World Business Council for Sustainable Development

The SPHERE framework: An implementation guide

Content

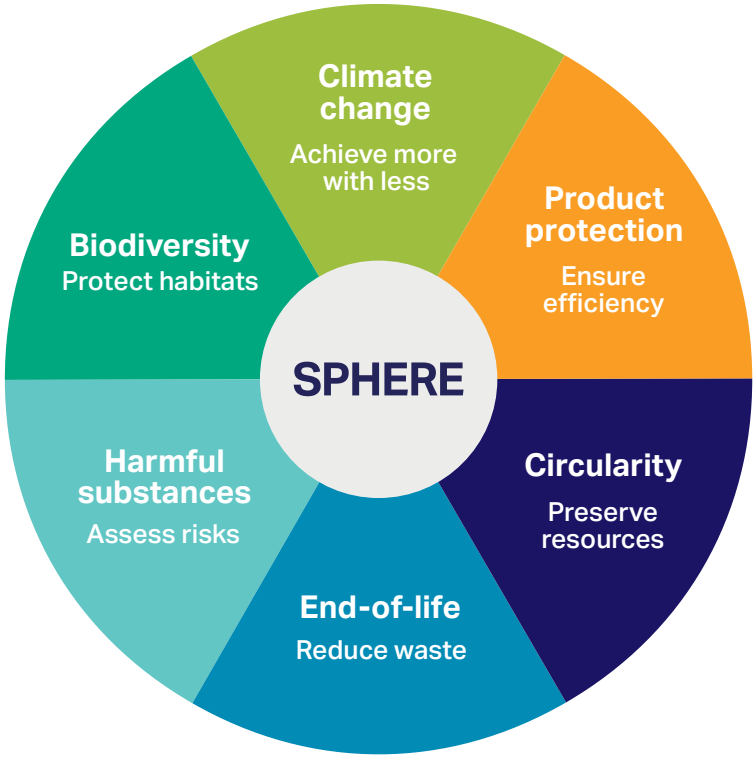
Acronyms and abbreviations

CCF	content carbon footprint
CFF	circular footprint formula
CGF	Consumer Goods Forum
CI	circularity indicator
CoA	certificate of analysis
CoC	chemicals of concern
CTI	Circular Transition Indicators
EMF	Ellen MacArthur Foundation
EPR	extended producer responsibility
FCOC	food chemicals of concern
FU	functional unit
GHG	greenhouse gas
GWP	global warming potential
HDPE	high-density polyethylene
IBC	Intermediate bulk container
ISO	International Organization for Standardization
JRC	Joint Research Centre
LANCA	Land-Use Indicator Value Calculation in Life-Cycle Assessment
LCA	life-cycle assessment
LDPE	low-density polyethylene
MCI	Material Circularity Indicator
MGA	Maturity Grid Assessment
MPW	mismanaged plastic waste
MWI	Mismanaged Waste Index
OPE	oriented polyethylene
OPP	oriented polypropylene
PCF	packaging carbon footprint
PCR	post-consumer resin or post-consumer recycled content
PE	polyethylene
PEF	product environmental footprint
PET	polyethylene terephthalate
PLP	Plastic Leak Project
PP	polypropylene
PS	polystyrene
SBT(s)	science-based target(s)
SPHERE	Sustainability in Packaging Holistic Evaluation for Decision-Making
UP	Understanding Packaging (name of initiative)
WBCSD	World Business Council for Sustainable Development

About the guide

The purpose of this guide is to assist packaging design teams and sustainability teams in applying the SPHERE framework.

SPHERE supports companies in improving their packaging portfolio according to their sustainability strategy and offers a unique way to balance the trade-offs between different environmental impacts. The framework builds on six principles for the environmental assessment of packaging, reconciling circularity and sustainability metrics for the first time: ensuring packaging efficiency, reducing climate change impacts and biodiversity loss, increasing circularity and proper end-of-life management, and avoiding harmful substances.



This guide presents an overview of the SPHERE Framework principles. For an in-depth explanation behind each principle, you can refer to WBCSD's SPHERE Framework report.

What the SPHERE Framework helps you do

Depending on the priorities of your company's sustainability strategy, you can select different packaging solutions. SPHERE can show you how different packaging options score across six environmental impacts and considerations and quantify them so that a trade-off analysis can be performed, better informing your decision-making process. For example, paper-based packaging might be the best option when it comes to recyclability compared to a flexible plastic pouch, but its impact in terms of carbon emissions and land use might be significantly higher. You may favor one or the other depending on whether your priority is to reduce carbon emissions, increasing circularity, or halt biodiversity loss, as well as considering the waste management infrastructures and potential leakage of packaging materials of the market you operate in.

SPHERE can also help you understand how making changes to a relatively sustainable item of packaging that accounts for 50% of sales in one country can have a much larger impact than improving a piece of unsustainable packaging that only accounts for 1% of sales in the same region.

What is outside the scope of SPHERE

The **SPHERE** framework is not designed for external reporting on sustainability performance. Should you wish to communicate the results externally, we advise you to add an extra layer of control for data integrity, as it is increasingly important to ensure data provenance and trustworthiness along the supply chain.

The current version of the framework is not suited to comparing environmental and social impacts. Lastly, this guide is not a tool. It requires some active data management from you, with the benefit of integrating your own company's complexities in the calculations.

