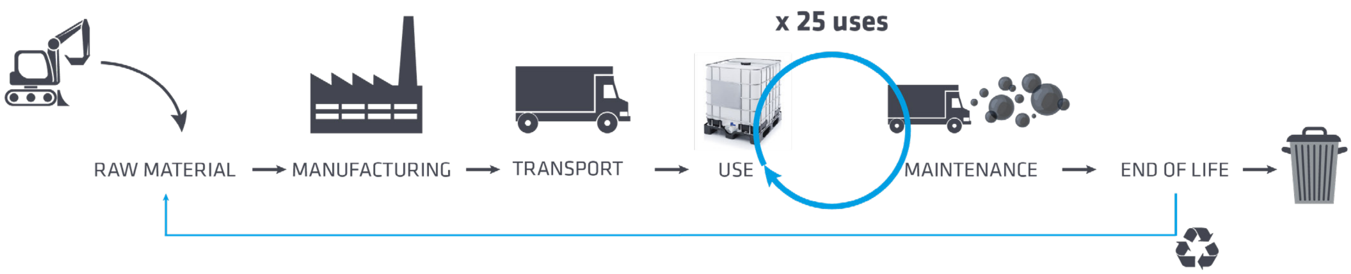
STAGE	DESCRIPTION	LIMITATIONS AND ASSUMPTIONS
Raw material extraction	The impact associated with the consumption of raw materials needed to manufacture the container.	The components representing less than 1% by weight of the total product have not been included in the assessment because they have been considered negligible.
Manufacturing	The processes needed to produce the container.	Information regarding the inputs and outputs of the manufacturing processes of these products is not available; for this reason, standard manufacturing processes from the ECOINVENT database[9] have been used to assess the environmental impact of this life cycle stage.
Transport	The transport of the IBCs has been included because the weight of the product affects the associated impact.	
Use	The use itself is not related to any impact. Nevertheless, the lifespan of the product is important to calculate and compare in light of environmental impact.	Considering the information from the plastic IBC manufacturer, the permitted period of use for the transport of hazardous goods with plastic IBCs is up to five years[10]. For foodstuff applications, the same lifespan has been considered as they will require exhaustive cleaning to sterilize the container before the next use. Stainless steel IBCs have seen over 20 years of work life[11]. The life expectancy of any IBC depends on the quality of care it receives as well as the products it carries. It has been assumed that the user makes a correct use of the IBC and the lifespan of the products is maximized.

9 https://www.ecoinvent.org/database/database.html
10 SCHÜTZ NEWS, all the latest of Schütz (July 2020). IBC Handling Guide: Current Guideline for the safe application of IBCS. Available on-line at: https://www.schuetz.net/downloads/news/2020/juli/schuetz-news-july-2020-en.pdf?cid=7cn
11 IBC Tanks. IBC tote frequently asked questions. https://www.ibctanks.com/faq#ibc-work-life-expectancy

Maintenance	The cleaning process after each use and the transport to the maintenance plant have been included.	Optimal cleaning is important to ensure good quality product is stored and transported. The empty or used container is collected from the consumer facility and substituted for an IBC that is ready for use. After cleaning, it is assumed that 25.5% of the plastic IBC is discarded because they are damaged or cannot be sufficiently cleaned[12]. It has been assumed that the IBCs are inspected periodically to detect whether corrosion, contamination, or other damages are affecting the characteristics of the container. The inspection is not included in the assessment.
End of life	The 'Polluter Pays Principle' has been applied: the waste to be recycled does not contribute to the environmental burden associated with the recycling process. Instead, this impact is assessed as part of the upcoming system, which uses such waste as recycled material. Consequently, for waste going to recycling, only transport to the collection site is considered.	The manufacturer of the plastic IBC offers a service to collect and recondition the emptied IBCs. They also deploy an internal recycling system: high quality recycled HDPE is generated and then used within a closed cycle to produce plastic components, such as corner protectors and plastic pallets for the IBCs[13].



System boundaries of the stainless steel IBC:



System boundaries of composite IBC:

12 https://www.sciencedirect.com/science/article/pii/S2212827117307771

13 SCHÜTZ NESW, all the latest of Schütz (July 2020). IBC Handling Guide: Current Guideline for the safe application of IBCS. Available on-line at: https://www.schuetz.net/downloads/news/2020/juli/schuetz-news-july-2020-en.pdf?cid=7cn

PHASE II: LIFE CYCLE INVENTORY

RAW MATERIALS

1000-LITER STAINLESS STEEL IBC:

