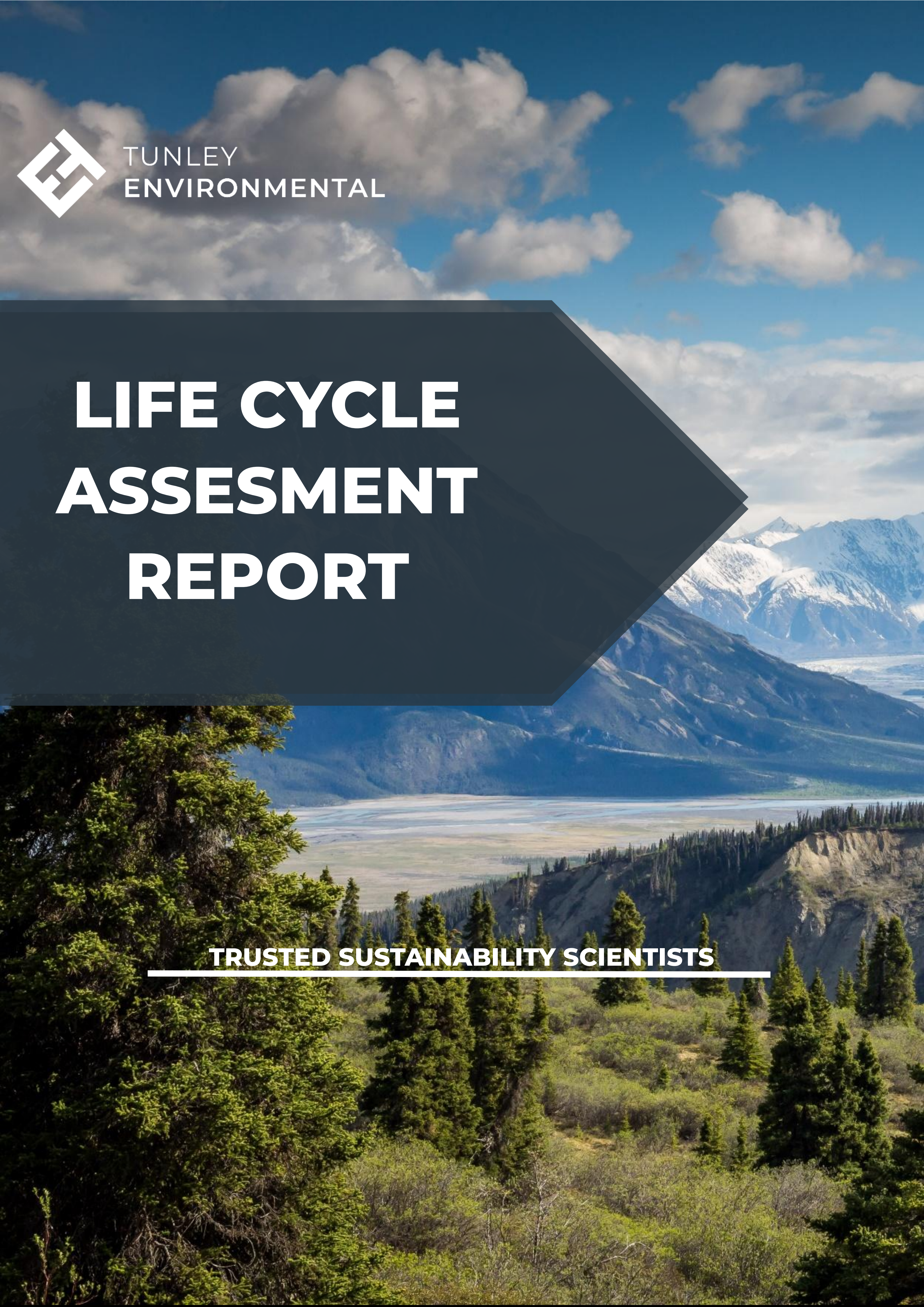

TUNLEY
ENVIRONMENTAL

# LIFE CYCLE ASSESEMENT REPORT

TRUSTED SUSTAINABILITY SCIENTISTS

TUNLEY ENVIRONMENTAL

# LCA REPORT

# SHARPAK SHARPS BINS

# FOR

# INPRESS PRECISION

Inpress
Certainty through precision

**CASE STUDY:** SINGLE-USE VS REUSABLE BIN

## Contents

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## Nomenclature

| Nomenclature | Description |
|---|---|
| GHG | Greenhouse Gases, gases that trap heat in our atmosphere. GHG include Carbon dioxide, methane, nitrous oxides, and fluorinated gases. |
| Embodied Carbon / Partial Product Carbon Footprint | The total GHG emissions generated to produce a product; It includes those from extraction, manufacture, processing, transportation, and assembly of every component. |
| Carbon Equivalent | The effect on global warming of a greenhouse gas (GHG) relative to that of $CO_2$. |
| Zero Carbon | The absence of GHG emissions |
| Greenhouse Gas Protocol | The GHG Protocol Corporate Accounting and Reporting Standard which provides requirements and guidance to prepare a corporate-level GHG emissions inventory. |
| Net Zero Carbon (NZC) | The sum effect of combining actions to reduce GHG emissions with actions to off-set them. |
| Carbon Offsetting | A reduction in emissions of GHG to compensate for unavoidable emissions. |
| Global Warming Potential (GWP) | The heat adsorbed by any GHG as a multiple of the equivalent in carbon dioxide. |
| IPCC | The Intergovernmental Panel on Climate Change. It provides regular scientific assessment on climate change to policy makers. |
| AR6 | The sixth assessment report of the IPCC. The most recent assessment report is 2021. |
| t $CO_2e$ | Notation for tonnes of carbon dioxide equivalent emissions. |
| kg $CO_2e$ | Notation for kilograms of carbon dioxide equivalent emissions. |
| ICE | The Inventory of Carbon and Energy. |
| Embodied Carbon Assessment (ECA) | Embodied carbon is the carbon footprint of a material. It considers how much greenhouse gas (GHGs) is released throughout the supply chain and is often measured from cradle to (factory) gate, or cradle to handover/site (of use). |
| Lifecycle Assessment (LCA) | A Lifecycle Assessment (LCA) is defined as the systematic analysis of the carbon emissions of products or services during their lifecycle. |
| Cradle-to-gate | A partial lifecycle of a product from raw materials through to the factory's gate. |
| Cradle-to-handover/site | A partial lifecycle of a product from raw materials through to delivery to the customer and does not include the end-of-life processes. |
| Cradle-to-grave | A full single lifecycle of a product from raw materials through to its end-of-life. |
| Cradle-to-cradle | A lifecycle assessment including consideration of reuse of the product or material in lieu of disposal at the end of a single life-time use. Pertains to the circular economy. |

# Executive Summary

Climate change poses a significant challenge to the environment, necessitating mitigation measures at international, national and local levels. It impacts businesses, natural systems and communities. The is caused by global warming, as a result of an increase in greenhouse gas (GHG) emissions, known as carbon emissions.

Inpress Precision would like to report on the carbon emissions involving a case study where their products, the single use Sharpak 60 sharps bin both with and without a 43% recycled plastic content are compared with their new product, Sharpak Zero 60, which is emptied and sanitised before reuse.

This circular process includes the production of the bins from virgin material before usual use of the sharps bin, followed by an emptying and cleaning process with a NOLOSS machine allowing the product to be reused. This process is expected to be repeated 10 times after which the plastic is closed loop recycled to produce a new bin. This recycling process can be repeated 10 times, giving the virgin plastic 100 uses before it is open loop recycled to become a different product.