How to navigate this implementation guide

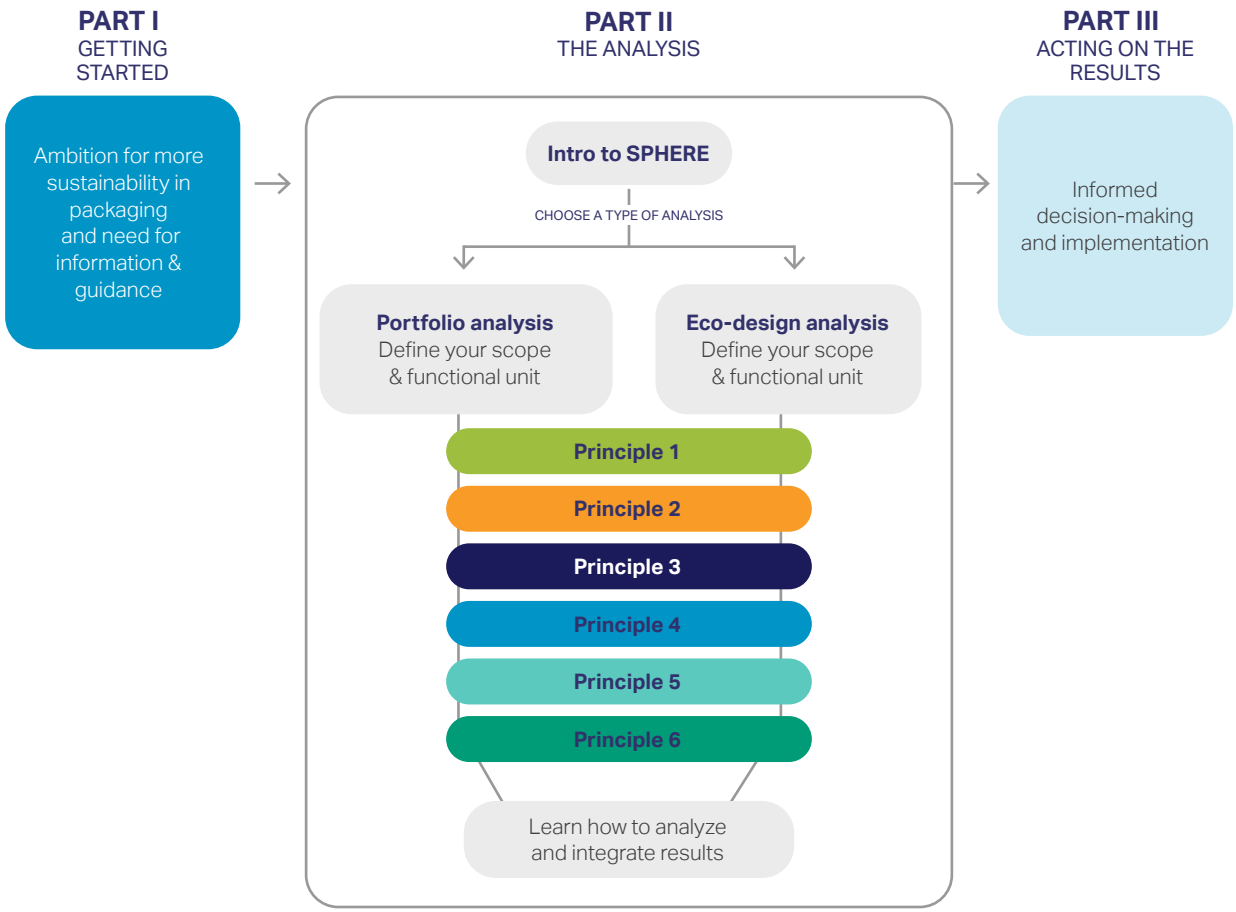
You will start by setting the basis of the analysis in the "Getting started" section in part I.

In part II, you can choose to follow all principles and perform a comparative analysis across the six environmental impacts and considerations associated with packaging or just read and apply the concepts most aligned with your company's current sustainability goals and objectives. As all principles are independent from one another, you do not need to read this manual consecutively.

Part III supports you in analyzing the data and provides recommendations for decision-making.

Throughout the guide, you will be able to follow a case study based on a fictional company named **Sphereal**, concretely illustrating how to apply the SPHERE Framework.

Figure 1: Visual summary of the process



In addition to this written guide, we have developed an excel spreadsheet that will allow you to input data and perform an assessment of the six principles yourself. You can download it here.

PART I:
Getting started

PART I: Getting started

Packaging sustainability

The SPHERE framework defines packaging sustainability as having maximum circularity and minimum environmental footprint, while avoiding the presence of harmful substances and being efficient in protecting the product it contains. SPHERE's six principles put this into context.

Step 1: Choose your SPHERE principles

Select the SPHERE principles that you would like to have in scope. Your company's sustainability strategy or your customer's sustainability strategy or even legislation in a specific country can be a good guide in selecting specific principles.

Table 1: Overview of the 6 SPHERE principles

Principle	Description	Pages
1. Minimize the drivers of climate change	Climate impacts of packaging via energy consumption and associated greenhouse gas emissions	14
2. Optimize efficiency	Protecting the product via how the packaging avoids product damage, losses and waste generation	20
3. Optimize circularity	Reuse, recycled content and renewable content within the product packaging	26
4. Optimize end of life	Regional end-of-life management contexts	33
5. Avoid harmful substances	Human health and environmental impacts due to leakage, ingestion and bioaccumulation of hazardous substances	38
6. Minimize the drivers of biodiversity loss	Water and land used in creating the packaging	45

Step 2: Set the baseline: type of analysis, categories and functional units

Type of analysis

- If your objective is to compare packaging solutions for one product, perform an **eco-design analysis**.
- If your objective is to analyze the overall performance of a range of packaging solutions for a portfolio of products, perform a **portfolio analysis**.

You can apply both analyses iteratively, allowing you to first identify priority hotspots within your packaging portfolio and then compare alternative solutions to improve or replace the packaging with the one that addresses the most pressing issue.

Product category and functional unit

Define as concretely as possible the product category and functional unit you intend to analyze. For an **eco-design analysis**, set a single product category and functional unit to ensure a consistent comparison between all packaging options. For a **portfolio analysis**, choose all product categories and functional units that you will compare.

The most common categorization is food or non-food, followed by further specific categories. Figure 2 provides examples of product categories. It is beneficial to use category names from your own company so your colleagues can understand the boundaries you have set for the analyses.

The functional unit can be:

- The amount of product the packaging is designed to contain (by mass or by volume)
- The quantity (number of items) and reason for which the non-food item is protected.

Examples: packaging for "dry food" (category) "containing 275g of cereals" (functional unit), or packaging for "electronic item" "protecting a fragile 200x20x80 cm, 1.5 kg screen".

Your turn! Define the product categories and functional units for your analysis:

Product category: _____

Functional unit: _____

Figure 2: Example overview of products in the food- and non- food categories

Step 3: List packaging features and market share

Packaging features

Once the baseline is set, list all the functions and features that each item of packaging should meet. You should consider the entire packaging system (primary, secondary and tertiary packaging) required to deliver the functional unit.

Below are some elemental questions that can help you describe these features.