	MATERIAL	WEIGHT (KG)
1000-liter stainless steel IBC	Stainless steel (AISI 304)	115
	Carbon steel (S235JR), galvanized	25

a) It has been assumed that 90% of the metal used to manufacture the stainless steel IBC is recycled[14]: a specific process has been created with SIMAPRO[15] software in order to evaluate the environmental impact related to the manufacture of the stainless steel, without considering the extraction of raw materials.

b) The stainless steel IBC also includes parts made of Ethylene Propylene Diene Monomer rubber (EPDM) and copper. Nevertheless, these components represent less than 1% of the total weight of the product and they have not been included in the environmental assessment, as the impact associated to these materials is negligible.

c) The galvanizing process consists of applying a protective zinc coating to the steel material to prevent rusting. According to the description of the SIMAPRO process, data given per ton of coated product had to be transformed, dividing it by the mean surface area of 60m2 per ton.

1000-LITER COMPOSITE IBC WITH PLASTIC INNER RECEPTACLE:

	MATERIAL	WEIGHT (KG)
1000-liter composite IBC with plastic inner receptacle	Polyethylene, high density (HDPE)	16
	Carbon steel (S235JR), galvanized	22
	Wood pallet	29
	Plastic pallet	19
	Pallet made of zinc plated steel	20

a) The composite IBC consists of one 1000L high density polyethylene (HDPE) container, with one pallet and maintained by one protective wire cage made of steel. Other components of the product are the bottle cap, corners protectors, and the bottom outlet; all of them are made of HDPE.

b) The pallet can be made of metal, plastic or wood.

c) The galvanizing process consists of applying a protective zinc coating to the steel material to prevent rusting. According the description of the SIMAPRO process, data given per ton of coated product had to be transformed dividing it by the mean surface area of 60m2 per ton.

14 https://www.worldstainless.org/files/issf/non-image-files/PDF/Team_Stainless/The_Global_Life_Cycle_of_Stainless_Steels.pdf
15 https://simapro.com/

MANUFACTURING PROCESS

Data from ECOINVENT[16] has been used to complete the life cycle stage of manufacturing in both types of IBCs, considering the different manufacturing processes.

TRANSPORT

An average distance of 1000 km has been assumed in the distribution of the product for both types of containers analyzed.

Nevertheless, the weight of the product transported also affects the environmental impact: the more weight transported, the higher the environmental impact.

PROCESS	WEIGHT (KG)
Stainless steel IBC transportation	140
Composite IBC transportation- wood pallet	67
Composite IBC transportation- plastic pallet	57
Composite IBC transportation- steel pallet	58

MAINTENANCE

The maintenance process is the same for both products: cleaning is needed after use in order to sterilize the container for the next use. The containers are washed with hot, pressurized water and a mix of chemical products indicated in the table below[17].

RESOURCES	AMOUNT	UNIT
Water	70	L
Natural gas	14	MJ
Detergent	48	g
Sodium hydroxide	103,5	g
Silicone surfactant	212	g
Energy	1,07	kWh

After the cleaning process, composite IBCs that are damaged or not sufficiently cleaned (permeated) are discarded and sent to waste management. These containers are replaced by new ones, including all the environmental impact related with the raw material extraction, manufacturing process, and transport until the consumer[18].

16 https://www.ecoinvent.org/database/database.html
17 https://www.sciencedirect.com/science/article/pii/S2212827117307771
18 https://www.sciencedirect.com/science/article/pii/S2212827117307771

END OF LIFE

Both products are recyclable. According the Polluter Pays Principle, the waste management of the products (that is, the recycling of the materials) has not been included in the assessment. In this life cycle stage only the transport to the waste management plant has been included.

PROCESS	WEIGHT (KG)
Stainless steel IBC transportation	140
Composite IBC transportation- wood pallet	67
Composite IBC transportation- plastic pallet	57
Composite IBC transportation- steel pallet	58

It is important to highlight that the inherent properties of permanent materials such as metals do not change with use, despite repeated recycling into new products[19].

METAL
TM
recycles
forever

Other materials such as plastics, however, degrade after each recycling process, and can only be recycled once or twice before they are "downcycled", which means they are recycled into something of lesser value[20]. In addition, composite IBCs cannot be recycled if the product inside has permeated the plastic receptacle, thus contaminating it. It is also important to highlight that its use and end of life stage have an important associated impact, which is the generation of micro-plastics[21].

19 https://www.metalpackagingeurope.org/sustainability
20 https://recyclenation.com/2017/06/how-many-times-can-recyclables-be-recycled/
21 https://www.nature.com/articles/s41598-020-61146-4

PHASE III: IMPACT ASSESSMENT

The environmental impact has been calculated using SIMAPRO software[22] and the ECOINVENT database[23]. The methodology selected for the life cycle assessment was the International Reference Life Cycle Data System (ILCD) midpoint method[24].