A case study comparing a hypothetical Sharpak 60 bin with varying levels of recycled content (0–100%) has also been included as a benchmark to assess the impact of recycled content on the product.

Quantifying carbon emissions in this case study puts Inpress Precision in a position to demonstrate sustainability and environmental responsibility to their customers and the wider public. It allows Inpress Precision to show how a measurable change can be made to climate change emissions and facilitate the achievement of Net-Zero Carbon (NZC). Inpress Precision and Tunley Environmental have collaborated to identify emission sources and collect data.

Tunley Environmental has conducted an independent assessment to quantify carbon emissions due to manufacture of sharps bins conducted by Inpress Precision and their material sources, based on the data provided by company. The evaluation herein reported includes two components of emission quantifications for:

i) **Scenario 1:** A single use sharps bin, 10 single use sharps bins, and 100 single use sharps bins,
ii) **Scenario 2:** A single use sharps bin with 43% recycled content, 10 single use sharps bins with 43% recycled content and 100 single use sharps bins with 43% recycled content,
iii) **Scenario 3:** A reusable sharps bin used once, a reusable sharps bin used 10 times and then recycled, and a reusable sharps bin used 100 times with 10 cycles of recycling,
iv) **Scenario 4:** Sharpak Recycled, a single use sharps bin with varying levels of recycled content (0–100%), 10 single use sharps bins with varying levels of recycled content and 100 single use sharps bins varying levels of recycled content.

Life cycle carbon assessments for the complete range of Sharpak Zero products, which vary in size were also completed with emission quantification for:

i) Sharpak Zero 35 (3.5 litres),
ii) Sharpak Zero 60 (6.0 litres),
iii) Sharpak Zero 120 (12.0 litres),

iv) Sharpak Zero 220 (22.0 litres).

Total carbon emissions in kg of carbon dioxide equivalents (kg $CO_2e$) for the single use Sharpak bin for the full life cycle of 1, 10 and 100 bins were estimated to be 1.65, 16.53 and 165.29 kg $CO_2e$ respectively (**Error! Reference source not found.**).

A 15.83% carbon saving can be made through the use of 43% recycled content in the single use bin, reducing emissions to 1.39, 13.91 and 139.12 kg $CO_2e$ for 1, 10 and 100 bins (**Error! Reference source not found.**).

However, by reusing and recycling the plastic, in the case of the Sharpak Zero sharps bin, the carbon emissions can be significantly reduced for both 10 and 100 uses. Emissions for the reusable sharps bin were 1.69, 3.14 and 17.77 kg$CO_2e$ for 1, 10 and 100 uses (Figure 1). In contrast, increasing recycled content in Sharpak 60, for 100 uses, bins reduces emissions from 165 kg to 110 kg$CO_2e$, which, while significant, remains substantially higher than Sharpak Zero sharps bin.

Emissions analysis of Sharpak 60 Recycled and Sharpak Zero 60 containers across 1, 10, and 100 uses shows that increasing recycled content reduces emissions in the Sharpak 60 Recycled range. However, Sharpak Zero 60 consistently achieves lower overall emissions, particularly over multiple uses, emitting just 17.8 kg $CO_2e$ over 100 uses compared to 116.7 kg for Sharpak 60 Recycled at 100% recycled content. This suggests that while recycled content helps reduce impact, reusability plays a more significant role in lowering carbon emissions.

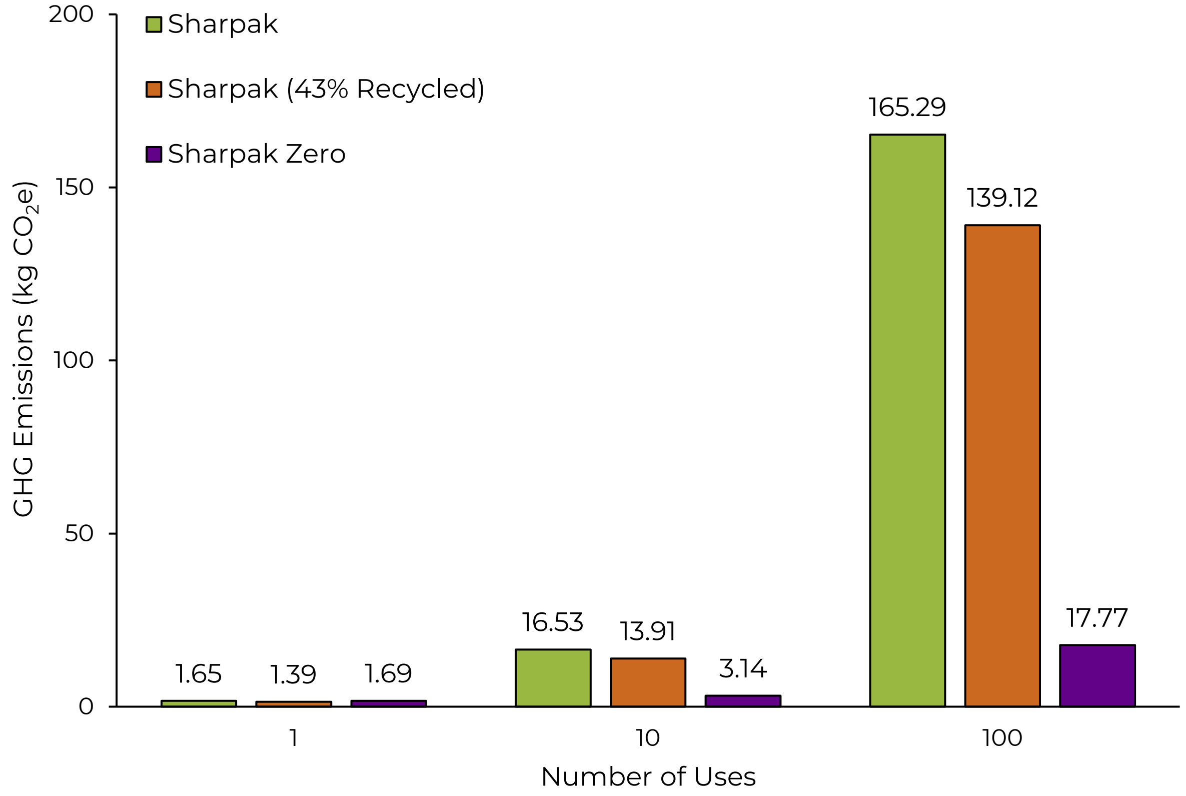


**Figure 1.** Greenhouse gas emissions from three scenarios.

By reusing their product (Sharpak Zero), Inpress Precision can save approximately 89.25% of GHG emissions (147.52 kg $CO_2e$) compared to the use of 100 single use no recycled content single use bins.

# Introduction

Tunley Environmental conducted this cradle-to-grave lifecycle assessment using the standard protocols stated in the methodology section and data provided by Inpress Precision for the manufacture and use of their sharp's bins, both single use and reusable.

For each scenario, where appropriate the assessment provides detailed quantification of GHG emissions due to:

i) Embodied carbon emissions from material usage for the Sharpak sharps bin,
ii) Emissions from transportation of the products,
iii) Emissions from assembly/dismantling/reinstallation of the new/reused products.

Emission sources considered for two scenarios include:

i) Scenario 1: Embodied carbon emissions, emissions from transportation, use phase and end-of-life processes of a Sharpak single use product,
ii) Scenario 2: Embodied carbon emissions, emissions from transportation, use phase and end-of-life processes of a Sharpak Zero reusable product.