What level of packaging will you analyze? (Select all that apply)

*Primary *Secondary *Tertiary

List all packaging properties:

Mono-material	|	Multiple materials
Additives	|	No additives
Flexible	|	Rigid (or both)

What is the packaging's approximate size? _____

What is the packaging type?

*Bottle	*Box	*Tray
*Can	*Tube	*Other: _____

Select all the materials it is made of (for multi-layer or multi-material, select all that apply):

Plastic:	*PET	*PP	*LDPE	*HDPE	*PS
*Carton	*Paper	*Steel	*Aluminum	*Glass	*Other: _____

Is the packaging designed to be:

*Single use *Reusable

Is the packaging recyclable or compostable?

Y/N ___ If yes: _____%

What is the packaging collection rate? _____ %

Repeat the procedure for each packaging option you are analyzing.

Tip! Create individual packaging ID cards to ensure consistency and keep track of all relevant information.

Market share

What is the geographic market share of your current packaging?

This enables you to use country-specific data to estimate the actual scale of the impacts.

Table 2: Template for capturing the market share of current packaging

			List all sales regions here
Market share	**Region 1**	**Region 2**	**Region 3**
Option 1			
Option 2			
Option 3			
List all packaging options here			

Note: Express market share as number of unit sales per country or percentage.

Next steps

We now invite you to go through the chapters representing the SPHERE principles that you selected. To get the necessary insights for each principle, this guide will help you choose the appropriate methodologies, thresholds and secondary data sources. This user guide also offers support in data collection and structuring of primary data.

The last part helps you bring the results together. This will facilitate a full overview where you can make informed and balanced decisions on the most sustainable packaging for your product.

Depending on the analysis selected, you can refer to the respective data analysis and decision-making section: portfolio analysis page 51, eco-design analysis page 57.

Case study

We develop an example case study throughout this Implementation Guide to illustrate how to apply each section of the SPHERE framework. Please note that **Sphereal** is a fictional company.

Case definition

Sphereal is looking to improve the sustainability performance of its breakfast cereals. While the company is already working on making its cereal products as sustainable as possible, it wants to focus on reducing the environmental impacts of its packaging as well.

The packaging design team proposed four packaging alternatives for the 500-g box and now wishes to know which of these suggested alternatives has the least environmental impact and if any performs better than the current solution. Thus, the team will also evaluate the original packaging and use it as a reference.

Defining the scope and objectives

Analysis type: Since the objective is to compare different packaging solutions for one product, the team will perform an eco-design analysis.

Classifying the packaging products

Sphereal defined a single product category and functional unit to compare all packaging options consistently.

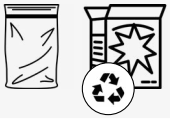
Product category: breakfast cereals

Functional unit: contain and protect 500 g of breakfast cereal.

Packaging features

Table 3 summarizes the most relevant features for each proposed packaging options:

Table 3: Overview of packaging options for the **Sphereal** case study

Option	Descriptive name	Packaging features
1	 Bag in a box (current)	PE bag in virgin carton box
2	 Bag in a box with maximum PCR content	PE bag in 100% post-consumer recycled carton box
3	 Stand-up pouch multi-material (cut to open)	Multi-material pouch made of virgin OPP and PE
4	 Stand-up pouch mono-material (smart open)	Mono-material OPE/PE pouch with easy-to-open seal

Option	Descriptive name	Packaging features
5	 Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch or glass jar

For this analysis, **Sphereal** assumed that tertiary packaging remains the same for any of the above solutions (wooden pallet used in transportation). Thus, the team kept it out of the equation as it affects all results equally.

Note: Changes in primary packaging solutions might influence secondary and tertiary packaging. If this is the case, include secondary and tertiary packaging features in the analysis for each packaging option.

Geographic market share

Sphereal sells this product in the USA, Poland, Egypt and Thailand. Table 4 shows the market share by country.

Table 4: Market share of **Sphereal** destination markets

Country	Market share
USA	33%
Poland	18%
Egypt	23%
Thailand	25%

Note: While this case study presents an eco-design analysis, you will use it to calculate different values (such as recycling rates) based on the market share weighted average. Each principle in this guide includes details and considerations.

PART II
The analysis

PART II
The analysis

Principle 1: Minimize the drivers of climate change

About the principle

Climate change impacts are often the most developed sustainability metrics in companies' sustainability programs. For that reason, it is a good first principle to evaluate in the SPHERE framework.

Climate impact methodologies also often cover other metrics that you can use as input for some of the five remaining SPHERE principles.

1. What are you measuring?

The global warming potential (GWP, over 100 years) of the packaging over its full life cycle is the recommended metric for Principle 1. This overview metric[1] is expressed in $kgCO_2eq$ per functional unit.

Alternatively, you can select one or more of the actionable metrics[2] below: cumulative energy demand for the packaging or share of renewable energy.

To ensure consistency, we advise you to calculate the same metric for packaging options.

Overview metric	Global warming potential
Actionable metrics	• Cumulative energy demand • Share of renewable energy

[1] An overview metric provides a high-level picture based on a collection of other metrics.

[2] An actionable metric is specific and helps measure components of the overview metric.

2. Methodologies to choose from

A life-cycle assessment (LCA) is the advised methodology for this principle. In the SPHERE framework, a screening LCA methodology is the minimum standard.

A screening LCA is a simplified approach that provides a fair estimate of the environmental impact of a product (or packaging) over its life cycle and identifies hotspots across the main life-cycle stages (production, transportation, use, end of life).

Nevertheless, we recommend you use a more granular LCA approach if you can, as it provides a more comprehensive understanding of the impacts of your packaging.

Table 5 provides an overview of methodologies and associated tools and guidelines you can use to evaluate principle 1 and includes additional principles covered by the methodology.