This Life Cycle Impact Assessment (LCIA) method includes 16 midpoint impact categories, which are briefly described below:

1. **Climate change**: Global Warming Potential (GWP), calculating the radiative forcing over a time horizon of 100 years[25].
2. **Ozone depletion**: Ozone Depletion Potential (ODP), calculating the destructive effects on the stratospheric ozone layer over a time horizon of 100 years[26].
3. **Human toxicity, cancer effects**: Comparative Toxic Unit for humans (CTUh), expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogram)[27].
4. **Human toxicity, non-cancer effects**: Comparative Toxic Unit for humans (CTUh) expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogram)[28].
5. **Particulate matter**: Quantification of the impact of premature death or disability that particulates/respiratory inorganics have on the population, in comparison to PM2.5. It includes the assessment of primary (PM10 and PM2.5) and secondary PM (including creation of secondary PM due to SOx, NOx and NH3 emissions) and CO[29].
6. **Ionizing radiation HH (human health)**: Quantification of the impact of ionizing radiation on the population, in comparison to Uranium 235[30].
7. **Ionizing radiation E (ecosystems)**: Comparative Toxic Unit for ecosystems (CTUe), expressing an estimate of the potentially affected fraction of species (PAF) integrated over time and volume per unit mass of a radionuclide emitted (PAF m3 year/kg). Relevant for freshwater ecosystems[31].
8. **Photochemical ozone formation**: Expression of the potential contribution to photochemical ozone formation[32].
9. **Acidification**: Accumulated Exceedance (AE), characterizing the change in critical load exceedance of the sensitive area in terrestrial and main freshwater ecosystems, to which acidifying substances deposit[33],[34].
10. **Terrestrial eutrophication**: Accumulated Exceedance (AE), characterizing the change in critical load exceedance of the sensitive area, to which eutrophying substances deposit[35],[36].
11. **Freshwater eutrophication**: Expression of the degree to which the emitted nutrients reaches the freshwater end compartment (phosphorus considered as limiting factor in freshwater)[37].

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22 https://simapro.com/

22 https://www.ecoinvent.org/database/database.html

24 https://eplca.jrc.ec.europa.eu/uploads/LCIA-characterization-factors-of-the-ILCD.pdf

25 https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_full_report.pdf

26 https://library.wmo.int/?lvl=notice_display&id=15453#.YCvlwuhKiUk

27 https://link.springer.com/article/10.1007/s11367-008-0038-4

28 https://link.springer.com/article/10.1007/s11367-008-0038-4

29 Rabl, A. and Spadaro, J.V. (2004). The RiskPoll software, version is 1.051 (dated August 2004).

30 https://www.sciencedirect.com/science/article/abs/pii/S0195925599000426

31 https://www.radioprotection.org/articles/radiopro/abs/2009/05/radiopro44161/radiopro44161.html

32 https://www.sciencedirect.com/science/article/abs/pii/S1352231007008667

33 https://link.springer.com/article/10.1065%2Flca2005.06.215

34 https://link.springer.com/article/10.1007%2Fs11367-008-0025-9

35 https://link.springer.com/article/10.1065%2Flca2005.06.215

36 https://link.springer.com/article/10.1007%2Fs11367-008-0025-9

37 https://www.researchgate.net/publication/230770853_Recipe_2008

12. Marine eutrophication: Expression of the degree to which the emitted nutrients reaches the marine end compartment (nitrogen considered as limiting factor in marine water)[38].

13. Freshwater ecotoxicity: Comparative Toxic Unit for ecosystems (CTUe), expressing an estimate of the potentially affected fraction of species (PAF) integrated over time and volume per unit mass of a chemical emitted (PAF m3 year/kg)[39].

14. Land use: Soil Organic Matter (SOM) based on changes in SOM, measured in (kg C/m2/a). Biodiversity impacts not covered by the data set[40].

15. Water resource depletion: Scarcity-adjusted amount of freshwater used[41].

16. Mineral, fossil & renewable resource depletion: Scarcity of mineral resource with the scarcity calculated as 'reserve base'. This refers to identified resources that meet specified minimum physical and chemical criteria related to current mining practice. The reserve base may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics[42].

PHASE IV: INTERPRETATION OF RESULTS

This section shows the comparison of the environmental impacts (Phase III) related to the containers described:

- A 1000L stainless steel IBC made by THIELMANN.
- A 1000L composite IBC with plastics inner receptacle.