Information on embodied carbon emissions and emissions from assembling processes were taken from appropriate sources detailed Appendix A – Data Sources and Assumptions. In this assessment, Tunley Environmental assume that:

i) The Sharpak Zero sharp bin is in good condition upon return and thus can be fully reused after emptying and sanitation,
ii) Transportation distance was estimated from the country or county of origin by average HGVs at 50% loading or sea freighting,
iii) Any unknown transportation distances were assumed to be 50 km,
iv) Waste cardboard packing material was recycled by the user and waste plastic packing was sent to landfill.

Appreciating the importance of determining major contributors to the emissions, Tunley Environmental provides detailed analysis and discussion on different components in each scenario; this will support Inpress Precision's customers with their decision-making processes to reduce their carbon emissions. Where information and data were limited, we made reasonable assumptions based on our expertise and external sources of data.

# Results

## Single Use Versus Reusable Sharps Bins

Here we compare 3 different scenarios, (i) a single use Sharpak 60 bin is produced, used and then incinerated, (ii) a single use Sharpak 60 bin with 43% recycled plastic content is produced, used and then incinerated and (iii) a reusable Sharpak Zero 60 bin is produced, used, returned and sanitised and then reused or recycled.

Figure 2 shows the life cycle of the Sharpak Zero product where in the first 9 cycles the product is used, cleaned and then repackaged for re-use and every 10th cycle the product is shredded for recycling the material into a new bin. At the 100th cycle or 10th recycling the product is open-loop recycled. It is noted that if at any point using the reuse cycles the bin is identified to be unfit for use, it will be recycled.

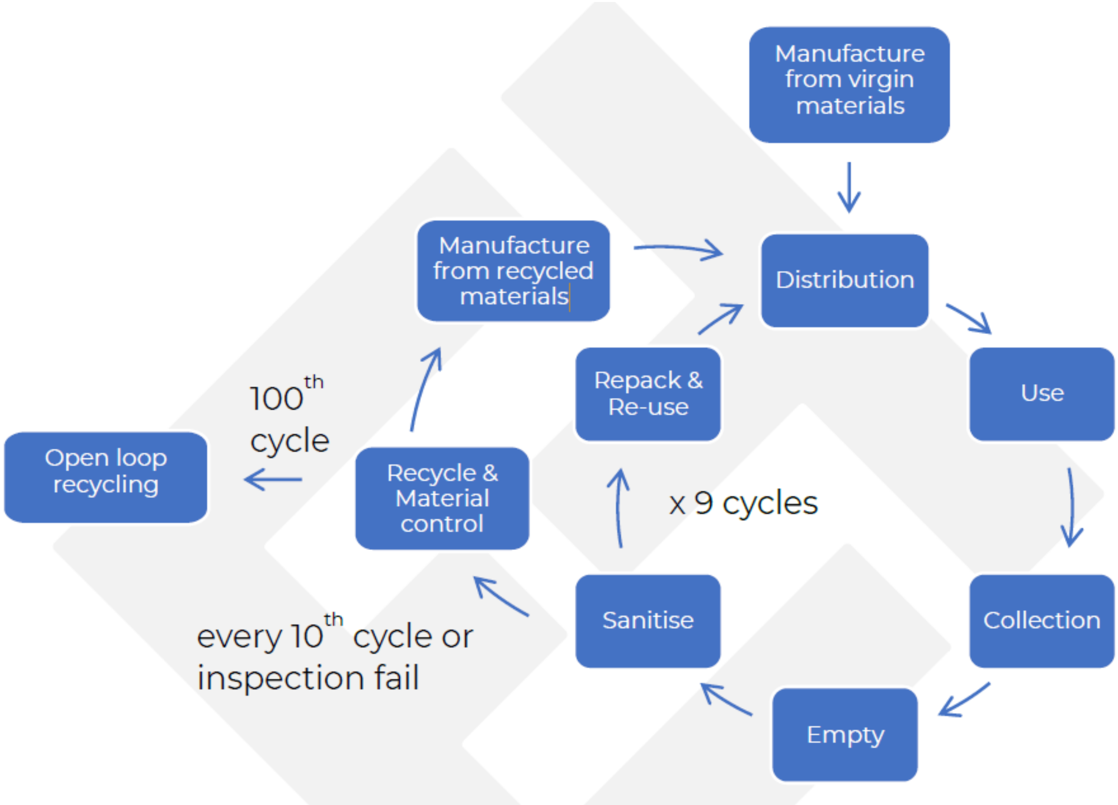


**Figure 2.** Life cycle of Sharpak Zero sharps bin

Table 1 shows the comparison of carbon emissions for the three types of sharps bins with total emissions from the single use bin calculated to be 1.65, 16.53, 165.29 kg $CO_2e$ for 1, 10 and 100 bins, emissions from the single use bin with 43% recycled content calculated at 1.39, 13.91 and 139.12 for 1, 10 and 100 bins and total emissions from the usable bin calculated to be 1.69, 3.14 and 17.77 kg $CO_2e$ for 1, 10 and 100 uses of the bin.

**Table 1.** Emissions data from the life cycle for the three sharps bins.

| | Item: | Sharpak 60 | | | Sharpak 60 (43% Recycled) | | | Sharpak Zero 60 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of Uses/Bins:** | **1** | **10** | **100** | **1** | **10** | **100** | **1** | **10** | **100** |
| **Cradle to Gate** | **Embodied Carbon** | 1.25 | 12.530 | 125.30 | 1.12 | 11.16 | 111.61 | 1.25 | 1.60 | 5.04 |
| | **Upstream Transport** | 0.31 | 3.048 | 30.48 | 0.18 | 1.82 | 18.24 | 0.31 | 0.32 | 0.42 |
| | **Production** | 0.01 | 0.094 | 0.94 | 0.01 | 0.10 | 0.95 | 0.01 | 0.01 | 0.09 |
| **Use** | **Distribution** | 0.03 | 0.303 | 3.03 | 0.03 | 0.31 | 3.06 | 0.03 | 0.30 | 3.03 |
| | **Waste Packaging** | 0.04 | 0.396 | 3.96 | 0.04 | 0.40 | 3.96 | 0.04 | 0.40 | 3.96 |
| **Maintenance** | **Collection Transport** | 0.01 | 0.075 | 0.75 | 0.01 | 0.08 | 0.76 | 0.04 | 0.36 | 3.63 |
| | **Emptying Process** | | | | | | | 0.011 | 0.11 | 1.10 |
| | **Sanitisation** | | | | | | | 0.001 | 0.01 | 0.11 |
| | **Material Control & Recycling** | | | | | | | | 0.03 | 0.37 |
| **EoL** | **Open-loop recycling** | | | | | | | 0.01 | 0.01 | 0.01 |
| | **Incineration** | 0.01 | 0.08 | 0.84 | 0.01 | 0.08 | 0.85 | | | |
| | **Total Emissions (kg $CO_2e$)** | **1.65** | **16.53** | **165.29** | **1.39** | **13.91** | **139.12** | **1.69** | **3.14** | **17.77** |
| | **Carbon Saving (kg $CO_2e$)** | | | | 0.26 | 2.62 | 26.17 | | 13.39 | 147.52 |
| | **Carbon Saving (%)** | | | | 15.83 | 15.83 | 15.83 | | 80.98 | 89.25 |

Here the carbon saving of (i) adding recycled content to the single use bin and (ii) reuse and recycling of the bin in comparison to the single use bin made from 100% virgin materials is evaluated. It is found that the addition of 43% recycled content reduces carbon emissions of the single use bin by 15.83% (0.26, 2.62 and 26.17 kg $CO_2e$ for 1, 10 and 100 bins). For the reusable bin (Sharpak Zero 60) if used only once, returned and recycled, there is no carbon benefit, however when used 10 times a carbon saving of 13.39 kg $CO_2e$ or 80.98% increasing to 89.25 % or 147.52 kg $CO_2e$ for 100 uses.