Table 5: Methodologies for principle 1

Methodology	Description	Metrics (overview/actionable)	Principles
Product environmental footprint (PEF)	Helps reduce the environmental impacts of goods, services and organizations taking into account supply chain activities	*Global warming potential* Cumulative energy demand Share of renewable Energy	1
SPICE	Focuses on packaging for cosmetics (primary, secondary and tertiary packaging)	*Global warming potential*	1, 3, s6
Product Sustainability Index	Stand-up pouch multi-material (cut to open)	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch or glass jar	1, 3
JRC Plastic LCA	Extensive LCA based method for plastics Includes recycling, material recovery and microplastic emissions	*Global warming potential* Cumulative energy demand	1, 2, 3, 5, 6
BBE / Bilan Environnemental des Emballages	Measures environmental impacts Tackles packaging waste through the development of eco-design initiatives	*Global warming potential* Cumulative energy demand Share of renewable energy	1, 3
Environmentally Extended Input-Output Analysis	Identifies economic drivers of any environmental impact Tracks how impacts "move" from sector to sector	*Global warming potential* Cumulative energy demand Share of renewable Energy	1, 3, 6
Oil Point Method	Evaluates environmental impacts focused on materials and production process (molding, extrusion, etc.)	Share of renewable energy	1, 3

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE principles and hence reduces efforts later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following when performing your LCA:

- Material composition
- Material weight
- Recycled content
- Upstream and downstream transportation means and distances
- Energy use

The more data collected from your own operations and from direct suppliers and users the better. These data points will help you be more accurate when calculating the emissions of your packaging case since you depend less on secondary sources.

When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

Tip! Define the scope and goal before performing any analysis (company, business unit, product, functional unit, system boundary and materials).

It may be necessary to collect data from up- and downstream partners and to collaborate with colleagues throughout your organization (e.g., LCA experts):

- **Upstream:** Be aware that some suppliers have already done a cradle-to-gate LCA and can thus give you the GWP in $kgCO_2eq$ for the product's life cycle until it leaves their facilities. If not, you need to collect emissions data according to the methodology and tool selected above.
- **Downstream:** Different use locations have different waste management systems in place, defining the emissions associated with use. An LCA accounts for different end-of-life scenarios, such as recycling, incineration, composting and landfill, and translates such fates into environmental impacts. For packaging options that include recycled materials or reuse schemes, you can use the circular footprint formula to allocate the associated burdens and benefits.

4. Databases

Emissions factors translate material choices, transportation distances, energy use and many other factors into the key global warming potential metric in $kgCO_2eq$. Below are some suggested trusted sources for secondary data for emissions factors in case they are not included in the tool you have selected to conduct the analysis.

Ecoinvent Database	Eora	Exiobase	Plastics Europe LCI Database

5. Making assumptions during the assessment

You should document any assumptions made based on secondary data sources and make them explicit. It is best practice to test the assumptions through sensitivity studies to understand how these affect the results. This supports the analysis of the five other SPHERE principles and helps in the interpretation of results.

Possible assumptions for an LCA:

- The analysis scope was cradle-to-grave;
- A bill of materials was available for all packaging solutions compared;
- Emissions from own operations are based on the company's primary data.

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. '0.5 kg CO_2eq per liter of product sold', referring to (for example):

- Science-based targets set for your company;
- A best-in-class reference that is known to your colleagues;
- Emissions factors requested by customers;
- Levels set by legislation;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

To assess and compare the impact different packaging options have on climate change, **Sphereal** starts by working on SPHERE Principle 1: Minimize the drivers of climate change. Its goal is to evaluate the CO_2eq footprint of all proposed solutions and favor those with the lowest value.

Table 6: Principle 1 information

Metric	Global warming potential **over 100 years** used to evaluate the packaging's associated emissions
Unit	Global warming potential measured in **kgCO_2eq** per functional unit
Methodology	**LCA** applied considering a cradle-to-cradle approach and the circular footprint formula (CFF) to account for reuse and recycling cases
Data sources	Secondary data retrieved using the **EF3.0 dataset from EcoInvent 3.8 Database** Plastic recycling rates taken from the **PLASTEAX** database
Collected data	Internal data collected for each packaging option: • Material type and weight • Recycled and renewable content per material type • Recyclability per material type • Number of use cycles • Packaging dimensions • Content count per packaging level (primary, secondary and tertiary)
Assumptions	Before starting the calculations, **Sphereal** made baseline assumptions to allow for accurate results and comparability: • Transport distance from supplier to retailer considered to be 700 km; • Average transport distance from retailer to client is a 5-km round trip, split up by car (62%), van (5%), walking or biking (33%), with an average carrying load of 20 kg of goods (taken from the PEF methodology update); • This eco-design analysis assumes that these distances and end-of-life fates apply equally for all the countries **Sphereal** operates in; • Recycling rates for plastics weighted based on market shares.
Thresholds	Packaging option 1 (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the reference product to set the GWP threshold for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 7: Principle 1 results

Principle 1: Minimize the drivers of climate change – results			
Option	**Descriptive name**	**Materials**	**kg CO_2eq**
1	Bag in a box (reference)	PE bag in virgin carton box	**0.082**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**0.075**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**0.082**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**0.084**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**0.053**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**0.176**

Conclusion

After evaluating the climate change impact of all packaging alternatives, option 5A (5.5-kg bulk PE bag with reusable cotton pouch) is found to be the best performer. However, packaging option 5B (5.5-kg bulk PE bag with the use of a glass jar) performs worse due to the emissions related to glass production and transport. Note that both the most and least sustainable solutions are deeply linked to consumer behavior, creating uncertainty for **Sphereal** in reducing packaging emissions. Evaluating other principles could shed light on additional environmental impacts before deciding on any packaging solution.

Principle 2: Optimize efficiency

About the principle

This principle assesses how efficient the packaging is in protecting the product it contains. In general, packaging will probably have a relatively smaller environmental impact compared to that of packaged goods. It is important, though, to use the adequate type and only the necessary amount of material to achieve the intended functionality.

1. What are you measuring?

The packaging-to-product carbon footprint ratio is the recommended metric for optimizing efficiency. This overview metric[3] compares the climate impacts of both the packaging and the product it contains and helps you establish whether you should focus on reducing content loss or reducing the carbon footprint of the packaging. The metric is dimensionless and can be expressed as a percentage.

Alternatively, you can select one or more of the actionable metrics[4] below. Some examples include the return rate of defects, shelf-life days, product loss reduction, packaging-to-product weight ratio, and packaging-to-product volume efficiency.

To ensure consistency, we advise you to calculate the same metric for all packaging options.