The impacts consider the stages described in Phase II: raw material consumption, manufacturing process, transport to the end user, maintenance (except for one single use), and end of life (transport to the waste treatment plant). When the lifespan of the product increases, the relative impact of the stainless steel IBC is reduced because only the maintenance impact is modified. Each year, the impact related to maintenance phase (transport and cleaning) is added.
On the other hand, the environmental impact of plastic IBCs evolves in different ways:

(i) A degradation rate of 25.5% has been considered in order to ensure the technical quality of the plastic[43]. The plastic containers that cannot be reused are sent to waste treatment plants and substituted with new ones.
(ii) The lifespan of the plastic IBC is 25 uses*. This means that a new plastic IBC will be needed every five years and the impacts associated with the life cycle of a new container should be included in the assessment.

**This lifespan is possible but not common; ≤10 is a more realistic assumption. However, a conservative scenario is considered here to show the clear advantage of using stainless steel.*

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38 https://www.researchgate.net/publication/230770853_Recipe_2008

39 https://link.springer.com/article/10.1007/s11367-008-0038-4

40 https://link.springer.com/article/10.1065/lca2006.05.250

41 https://www.researchgate.net/publication/237790160_Swiss_Ecological_Scarcity_Method_The_New_Version_2006

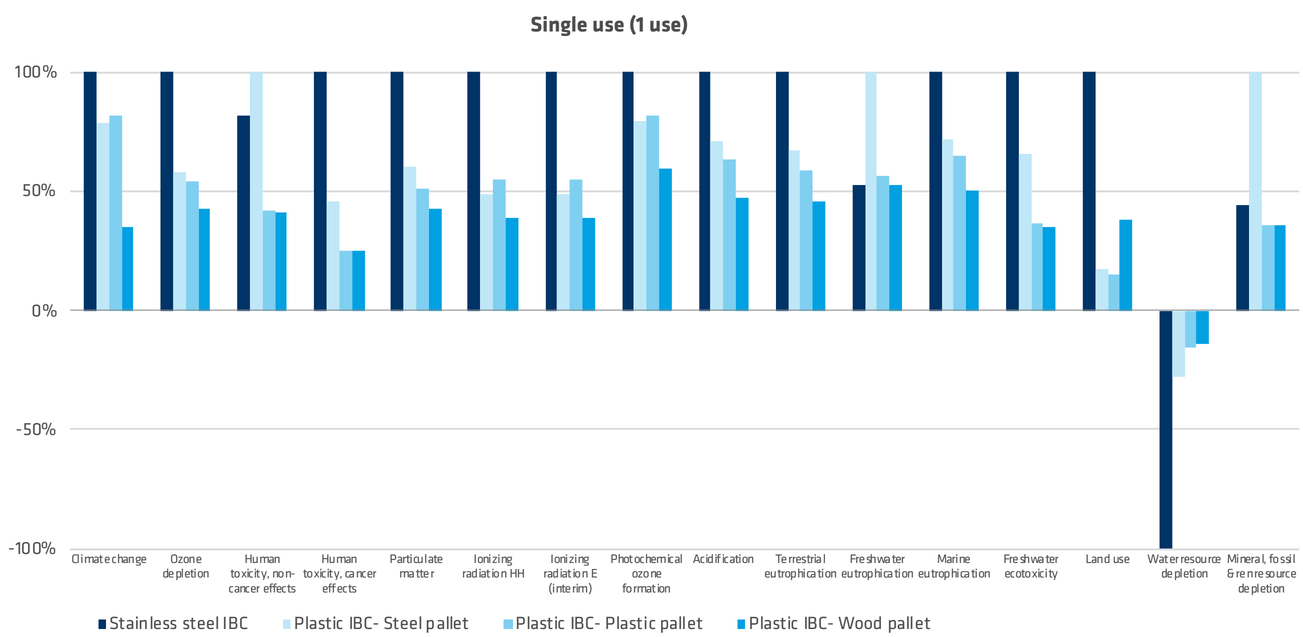
42 https://www.leidenuniv.nl/cml/ssp/projects/lca2/report_abiotic_depletion_web.pdf

43 https://www.sciencedirect.com/science/article/pii/S2212827117307771

Thus, since the lifespan of the product is relevant to evaluate the environmental impact of the container, a comparison between the different IBCs assessed has been conducted, considering the following lifespans and an average of five uses per year: single use, one year (five uses), two years (ten uses), five years (25 uses), ten years (50 uses) and 20 years (100 uses).

When **ONE SINGLE USE** is considered, the environmental profile of the stainless steel container is higher than the plastic one for most of the impact categories. The reason for that is clearly the high contribution of the raw material consumption. For the impact categories of human toxicity (non-cancer effects), freshwater eutrophication, and mineral, fossil and renewable resource depletion, the plastic container with steel pallet generates an environmental impact higher than the stainless steel IBC.