For 1, 10 and 100 bins the largest portion of the carbon emissions from the single use sharps bins are from embodied carbon emissions of the materials at 75.80% (1.253, 12.530 and 125.30 kg $CO_2e$) for the Sharpak 60 bin and 80.22% (1.20, 12.00 and 120.01 kg $CO_2e$) for the Sharpak 60 (43% recycled). Upstream transport of materials is reduced in the 43% recycled content bin from 18.44% (0.31, 3.048 and 30.48, kg $CO_2e$ for 1, 10 and 100 uses) to 13.11% (0.18, 1.82 and 18.24 kg $CO_2e$ for 1, 10 and 100 uses), Figure 3.

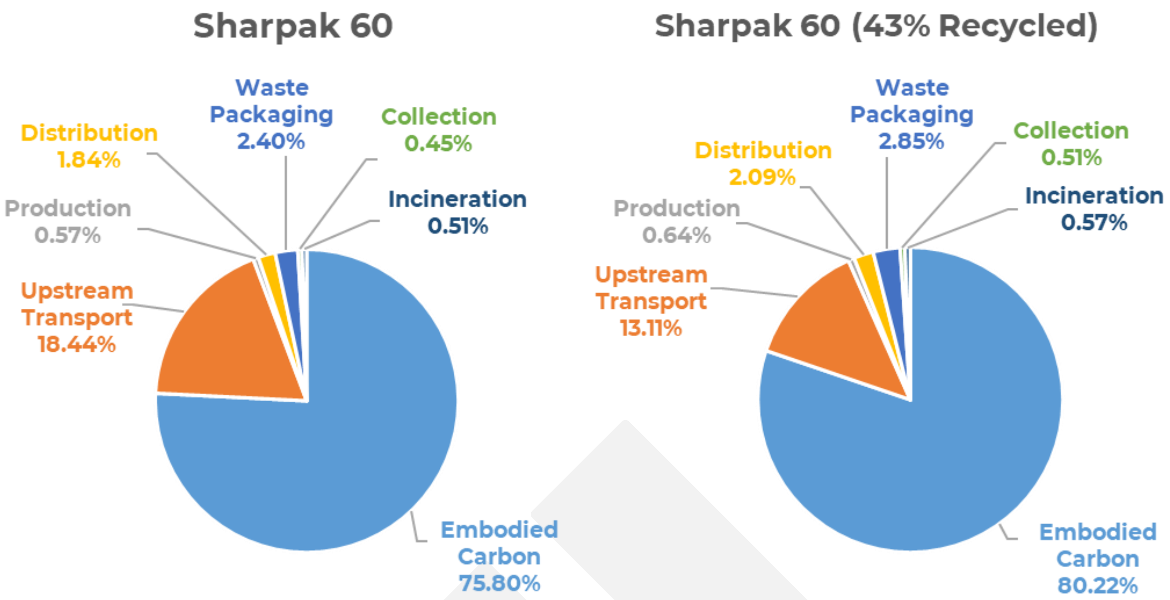


**Figure 3.** GHG emissions from each life cycle stage of one (left) Sharpak 60 and (right) Sharpak 60 (43% recycled).

During the lifecycle of one Sharpak Zero product, where it is produced from virgin materials, distributed to the customer and returned to impress for cleaning and recycling, the majority of the carbon emissions, 73.97% or 1.253 kg $CO_2$e, still arise from the embodied carbon emissions of the materials as shown in Figure 4.

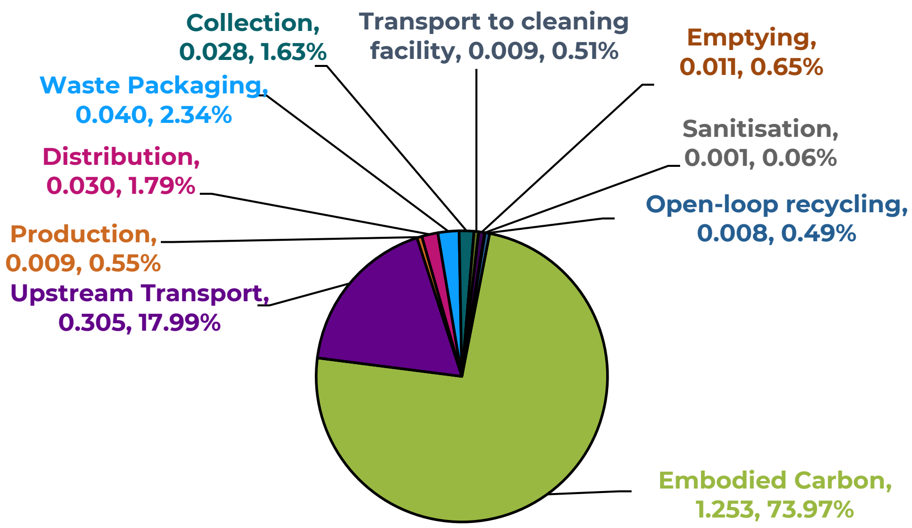


**Figure 4.** GHG emissions from each life cycle stage of the Sharpak Zero 60 when used only once and then recycled.

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However, when evaluating a Sharpak Zero 60 used for 100 cycles, the embodied carbon emissions from materials, although still the majority of emissions, are dramatically reduced to 28.36% (5.039 kg $CO_2e$) in comparison to 73.97% in the single use case, Figure 5. It is also noted that upon reuse of the sharps bin, factors such as the waste from packaging and collection transport become a larger portion of the carbon emissions and therefore efforts to reduce emissions further could target these stages of the life cycle.

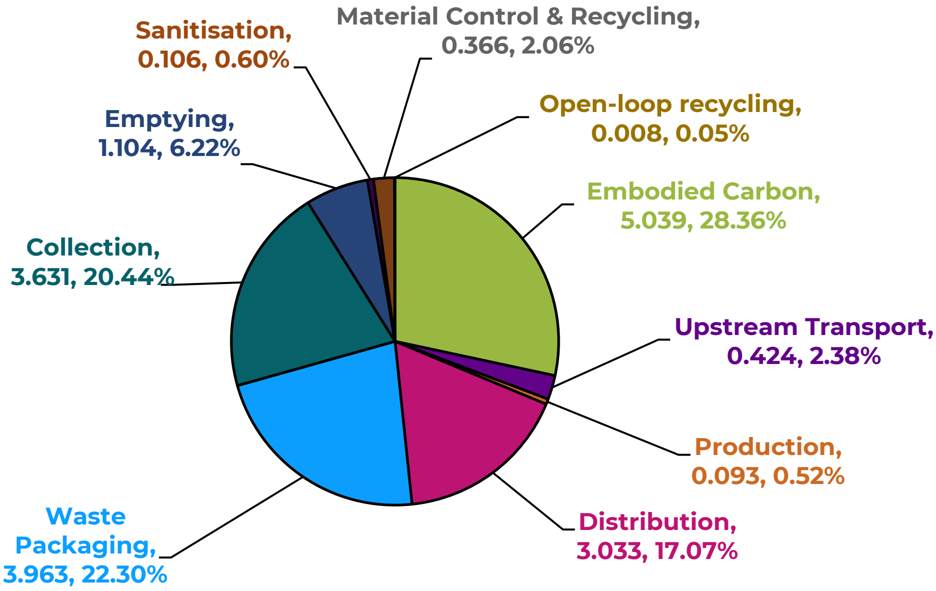


**Figure 5.** GHG emissions from each life cycle stage of the Sharpak Zero 60 when used 100 times and then recycled.

This case study has shown that by collecting, emptying, sanitising, reusing, and recycling a sharps bin to give 100 uses a total carbon saving of 147.52 kg $CO_2e$ or 89.25% can be made when compared to 100 life cycles of a single use sharps bin.