Overview metric	Packaging-to-product CO_2eq ratio
Actionable metrics	• Return rate of defects • Shelf-life days • Product loss reduction • Packaging-to-product weight ratio • Packaging-to-product volume efficiency

2. Methodologies to choose from

Use an LCA to calculate the carbon footprint for both the packaging and its content. Then evaluate the packaging's relative impact with the following equation:

$$\textit{Packaging-to-product } CO_2\textit{eq ratio} = PCF / [PCF + CCF]$$

Where,
PCF: packaging carbon footprint

CCF: content carbon footprint

A high score means the focus should be on reducing the carbon footprint of the packaging, while a low score means the focus should be on minimizing product or content loss.

Table 8 gives an overview of other tools and guidelines you can use to evaluate principle 2 and includes additional principles covered by the methodology.

Use the Maturity Grid Assessment (MGA) tool for food products. It helps you measure environmental data and sector-specific considerations for food and food packaging in a simplified way.
Collecting the necessary data might require communication and collaboration across departments but the tool does not require LCA competence.

[3] An overview metric provides a high-level picture based on a collection of other metrics.

[4] An actionable metric is specific and helps to measure components of the overview metric.

Table 8: Methodologies for principle 2

Methodology	Description	Metrics (overview/actionable)	Principles
Maturity Grid Assessment	Helps designers consider key design trade-offs for food products No LCA competence required	*Packaging-to-product carbon footprint ratio*	2, 3
JRC Plastic LCA	Extensive LCA-based method for plastics Includes recycling, material recovery and microplastic emissions	Product loss rate	1, 2, 3, 5, 6

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE principles and hence reduces efforts later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following when performing your LCA:

- Material composition
- Material weight
- Recycled content
- Upstream and downstream transportation distances
- Energy use
- Product loss weight

The more data collected from your own operations and from direct suppliers and users the better. These data points will help you be more accurate when calculating your packaging emissions since you depend less on secondary sources.

When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

4. Databases

Below are some suggested trusted sources of secondary data for emissions factors in case they are not included in the tool you have selected to conduct the analysis.

Ecoinvent Database	Eora	Exiobase	Plastics Europe Public Life Cycle Inventory (LCI) Database

5. Making assumptions when assessing the principle

You should document any assumptions made based on secondary data sources and make them explicit. It is best practice to test the assumptions through sensitivity studies to understand how these affect the results. This supports the analysis of the five other SPHERE principles and helps in the interpretation of results.

Below is an example of a possible assumption for the LCA analysis of the contents.

- Took the breakfast cereal impact from the AgriBalyse3.0 database as a proxy for the CO_2 impact of the product.

Tip! Important considerations to take into account while evaluating this principle:

- As with any LCA analysis, consider the same system boundaries and functional units to assess the carbon footprint for both the packaging and its content.
- Consider differences in packaging applications and plan material or design comparisons accordingly. Food, cosmetic and pharmaceutical product packaging (among others) faces different regulatory requirements than most non-food packaging.
- Measure criteria like the material carbon footprint for the complete packaging system, which consists of primary, secondary and tertiary packaging. Improving the footprint of one packaging level could lead to an increase in carbon emissions for another.
- It may be necessary to collect data from up- and downstream partners and to collaborate with colleagues throughout your organization.

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. '100 g of packaging per kg of product', referring to (for example):

- A best-in-class reference that is known to your colleagues;
- Maximum packaging volume requested by customers;
- Levels set by legislation;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

To assess the efficiency of the different packaging options compared to the product it contains, **Sphereal** choose to work on SPHERE Principle 2: Optimize efficiency.

The goal is to assess the packaging's relative emissions with respect to the content's emissions for each of the proposed solutions.

Table 9: Principle 2 information

Metric	**Packaging-to-product CO_2 ratio** used to evaluate the packaging's efficiency
Unit	Packaging-to-product CO_2 ratio is a dimensionless value and can be expressed in a percentage basis **(%)**
Methodology	Applied an **LCA** considering a cradle-to-cradle approach and the circular footprint formula to account for packaging reuse and recycling cases Also evaluated cereal emissions through an LCA
Data sources	Secondary data retrieved using the **EF3.0 dataset from EcoInvent 3.8 Database** Plastic recycling rates taken from the **PLASTEAX** database Data for breakfast cereals taken from **Agribalyse 3.0.1.**
Collected data	Internal data collected for each packaging option: • Material type and weight • Recycled and renewable content per material type • Recyclability per material type • Number of use cycles • Packaging dimensions • Content count per packaging level (primary, secondary and tertiary)
Assumptions	Before starting the calculations, **Sphereal** made baseline assumptions to allow for accurate results and comparability: • Impact for breakfast cereals taken from Agribalyse 3.0.1 database as a proxy for the CO_2 impact of the product; • Activity name = breakfast cereals, corn flakes, plain (not fortified with vitamins and chemical elements); • CCF estimated considering the CO_2 impact for agriculture and transformation; CCF = 2.89 $kgCO_2eq/kg$; • Did not focus on product loss at packing step or on differences in shelf life at the retailer or the client; • Transport distance from supplier to retailer considered to be 700 km; • The average transport distance from retailer to client is a 5-km round trip, split up by car (62%), van (5%), walking or biking (33%) with an average carrying load of 20 kg of goods (taken from the product environmental footprint (PEF) methodology update); • For the eco-design analysis, **Sphereal** assumed that these distances and end-of-life fates apply equally for all countries it operates in; • Recycling rates weighted based on market share.
Thresholds	**Packaging option 1** (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the **reference** product to set the packaging-to-product CO_2eq ratio threshold for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 10: Principle 2 results

Principle 2: Optimize efficiency – results			
Option	**Descriptive name**	**Materials**	**Packaging-to-product CO_2 ratio**
1	Bag in a box (current)	PE bag in virgin carton box	**6%**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**5%**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**6%**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**6%**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**4%**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**12%**

Conclusion

After calculating the packaging-to-product CO_2 ratio, the results suggest putting efforts on reducing the content's (cereal flakes) CO_2eq footprint. In general, most packaging solutions have a low packaging-to-product ratio. In this case, option 5A (5.5-kg bulk PE bag with cotton pouch) is the most efficient packaging option. While the results of option 5B (5.5-kg bulk PE bag with glass jar) are still on the lower end, **Sphereal** could improve the packaging's efficiency by opting for other solutions or working to lower its associated emissions.