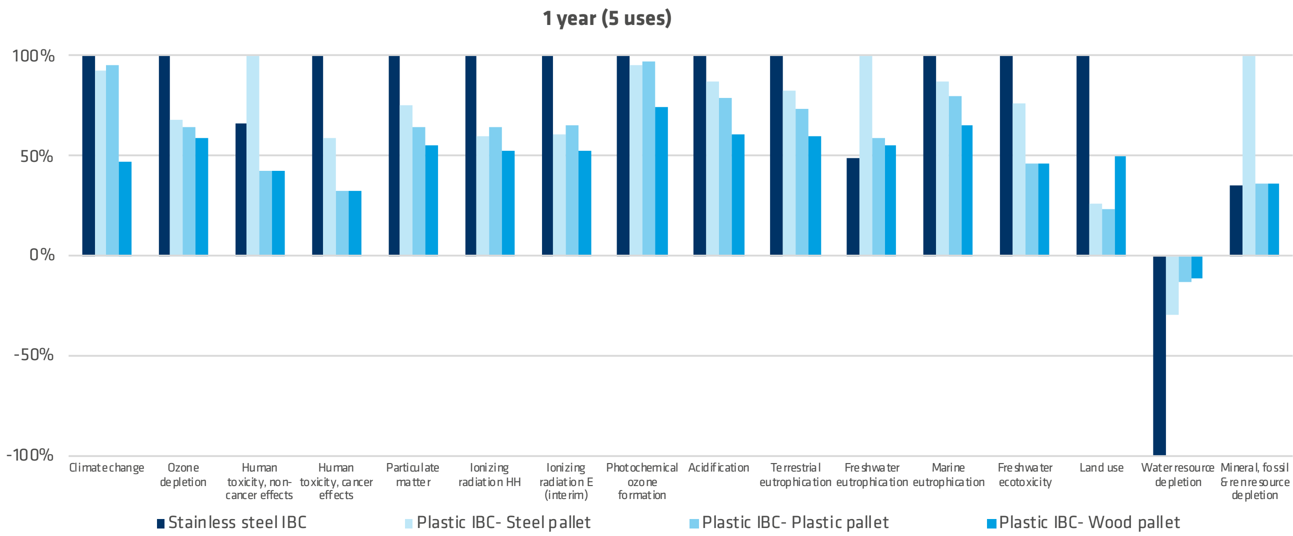
The water resource depletion impact category is represented in negative values[44]. The impact mechanisms for extraction of water can be considered to have a common base: the reduction in the availability of water to maintain the natural and human activities in a region. This impact category reflects the degree of scarcity of water of a certain quality per region and the technological and economic accessibility of the resources.



Environmental impact comparison of the IBC tanks considering a single use lifespan. (Relative values)

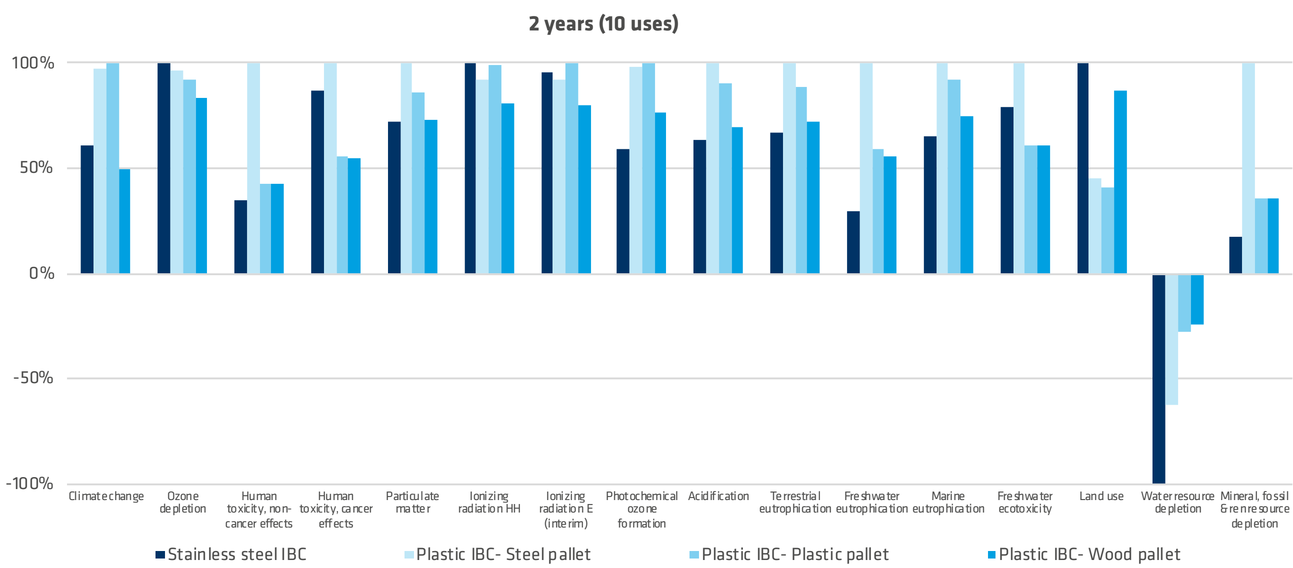
44 The water balance is calculated considering different factors that can result in negative values or positive impacts on the environment:
- The maximum surface and groundwater yield, which in turn depends on the precipitation, evaporation, runoff rates, etc. of the catchments.
- The extraction of surface and groundwater reserves for human and ecosystem consumption.
- The transfer of water reserves between catchments where the maximum yields are inadequate.