This case study demonstrates that by collecting, emptying, sanitising, reusing, and recycling a sharps bin for 100 uses (Sharpak Zero), a total carbon saving of 147.52 kg $CO_2e$ (equivalent to an 89.25% reduction) can be achieved when compared to 100 life cycles of a single-use sharps bin made with 43% recycled content. When compared to 100 life cycles of a single-use sharps bin made entirely from recycled materials, the saving remains substantial at 84.78%, equivalent to 98.95 kg $CO_2e$ saved.

## Recycled Content Sharpak 60 (0-100%)

Figure 6 and Table 2 illustrate the GHG emissions associated between a hypothetical Sharpak model with varying levels of recycled content (0–100%, Sharpak Recycled) compared to Sharpak Zero. This analysis is performed over various use scenarios, 1 use, 10 uses and 100 uses.

Emissions are compared for Sharpak 60 Recycled containers with varying recycled content and for Sharpak Zero 60 across 1, 10, and 100 uses. The results show that increasing the percentage of recycled content in Sharpak 60 Recycled steadily lowers carbon emissions, with the lowest emissions occurring at 100% recycled content. However, even at this level, Sharpak 60 Recycled (110.2 kg $CO_2$e over 100 uses) has notably higher emissions than Sharpak Zero 60, which records just 17.8 kg $CO_2$e over the same number of uses. Sharpak Zero also shows a slower rate of emissions growth across multiple uses, suggesting greater efficiency in repeat-use scenarios.

Overall, while increasing recycled content reduces emissions in Sharpak 60 Recycled, the combination of reusability and lower per-use emissions makes Sharpak Zero the more environmentally efficient option over time.

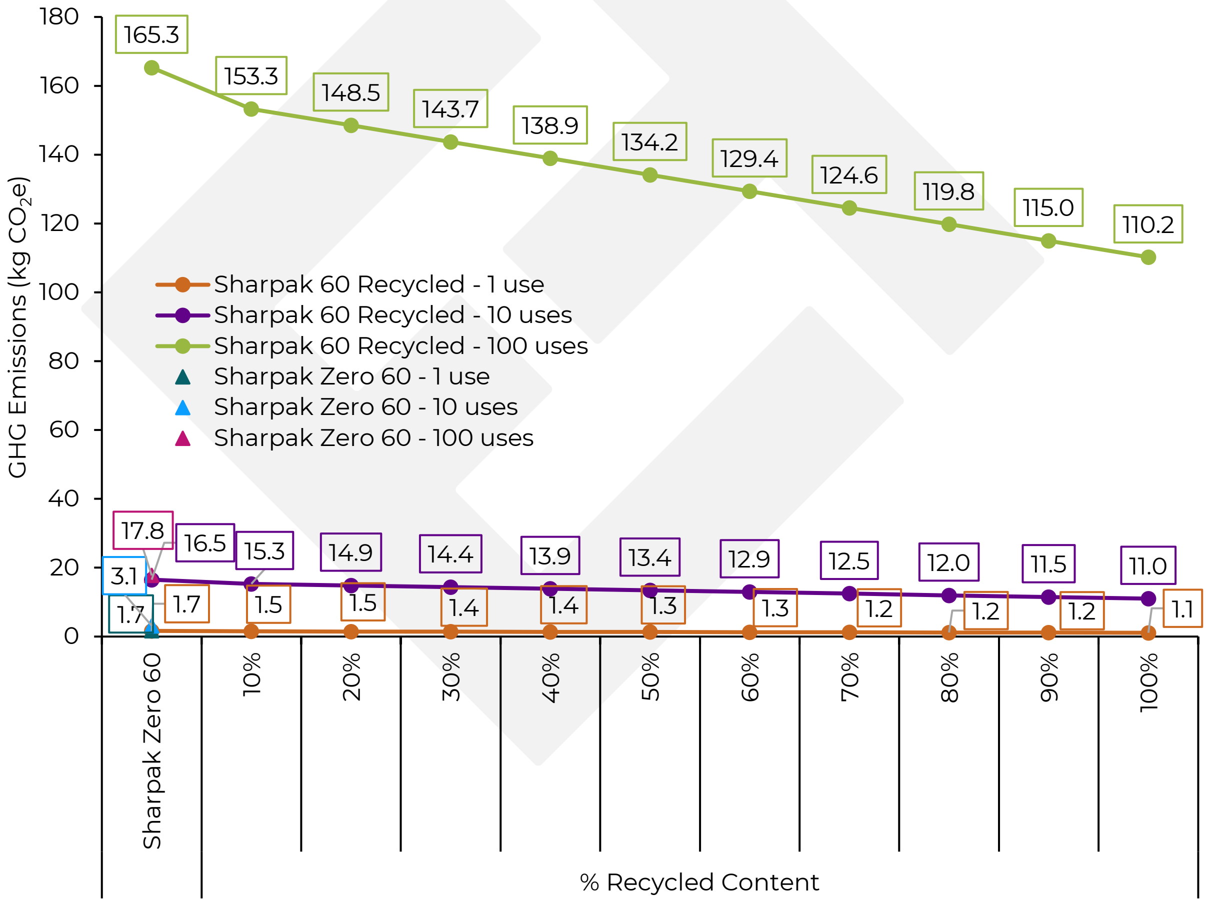


**Figure 6.** GHG emissions for single-use and reusable Sharpak bins across varying percentages of recycled plastic content



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**Table 2.** Emissions data from the varying recycled content and uses of the hypothetical Sharpak 60 Recycled compared to Sharpak Zero.

| | | Sharpak 60 Recycled (Cradle-to-Grave, kg $CO_2e$) | | |
|---|---|---|---|---|
| | | Sharpak 60 Recycled - 1 use | Sharpak 60 Recycled - 10 uses | Sharpak 60 Recycled - 100 uses |
| % Recycled Content | 0% | 1.65 | 16.5 | 165.3 |
| | 10% | 1.53 | 15.3 | 153.3 |
| | 20% | 1.49 | 14.9 | 148.5 |
| | 30% | 1.44 | 14.4 | 143.7 |
| | 40% | 1.39 | 13.9 | 138.9 |
| | 50% | 1.34 | 13.4 | 134.2 |
| | 60% | 1.29 | 12.9 | 129.4 |
| | 70% | 1.25 | 12.5 | 124.6 |
| | 80% | 1.20 | 12.0 | 119.8 |
| | 90% | 1.15 | 11.5 | 115.0 |
| | 100% | 1.10 | 11.0 | 110.2 |
| | **Item** | **Sharpak Zero 60 - 1 use** | **Sharpak Zero 60 - 10 uses** | **Sharpak Zero 60 - 100 uses** |
| **Sharpak Zero 60 (Cradle-to-Grave, kg $CO_2e$)** | | 1.69 | 3.14 | 17.77 |

## Carbon Emissions from the Sharpak Zero Range

Inpress precision have created a full range of reusable sharps bins which vary in size from 3.5L (Sharpak Zero 35) up to 22L (Sharpak Zero 220). The carbon emissions of the 4 sizes (Sharpak Zero 35, Sharpak Zero60, Sharpak Zero 120 and Sharpak Zero 220) were calculated and are shown in Figure 7 for 1, 10 and 100 uses.