Principle 3: Optimize circularity

About the principle

The circular economy is an economic model that is regenerative by design. The goal is to retain the value of the circulating resources, products, parts and materials by creating a system with innovative business models that allow for renewability, long life, optimal (re)use, refurbishment, remanufacturing, recycling and biodegradability. By applying these principles, organizations can collaborate to design out waste, increase resource productivity and maintain resource use within planetary boundaries. This principle tries to capture the extent to which a packaging solution is part of a next-use phase on a material or product level.

1. What are you measuring?

Principle 3 measures how circular a product or material is. This overview metric[5] is expressed as a value between 0 or 0% (low circularity) and 1 or 100% (full circularity).

Alternatively, you can select one or more of the actionable metrics[6] below. These are, for example, the reuse rate, recyclability, recovery rate, renewable content or recycled content used in a product. These can give you an idea of how circular your packaging is in that specific aspect.

To ensure consistency, we advise you to calculate the same metric for all packaging options.

Overview metric	Circularity
Actionable metrics	• Reuse rate • Recyclability • Recovery rate • Renewable content • Recycled content

2. Methodologies to choose from

The WBCSD's Circular Transition Indicator (CTI) v4.0 is a methodology to assess circularity from the company level to the product level, including packaging. CTI focuses on circular and linear mass flows that enter and leave the system boundaries, in which design, procurement and recovery models are crucial levers to determine how well it performs. CTI's headline indicator – percentage material circularity – captures material inflows and outflows, providing a score from 0% to 100%, showing the ability to minimize resource extraction and waste material.

The Ellen MacArthur Foundation (EMF) Material Circularity Indicator (MCI) is a methodology you can use when trying to determine the circularity of a product, measured with a score from 0 (not circular) to 1 (fully circular). It can be applied both to single products and entire product ranges.

[5] An overview metric provides a high-level picture based on a collection of other metrics.

[6] An actionable metric is specific and helps to measure components of the overview metric.

Table 11 provides an overview of tools and guidelines you can use to evaluate different aspects of circularity and includes additional principles covered by the methodology.

Table 11: Methodologies and tools for principle 3

Methodology	Description	Metrics (overview/actionable)	Principles
Circular Transition Indicator (CTI) v4.0	Measures and improves circular performance of businesses and products Identifies circular opportunities and linear risks	*Material circularity indicator* Renewable inflow Secondary inflow Recovery potential Actual recovery Product lifetime Circular material productivity Critical materials CTI revenue	1, 3, 5
Material Circularity Indicator (MCI)	Intended for decision making in the design of new products to take circularity into account as a criterion and input for design decisions	*Circularity indicator* Reuse rate Recyclability Recovery rate Renewable content Recycled content	3
Maturity Grid Assessment	Helps designers consider key design trade-offs for food products No LCA competence required	*Circularity indicator* Reuse rate Recyclability Renewable content Recycled content	2, 3
JRC Plastic LCA	Extensive LCA based method for plastics. Includes recycling, material recovery and microplastic emissions	*Circularity indicator* Reuse rate Recyclability Recovery rate Recycled content	1, 2, 3, 5, 6
SPICE	Focuses on packaging for cosmetics (primary, secondary and tertiary packaging)	Reuse rate Recyclability Renewable content Recycled content	1, 3, 6
BBE / Bilan Environnemental des Emballages	Measures environmental impacts Tackles packaging waste through the development of eco-design initiatives	Recyclability Recycled content	1, 3
Oil Point Method	Evaluates environmental impacts focused on materials and production process (molding, extrusion, etc.)	Reuse rate	1, 3

Methodology	Description	Metrics (overview/actionable)	Principles
ReSource Footprint Tracker	Company-level tracking of plastic mitigation activities impact through annual public reporting	Recycled content	3, 4
RecyClass	Evaluates and ranks the recyclability of a plastic packaging based on state-of-the-art EU technology	Recyclability Recovery rate Recycled content	3, 5
CE Indicator Prototype	Suitable characteristics of indicators for measuring performance of products within the EMF CE model	*Circularity indicator* Reuse rate Recycled content	3
Retained Environmental Value (REV)	Measures the environmental value retained through reuse, remanufacturing, repairing or recycling	*Circularity indicator* Reuse rate Recovery rate Recycled content	3
Environmentally Extended Input-Output Analysis (EEIOA)	Identifies economic drivers of any environmental impact Tracks how impacts "move" from sector to sector	Other	1, 3, 6
Product Sustainability Index	Assesses a product's sustainability performance Can compare products to improve product design	Other	1, 3

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE principles and hence reduces effort later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following to calculate the packaging's circularity:

- Local end-of-life fate for the packaging format/type
- Material composition
- Packaging formats
- Material flows
- Renewable content
- Recycled content.

The data to measure progress on this principle should aim for primary data from the company and up- and downstream partners. If that information is not available, you can use secondary data to fill the gap. When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

4. Databases

Below are some suggested trusted sources for secondary data, in case it is not included in the methodology you have selected to conduct the analysis.

Plastics Europe Public Life Cycle Inventory (LCI) Database	Food Contact Chemicals Database	Plastic IQ

5. Making assumptions during the assessment

You should document any assumptions made based on secondary data sources and make them explicit. This supports the analysis of the five other SPHERE principles and helps interpret the results.

Below is an example of possible assumptions for a circularity analysis:

- Recycled content is given based on PEF guidance for glass and textiles;
- Number of reuses assumed internally:
  - Cotton pouch = 50
  - Glass jar = 100.

Tip! Important considerations to take into account while evaluating this principle:

- Consider basic principles of circularity like designing out waste and pollution, keeping products and materials in use and regenerating natural systems;
- Use country-specific waste management values considering the countries where you operate;
- Use your enterprise resource planning software, which may already collate some of this information, give you a digital representation of your business processes and be easy for you to access; it may contain useful circularity data on your internal production systems (e.g., recycled content for packaging) as well external data (e.g., downstream recyclability);
- Adapt generalized data used in the context of the circularity assessment to the specific context of your company; using other companies as examples can prove difficult and is only possible if they are operating in a similar context and apply similar assumptions;
- Companies could also derive good metrics from their underlying enterprise resource planning or product life-cycle management systems.

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. 'circularity score of 80%', referring to (for example):

- A best-in-class reference that is known to your colleagues;
- Recycled content rates requested by customers;
- Levels set by extended producer responsibility (EPR) legislation;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

Sphereal wants to assess how circular its packaging options are using criteria including amount of post-consumer recycled content, recyclability and reusability. With this principle, the company wants to find out which packaging option contributes to a more regenerative operation.