If a **LIFESPAN OF ONE YEAR** is considered (five uses), the stainless steel IBC has a higher environmental impact for most of the impact categories analyzed (except for the human toxicity (non-cancer effects), freshwater eutrophication, and mineral, fossil and renewable resource depletion impact categories).



Environmental impact comparison of the IBCs considering one year of lifespan (five uses). (Relative values)

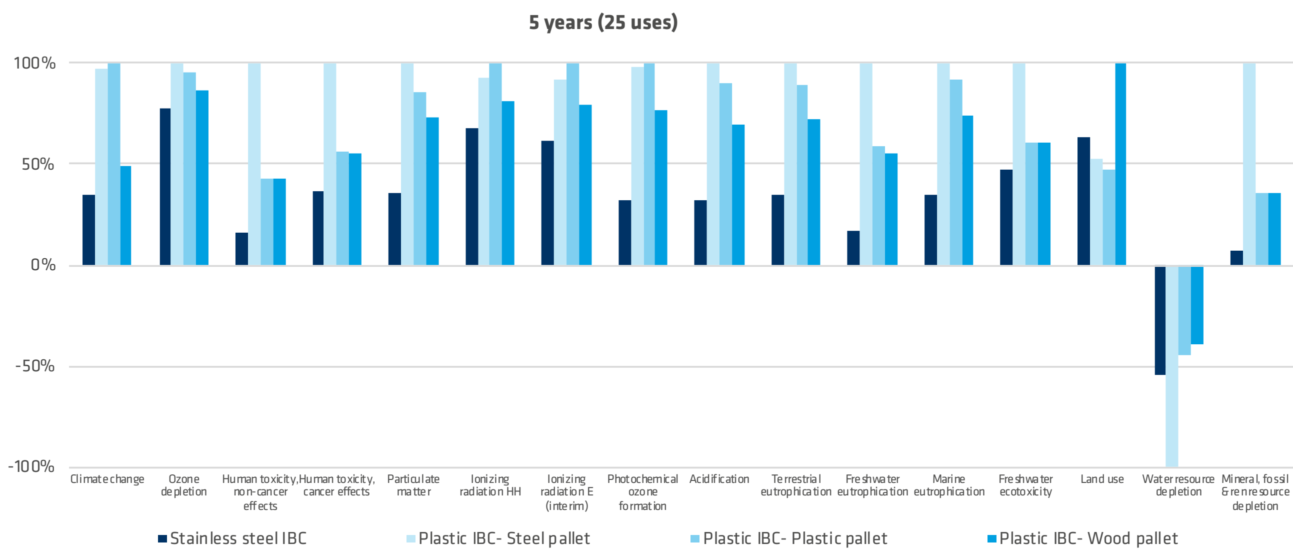
When **TWO YEARS OF LIFESPAN** are considered (ten uses), **environmental impacts of the plastic IBC increase over the impact of the stainless steel IBC in most of the impact categories**. The stainless steel IBC represents a greater environmental impact for the following impact categories: ozone depletion, ionizing radiation HH, land use and water resource depletion.