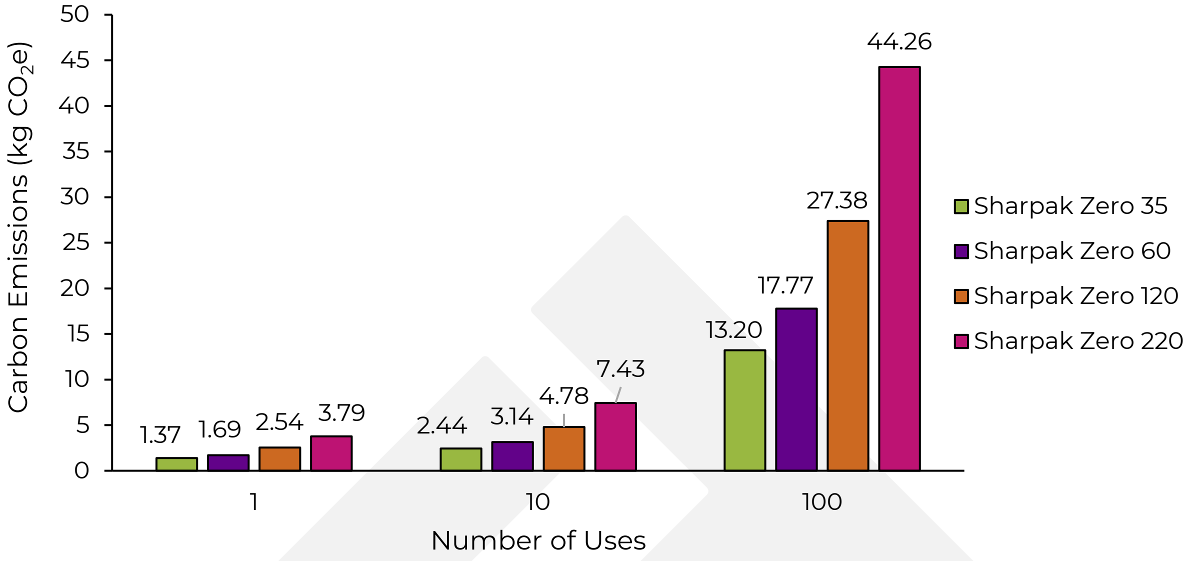


**Figure 7.** GHG emissions of the range of Sharpak Zero products

Due to the difference in size and weight of the products the larger products have greater carbon emissions, however when the total volume of waste which the sharps bin is able to hold is taken into account, the carbon footprint of each of the bins is similar. The carbon emission per litre volume of the bin is shown in Figure 8. This shows that it is more carbon efficient to use a larger bin, for example the Sharpak Zero 120 or 220, as these bins provide a lower kg $CO_2$e per litre (2.28 and 2.01 kg $CO_2$e for 100 uses) in comparison to the Sharpak Zero 35 (3.77 kg $CO_2$e for 100 uses).

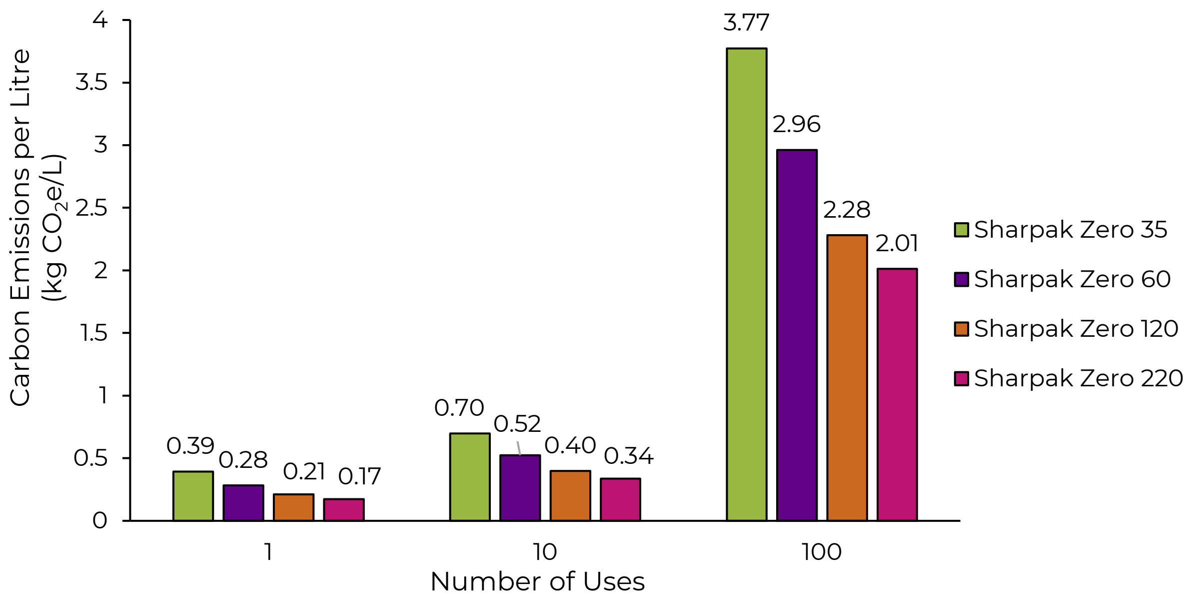


**Figure 8.** Carbon emissions per litre volume of the Sharpak Zero range

The carbon emissions per litre volume per use of the sharps bin also reflect that the larger the bin (Figure 9), the more carbon efficient it is. For example, a Sharpak Zero 35 used 10 times has an emission 0.07 kg $CO_2$e per litre per use, whereas the Sharpak Zero 220 has only 0.04 kg $CO_2$e per litre per use. This is reduced to only 0.02 kg $CO_2$e per litre per use upon reuse 100 times of both the Sharpak Zero 120 and Sharpak Zero 220.