Table 12: Principle 3 information

Overview metric	Packaging circularity
Unit	Circularity is a dimensionless value that can be expressed as a percentage **(%).** The higher the value the more circular a product is.
Methodology	**Sphereal** selected EMF's MCI as it offers detailed guidance and a single score to enable comparison between reusable packaging alternatives.
Data sources	Recycling rates for different materials taken from PLASTEAX, JRC - PEF, What a Waste 2.0, Environmental Protection Agency (EPA) and the Journal of International Business and Economics (JIBE).
Collected data	Internal data collected for each packaging option: • Recycled and renewable content per material type • Recyclability per material type • Number of use cycles
Assumptions	Before starting the calculations, **Sphereal** made baseline assumptions: • Number of reuses: - Cotton pouch = 50 - Glass jar = 100 • Recycled content given in PEF guidance for glass and textiles • Average recycling rates by material: - Carton = 32.6% - Flexible LDPE = 3.6% - Flexible plastics = 2.8% And weighted for market share • Circularity indicator (MCI) for option 5 (client last-mile packaging with cotton pouch or glass jar) assessed separately then compared with other packaging as there were different assumptions on reusability
Thresholds	**Packaging option 1** (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the **reference** product to set the circularity threshold for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 13: Principle 3 results

Principle 3: Optimize circularity – results			
Option	**Descriptive name**	**Materials**	**Circularity (0-100%)**
1	Bag in a box (current)	PE bag in virgin carton box	**31%**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**61%**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**28%**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**29%**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**71%**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**98%**

Conclusion

After calculating, the company collects the results as shown in table 13. For the circularity case, the higher the value the more circular the packaging options are. **Sphereal**'s analysis reveals that options 3 and 4 (multi-material and mono-material standing pouch) are the least circular alternatives due to the absence of recycled or renewable content. The use of recycled materials improves the overall circularity of the packaging, as option 2 indicates. However, the best way to improve circularity is the inclusion of reusable materials, as seen with options 5A and 5B (5.5-kg bulk PE bag with cotton pouch or glass jar). In this case, **Sphereal** is advised to favor these options if the company's main goal is to improve circularity performance.

Principle 4: Optimize end of life

About the principle

SPHERE Principle 4 is complementary to principle 3 as it looks at how packaging waste that is not recycled impacts the environment.

It relies on the processing capacity of regional waste collection systems and company-specific activities to process waste on top of existing infrastructure.

1. What are you measuring?

The Mismanaged Waste Index (MWI) value is the percentage of waste not collected and improperly disposed of. Leakage tells how much waste ends up in the environment. These are the recommended overview metrics[7] for principle 4.

Alternatively, you can select one or more of the actionable metrics[8] below. These can give you an idea of the end-of-life fate of packaging waste, such as its collection rate, rate of proper waste management, release rate or littering rate.

To ensure consistency, we advise you to calculate the same metric for all packaging options.

Overview metric	• Mismanaged Waste Index (%) • Leakage (in g per FU)
Actionable metrics	• Collection rate • Rate of proper waste management • Release rate • Littering rate

2. Methodologies to choose from

The Plastic Leak Project (PLP) offers methodological guidance on how to calculate mismanaged waste that leaks into the environment per country. The methodology focusses on plastics but you can use the general principles beyond plastics.

Table 14 shows an overview of tools and guidelines you can use to evaluate different end-of-life fates and includes additional principles covered by the methodology.

Table 14: Methodologies and tools for principle 4

Methodology	Description	Metrics (overview/actionable)	Principles
Plastic Leak Project (PLP)	Designed to mitigate plastic leakage by supporting companies in identifying the most relevant and fruitful actions and strategies to "close the tap"	*Mismanaged plastics* Plastic leakage Leakage rate Collection rate Rate of proper waste management Release rate Littering rate	4
ReSource Footprint Tracker	Company-level tracking of impacts of plastic mitigation activities through annual public reporting	*Mismanaged plastics* Littering rate	3, 4

[7] An overview metric provides a high-level picture based on a collection of other metrics.

[8] An actionable metric is specific and helps to measure components of the overview metric.

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE principles and hence reduces effort later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following to calculate the packaging's end-of-life analyses:

- Sales data
- Packaging volume per country
- Material composition
- Packaging weight.

These data points will help you to be accurate and depend less on data proxies. Data proxies are general data factors for products similar to those you're aiming to map. This type of data is available in online databases and we only recommend its use if you need to complete data gaps.

When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

4. Databases

Below are some suggested trusted sources for secondary data.

What a Waste 2.0	Plasteax	ReSource

5. Making assumptions when assessing the principle

You should document any assumptions made based on secondary data sources and make them explicit. This supports the analysis of the five other SPHERE principles and helps you interpret the results.

Below is an example of possible assumptions for Principle 4: Optimize end-of-life results:

- All data based on PLASTEAX data;
- Packaging made of different plastics that cannot be easily separated considered only for incineration, landfill or mismanaged;
- Used country-specific waste management values considering the top five countries where we operate; final result uses a weighted average.

Tip! Important considerations to take into account while evaluating this principle:

- Define your scope before doing any analysis. For portfolio analyses, if data is available, it might be better to make an analysis per region at this point.
- Be careful when using generalized or high-level data to quantify your impacts. Some data only allows for rough calculations.
- Different materials and packaging formats result in different end-of-life scenarios, depending on the country where you operate. Be sure to assess all packaging levels of your products.
- If you feel that your packaging is not accurately represented in the given end-of-life scenario in the suggested databases, additional secondary data may be necessary depending on the country of destination (for What a Waste 2.0).
- Before determining a specific leakage or drawing detailed conclusions, it might be necessary to conduct a proper material footprint calculation, for instance using the Plastic Leak Project (PLP) for plastics.

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. 'leakage rate below 15%', referring to (for example):

- Science-based targets set for your company;
- A best-in-class reference that is known to your colleagues;
- Emissions factors requested by customers;
- Levels set by legislation;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

Sphereal is looking to optimize how the plastic components in its packaging end their lives by choosing materials that are best handled through common waste management systems. To assess and compare what would happen to the proposed packaging solutions once they are discarded, **Sphereal** decided to work on SPHERE Principle 4 and to focus on plastic materials for this principle. The goal is to minimize the amount of plastic that would end up mismanaged and prone to leakage.