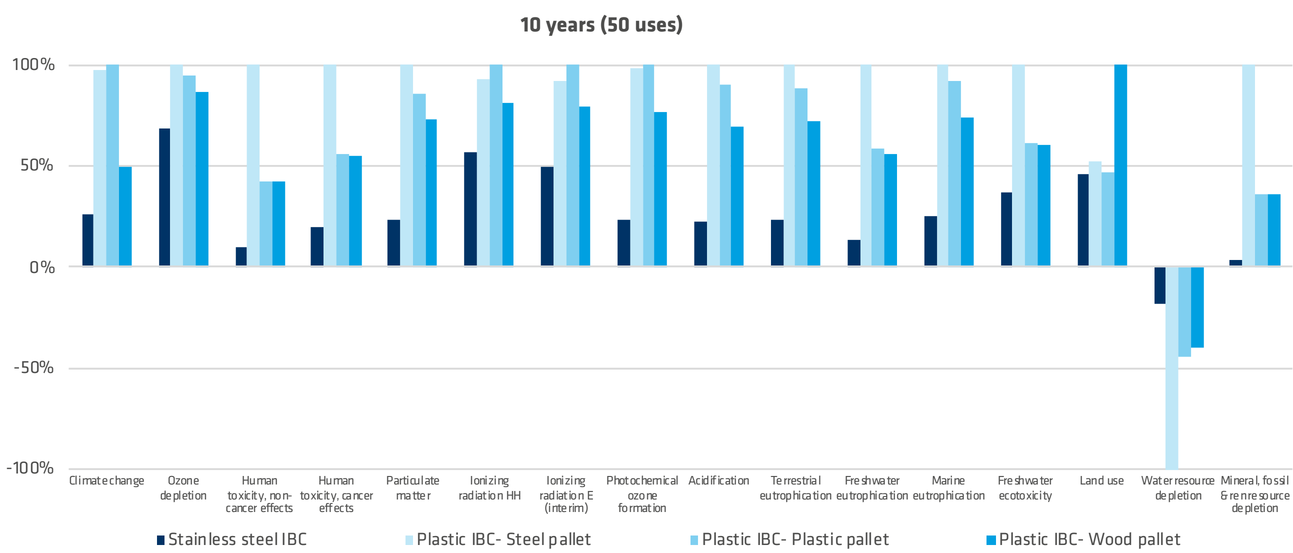
Environmental impact comparison of the IBCs considering two years of lifespan (ten uses). (Relative values)

In the next three figures the evolution of the environmental profiles for **5, 10 and 20 YEARS OF LIFESPAN** of the containers assessed in the project are included.

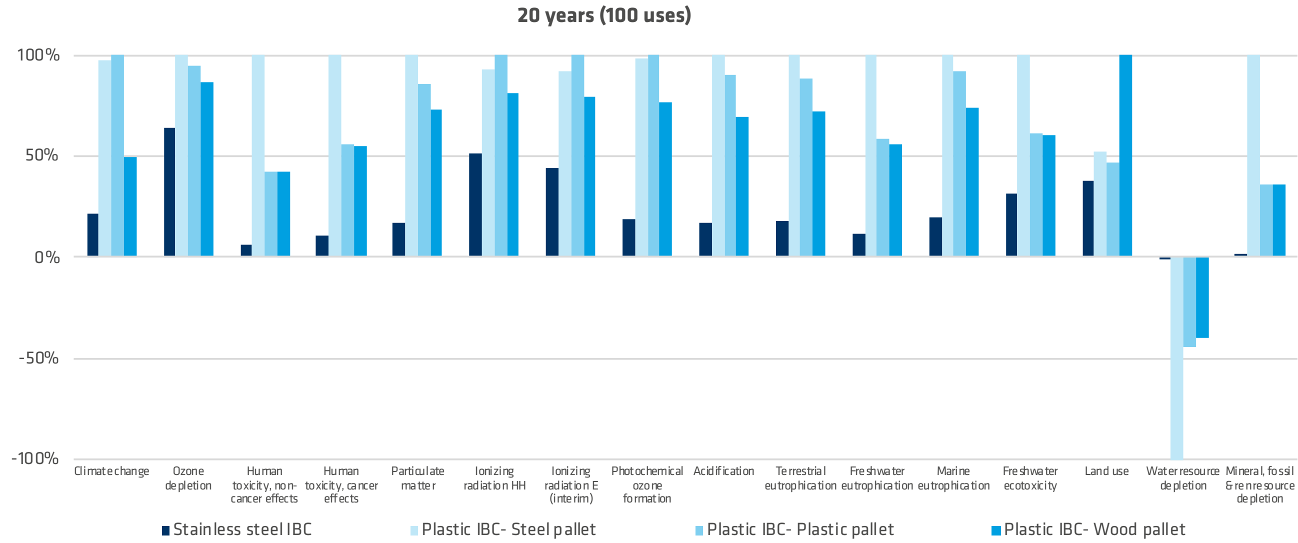
These figures show there are **clear benefits of using stainless steel containers from five years of lifespan**. At this point, the stainless steel IBC has a bigger environmental impact than the plastic IBC with steel and plastic pallet for the impact category of land use. Equally, there is a greater impact than the plastic IBCs with plastic and wood pallet for the impact category of water resource depletion.