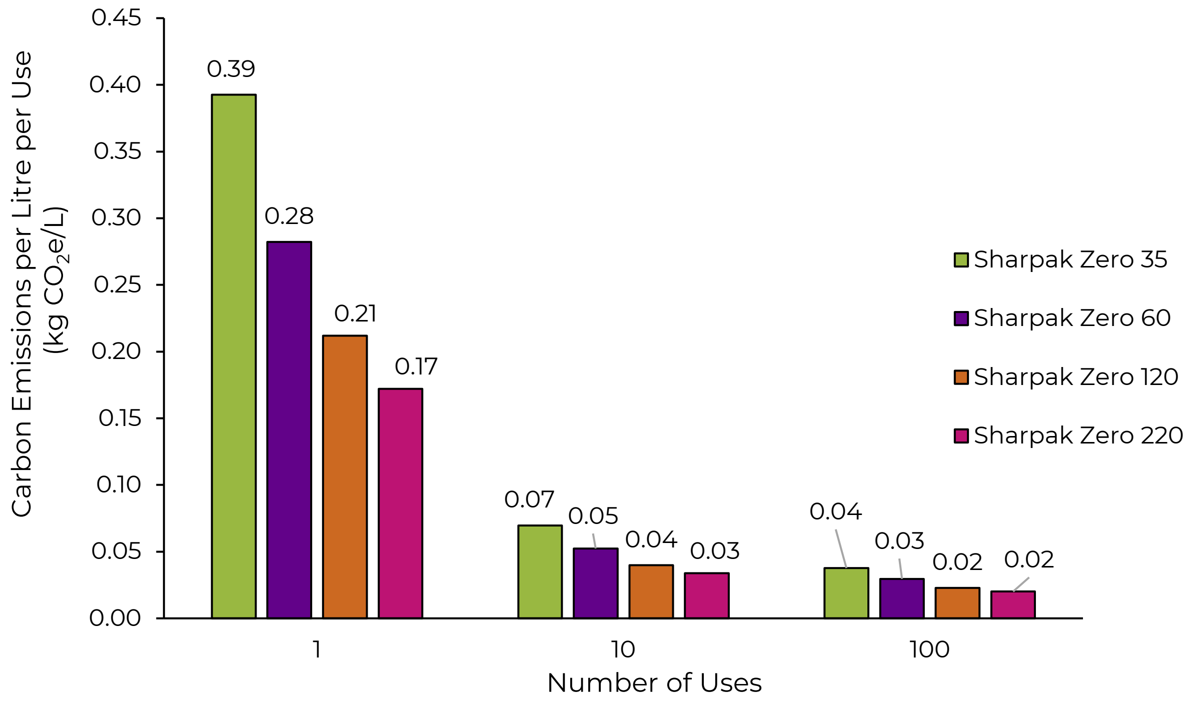


**Figure 9.** Carbon emissions per litre volume, per use of the Sharpak Zero range

## Conclusion

Total GHG emissions for three scenarios ((i) 100 single use sharps bins, (ii) 100 single use sharps bins with 43% recycled content and (iii) a reusable sharps bin used 100 times were calculated to be 165.29, 139.12 and 17.77 kg $CO_2$e, respectively. When comparing the Sharpak Zero range it was also found that it was more carbon efficient to reuse a larger sharps bin, as the kg $CO_2$e produced per litre was reduced from 3.77 to 2.01 kg $CO_2$e. The carbon footprint quantification presented in this report was conducted using data provided to Tunley Environmental by Inpress Precision.

Tunley Environmental has provided Inpress Precision with detailed analysis and discussion of the emission data. By returning and reusing their products, Inpress Precision's customers can save 89.25% of carbon emissions, when the reusable product is allowed to complete a full life cycle of 100 uses.



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# LCA Methodology

The lifecycle analysis for the use-phase life cycle assessment of Inpress Precision's Sharpak products was completed using methodology consistent with the international standard BS EN ISO 14067:2018 in a manner consistent with the International Standards on Life Cycle Analysis (LCA) (ISO 14040 and ISO 14044). Herein, we provide the mandatory methodology for all data, scope, goals, function, functional units, cut-offs, exemptions, *etc.* as per minimum requirements of the aforementioned standards.

## Activity and Emissions Data

To assess the carbon footprint of the products, two types of data are utilized: activity data and emission data. Specific activity data (primary data) was gathered by Inpress Precision where feasible. Where specific data was not available, reasonable assumptions were made using relevant databases and expertise. Description of primary data supplied by Inpress Precision to Tunley is provided in full in Table A1.

**Table A1.** Inpress Precision data provided for lifecycle analysis.

| Data | Description | Units |
|---|---|---|
| Weight of the Raw Materials | The weight and material composition of the trays was provided by Inpress Precision | kg |
| Electricity, Gas and Water Use | Details on the utility use was provided by Inpress Precision | kWh, L |
| Packaging Materials | Details on the packaging materials was provided by Inpress Precision | kg |
| Waste Material | Details on the waste material during manufacture was provided by Inpress Precision | kg |
| Location of raw materials and transport to/from of products | Details on the location where raw materials and products were sourced and dispatched was provided by Inpress Precision. Tunley Environmental used the text field to calculate the distances using Google Maps | t.km |
| Description of end-of-life process | Details on the process the product will undergo at the end-of-life were provided by Inpress Precision | kg |

## Impact Assessment

The results of the carbon footprint calculations reveal the potential impact of each emitted greenhouse gas on climate change. This impact is expressed using the IPCC Global Warming Potential indicator, which utilizes a 100-year time frame and presents the impact in kg $CO_2$e per functional unit: use of the product, scaled to 1, 10 and 100 uses.

## Scope, Function, and Functional Unit

This was a lifecycle assessment aiming to cover all material sources of emissions during the lifecycle. Materiality in this context is defined as anything contributing more than an estimated 1% of total emissions. A full outline of all lifecycle modules, their description, and the materiality of them in this assessment is provided in Table A2.

The primary function of the Product is as a sharps bin, for the safe disposal of hazardous medical waste.

The reference flow of this assessment is kilogram of product, which was scaled to each use.

**Table A2.** Materiality assessment and notation for quantified LCA categories.

| LCA Category | Data Category Description | Materiality |
|---|---|---|
| A1 Raw Materials | Embodied carbon of the raw materials, chemicals, and components used. | Material – quantified. |
| A2 Transport | Emissions from the upstream transportation of the components and raw materials to the manufacturing facility. | Material – quantified. |
| A3 Manufacturing | Emissions from the manufacturing processes used in production of the product. | Material – quantified. |
| A4 Transport to site | Emissions from transportation of the final product to the consumer. | Material – quantified. |
| A5 Installation | Installation processes and related emissions caused through installation. | Non-Material – Outside of scope. |
| B1 Use/Application | This is in relation to usage-based emissions not categorized as water or energy. Such as combustion. | Non-Material – Outside of scope. |
| B2 Maintenance | Regular expected maintenance of the equipment over the lifetime including all components, travel, electricity, *etc.* | Material – quantified. |
| B3 Repair | Emissions related to the repair of any broken-down equipment. Is it the parts, travel, service time, *etc.* | Material – Outside of scope |
| B4 Replacement | Emissions associated with any wholly replaced items. | Material – quantified. |
| B5 Refurbishment | Emissions associated with the refurbishment of end-of-life items to extend expected lifetime. | Material – Outside of scope |
| B6 Operational Energy Use | Emissions associated with energy usage of the item/equipment over its lifetime. | Non-Material – Outside of scope. |
| B7 Operational Water Use | Emissions associated with water usage of the item/equipment over its lifetime. | Non-Material – Outside of scope. |

| LCA Category | Data Category Description | Materiality |
| --- | --- | --- |
| C1 Deconstruction | Emissions associated with any deconstruction processes. | Non-Material – Outside of scope. |
| C2 Transport | Emissions associated with the transportation of the item/equipment at end-of-life. | Material – quantified. |
| C3 Waste Processing | Emissions associated with recycling processes for materials at end-of-life. | Material – quantified. |
| C4 Disposal | Emissions associated with non-recycling disposal scenarios for materials at end-of-life. | Material – quantified. |
| D Benefits and loads | Any notable reductions or offsets through the products operation *e.g.* biogenic sequestration or energy generation. | N/A |

## System Boundary & Allocation Procedure

The system boundaries encompass all unit processes that contribute measurably to the objective of the study. In this study, except where otherwise noted, all relevant, required, and known materials and processes were included in the life cycle inventory.