Environmental impact comparison of the IBCs considering five years of lifespan (25 uses). (Relative values)



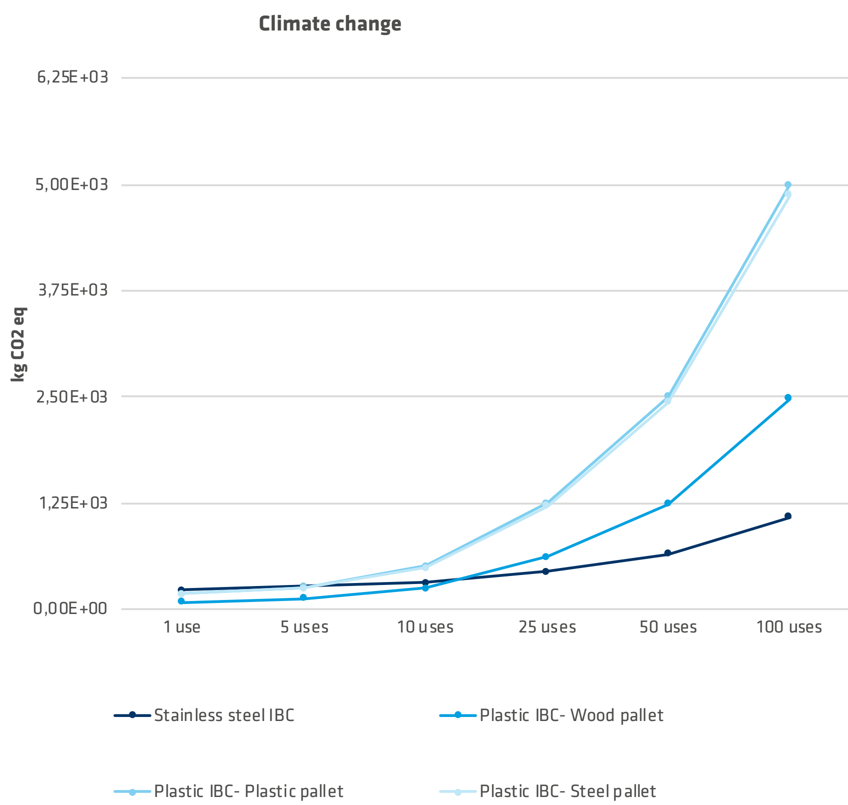
Environmental impact comparison of the IBCs considering ten years of lifespan (50 uses). (Relative values)



Environmental impact comparison of the IBCs considering 20 years of lifespan (100 uses). (Relative values)

Zooming into one of the most well-known categories, climate change – also referred to as carbon footprint – it can be observed that the trend varies in the different IBCs analyzed when the kgCO_2eq are represented versus the lifespan of the containers.

This figure demonstrates the **advantages of the use of stainless steel IBCs** and how these advantages increase with the number of rotations, as this reduces raw material consumption and waste generation.



CONCLUSIONS AND ADDITIONAL NOTES

Due to its inherent reusable character, it is important to consider the life cycle of an IBC when the decision-making moment arrives. This means thinking about the product to be stored and transported, but also about the rotations and external conditions the IBC will be subjected to.

This whitepaper has focused on the environmental impact of stainless steel and composite IBCs, considering average lifetime and number of rotations per year. Based on these assumptions, **after two years (or ten rotations), the environmental impact of the plastic IBC increases over the impact of the stainless steel IBC in most of the impact categories, with these environmental advantages growing exponentially with the number of uses**.

FIRE RISK

Besides this quantified fact, there is another clear situation where stainless steel is the material of choice when selecting an IBC: fire risk. This is not only because of the potential surroundings but also the possible flammability of the product contained. Thus, the use of stainless steel IBCs prevents catastrophic consequences in case of fire.

Under harmonized conditions of fire testing, composite IBCs with plastic inner receptacles start to melt after 18 seconds with the subsequent flow of the product inside. In contrast, stainless steel IBCs resist 30 minutes of fire exposure without bursting.

Stainless steel IBC after a fire test

COST

But what about the cost? Stainless steel IBCs are more expensive than composite ones, and thus, it is necessary to think about whether investing takes into account the life cycle costs.

Considering the reusability of both composite IBCs with plastic inner receptacles and stainless steel IBCs, the transport and washing processes would have similar costs, and thus, it is only the selling price that would vary significantly.

On average, stainless steel IBCs cost ten times more than plastic ones, which means that the initial investment is paid off after less than two years (ten rotations), considering an average use of five rotations/year and the fact that 25.5% of the plastic IBCs is discarded after washing, because they are damaged or cannot be sufficiently cleaned[45].
Additionally, it should never be forgotten the scrap value that stainless steel has once its life has ended. This allows the owner to recoup approximately 10% of the initial price.

As a result, **stainless steel is by far the superior choice in regard to sustainability and return on investment.**

45 https://www.sciencedirect.com/science/article/pii/S2212827117307771

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