## Completeness Check

Overall, the carbon footprints are deemed to be calculated with sufficient representativeness and accuracy concerning both system boundaries and data completeness, in alignment with the goal and scope of the assessment. The data used for calculating the carbon footprint comprises either Inpress Precision-specific primary data or generic data from databases that meet the set requirements for data quality, thus ensuring representativeness for the studied system.

## Limitations

The methodology employed encompasses only one impact category, Climate Change, which assigns a single score to the product's impact. However, this approach overlooks other environmental aspects, leading to a restricted perspective. Moreover, it only considers the operational energy use of the device, however, this is representative of the study.

## Goals and Objectives

This report details the results of a carbon footprint assessment carried out by Tunley Environmental for Inpress Precision. A cradle-to-grave (A1 – C4) carbon footprint, evaluating the impact of the Inpress Precision Sharpaks's greenhouse gas (GHG) emissions their whole lifecycle. The assessment was modelled to assess the impact category of climate change. A one-peer critical review of this assessment was carried out internally by impartial experts at Tunley Environmental to ensure conformance to ISO 14067:2018.

The goal of the assessment included two primary objectives:

1. To assess the cradle-to-grave carbon footprint, for the Inpress Precision's products.
2. Present findings in a clear and actionable manner to inform decision-making.

The intended application of this assessment is the calculation of the whole life carbon footprint for the Inpress Precision products using a 100-year time horizon and IPCC 2021 metrics.

The reasons for conducting this assessment are:

- To gain an understanding of the GHG footprint of the products
- Internal communication by Inpress Precision.
- Communication with Inpress Precision relevant stakeholders within a limited remit.

The intended audience of this assessment is internal communication within Inpress Precision and limited communication with suitable external stakeholders.

The carbon footprint is calculated using 100-year Global Warming Potentials (GWPs) as stated in the IPCC Sixth Assessment Report, 2021 (AR6) and are reported in kg $CO_2e$ in line with the single impact category, as required by ISO 14067:2018.

# Appendix A – Data Sources and Assumptions

**Table A1.** Data sources and assumptions. Refer to Appendix B for information on the accuracy scoring system.

| Item | Assumptions and comments | Overall score |
|---|---|---|
| Embodied Carbon | Materials and weight data provided by Inpress, emission factors obtained from DEFRA 2023. | 2 |
| Upstream Transport | Initial and final destinations of materials provided by Inpress, emission factors obtained from DEFRA 2023. | 2 |
| Production | Electricity usage and waste production data provided by Inpress emission factors obtained from DEFRA 2023 and IPCC data on renewable energy sources. | 1 |
| Distribution | Distance to customer provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |
| Waste Packaging | Packaging weight data provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |
| Collection Transport | Estimated distance of travel from customer to incineration waste site, distance data provided by Inpress to recycling site, emission factors obtained from DEFRA 2023. | 2 |
| Emptying Process | Electricity usage data provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |
| Sanitisation | Water and detergent usage data provided by Inpress, emission factors obtained from DEFRA 2023 and EcoInvent v2.2. | 2 |
| Material Control & Recycling | Weight provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |
| Open-loop recycling | Weight provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |
| Incineration | Weight provided by Inpress, emission factors obtained from DEFRA 2023. | 1 |

# Appendix B – Accuracy Rating System

All the raw data provided to Tunley Engineering were broken down into accuracy levels reflective of the data sources provided (Table B1). This allows for inaccuracy and uncertainty to be accounted for in this assessment. Both activity data (*e.g.*, quantities of material, usage of electricity, *etc*) and emission factors are scored using the same band-based system, with 1-6 corresponding to the highest & lowest levels of accuracy, respectively.

Emission factors are to be evaluated using the following five indicators:

a) Technological relevance.
b) Temporal coverage.
c) Geographical coverage.
d) Completeness.
e) Reliability (e.g., peer-reviewed source, reproducible, low uncertainty in the information provided).

**Table B1.** Accuracy bands assigned to data, description of data assignments.

| Accuracy Score | Description |
|---|---|
| 1 | Activity data accurately measured, fully accounted for and/or reported. Emission factor satisfies all five indicators. |
| 2 | Activity data provided directly by company/organisation; some generalisations made. Emission factor satisfies four indicators. |
| 3 | Activity data produced based on information provided by company/organisation. Emission factor satisfies three indicators. |
| 4 | Activity data assumption based on similar product/event reports by the same company/organisation. Emission factor satisfies two indicators. |
| 5 | Activity data assumption based on product/event reports by a similar company/organisation. Emission factor satisfies one indicator. |
| 6 | Activity data assumption made based only on publicly available information. Emission factor is estimated using the data available for a broader data category to which the emission source belongs, the estimated emission factor does not meet the indicators' requirements. |

**Figure B1.** Overall error score matrix for accuracy assessment.

| Error score | | | EMISSON FACTOR | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Band 1 | Band 2 | Band 3 | Band 4 | Band 5 | Band 6 |
| | | | Excellent | Very good | Good | Relevant | Acceptable | Poor |
| ACTIVITY DATA | Band 1 | Excellent | 1 | 2 | 3 | 4 | 5 | 6 |
| | Band 2 | Very good | 2 | 4 | 6 | 8 | 10 | 12 |
| | Band 3 | Good | 3 | 6 | 9 | 12 | 15 | 18 |
| | Band 4 | Relevant | 4 | 8 | 12 | 16 | 20 | 24 |
| | Band 5 | Acceptable | 5 | 10 | 15 | 20 | 25 | 30 |
| | Band 6 | Poor | 6 | 12 | 18 | 24 | 30 | 36 |

**Figure B2.** Actions to improve data quality and reduce uncertainty.

| Error score | Action |
|---|---|
| 1 and 2 | Use the data, **no further action** required. |
| 3 and 4 | Can use the data, **recommended to improve** data quality by e.g., i) checking raw data with client (assessing recollection need) and ii) sourcing different emission factors or averaging several data points, required to declare this in the report. |
| Between 5 and 10 | **Only use** the data **when** no further improvements can be made. |
| Between 12 and 25 | **Required to improve data quality** (see above). |
| 30 and 36 | **Do not use the data**, discuss with the client and the carbon team to improve data quality and/or to assess whether the data can be used and the approach to report this. |

## Approval

| | |
|---|---|
| Author: | Lara Dresser |
| Position: | Carbon Reduction Scientist |
| Written Date: | 16th August 2023 |
| Peer-reviewed by: | Dr Gareth Davies, PhD MChem |
| Position: | Carbon Reduction Scientist |
| Reviewed Date: | 21st August 2023 |
| QA approved by: | ☒ Approved ☐ Revision: N/A<br>Dr Gareth Davies, PhD MChem |
| Position: | Senior Scientist |
| Approval date: | 05th June 2025 |
| Reference: | InpressPrecision-LCA_25-2 |
| Revision: | D |

| Revision History: | Change Description: | Changed by: | Date: | Approved by: | Date: |
|---|---|---|---|---|---|
| B | Recycled content changed from 30% to 43% | LD | 5th September 2023 | GD | 5th September 2023 |
| C | Figure 6 altered | LD | 22nd September 2023 | GD | 22nd September 2023 |
| D | Recycled content added | NW, AHK | 4th June 2025 | LH | 5th June 2025 |
| E | | | | | |
| F | | | | | |

## Tunley Environmental Report Emission Statement

Tunley Environmental GHG emissions from completing this assessment were 0.97 kg $CO_2e$.

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