The output of the calculations gives an absolute value of grams of mismanaged packaging per functional unit. Hence, the lowest possible value is preferable.

Table 15: Principle 4 information

Metric	The **Mismanaged Plastic Waste (MPW)** metric is used to evaluate how much plastic packaging ends up uncollected or improperly disposed of. This metric is a function of the **MWI** value multiplied by the total quantity of plastic waste.
Unit	MPW is the mass of mismanaged waste per functional unit. Since these packaging solutions are relatively light, mass is expressed in grams **(g mismanaged)**.
Methodology	**PLP** is the recommended methodology to calculate MWI for plastic materials.
Data sources	Recycling rates for different plastic materials come from the **PLASTEAX** database.
Collected data	Internal data collected for each packaging option: • Material type and weight • Material recyclability
Assumptions	Use of the following assumptions to set the proper scope for analysis: • This case applies a shortcut method using weighted recycling rates by market. Doing a more accurate analysis on a country level would account for waste management infrastructure differences. • The assessment only takes into account the plastic fraction of mismanaged packaging. Other material fractions may be mismanaged at the same time but are not accounted for here.
Thresholds	**Packaging option 1** (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the **reference** product to set the MWI ratio threshold for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 16: Principle 4 results

Principle 4: Optimize end-of-life – results			
Option	**Descriptive name**	**Materials**	**Grams mismanaged**
1	Bag in a box (current)	PE bag in virgin carton box	**3.6**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**3.7**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**5.1**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**5.0**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**2.2**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**2.2**

Conclusion

The variation in mismanagement rate (MWI) depends on the difference in polymer compositions of the packaging options since **Sphereal** assumes recycling rates are identical for all operating countries. In this case, only option 3 (multilayer pouch OPP/PE) has a different recycling rate since it combines PE and a multilayer polymer, while all other options only use PE. Consequently, the final weight of mismanaged plastic mainly depends on the total weight of plastic per functional unit for each packaging option. Thus, the bulk packaging options 5A and 5B (5.5-kg bulk PE bag with the use of a cotton pouch or a glass jar) would be the best choice for **Sphereal** when aiming to optimize the end-of-life results of their packaging.

Additionally, **Sphereal** has chosen to focus on the final mismanaged plastic quantity. However, it could be interesting to estimate the MWI for other materials.

Keep in mind:
Packaging made of different plastics that are not easily separable are more difficult and expensive to recycle and therefore more likely to be mismanaged.

Principle 5: Avoid harmful substances

About the principle

Nowadays, it might be challenging to get high quality data to quantify the adverse health and environmental effects caused by toxic chemicals released from everyday products, such as those that leach from packaging and might contaminate food. An undesired chemical presence in some waste feedstock may affect the quality of recycled products. Thus, it is important to begin tracking some indicators, even if incomplete, to pave the way for safer chemistry in food and non-food consumer products.

This principle aims to increase transparency across the supply chain regarding the chemical impact of a product and motivate designers and decision-makers to eliminate hazardous chemicals as part of a transition to safe and circular products.

1. What are you measuring?

The overall chemicals of concern (CoC) score is the recommended metric for principle 5.
This overview metric[9] shows if there are any toxic chemicals present in the packaging and how likely their release is.

The CoC presence and the inertness score are two actionable metrics[10] that comprise the overview metric. The CoC presence measures if there are any intentionally added chemicals and the reliability of the information provided by the suppliers. The inertness score considers the likelihood of a material releasing chemicals from the product into food and the environment.

To ensure consistency, we advise you to calculate the same metric for all packaging options.

Overview metric	Overall chemicals of concern (CoC) score
Actionable metrics	• CoC presence • Inertness score

2. Methodologies to choose from

Use the Understanding Packaging (UP) Scorecard methodology as a high-level tracker of toxic chemicals in food packaging and their potential release into food products. This methodology focuses on food packaging, but you can also use it as a basis to evaluate non-food packaging.

To calculate the overall CoC score, use the following equations:

Overall CoC score = CoC presence score + Inertness score

Where,
CoC presence score = food chemicals of concern (FCoC) tier x disclosure tier + 1

Use Table 17 as a reference to get the FCoC tier.

[9] An overview metric provides a high-level picture based on a collection of other metrics.
[10] An actionable metric is specific and helps to measure components of the overview metric.

Table 17: Criteria used to define chemicals within each of the three tiers

Tier	Description
0	Not compliant for chemicals of concern identified in tier 1
1	Does not intentionally contain any of the chemicals of concern identified in List 1
2	Does not intentionally contain any of the chemicals of concern identified in tier 1 plus chemicals of concern identified in List 2
3	Does not intentionally contain any of the chemicals of concern identified in tier 2 or any of the priority food contact chemicals identified in the Food Contact Chemicals database

Use table 18 as a reference to get the disclosure tier.

Table 18: Criteria used to define chemicals within each of the three tiers

Tier	Description
0	Supplier is unable to provide information about in-scope chemicals of concern in the materials within the food ware or packaging product.
1	Supplier self-reports compliance of all in-scope chemicals of concern within the tier.
2	Supplier provides a statement on their website or written declaration from an officer-level representative of the company to demonstrate compliance with all in-scope chemicals of concern within the tier.
3	Supplier provides third-party verified certificates of analysis (CoA) and/or approved certification program equivalent for all in-scope chemicals of concern within the tier.

In addition to considering the presence of CoC in a packaging product, you should also consider how exposed customers are to these substances due to their migration from the product into the food or the environment.

Assign an inertness score considering the material that is in direct contact with food:

Table 19: Inertness scores of materials in direct contact with food

Value	Material
10	Ceramic Glass Stainless steel
1	Recycled paper and board Any other material

See UP Scorecard methodology for details on the assumptions behind these values. This methodology is a work in progress and will undergo continuous updating and improvement.

The total CoC score ranges from 2 to 20. The higher the score the safer it is as a packaging option.

Table 20 shows an overview of other tools and guidelines you can use to evaluate chemical hazards and includes additional principles covered by the methodology.

Table 20: Overview of alternative methodologies and tools for principle 5

Methodology	Description	Metrics (overview/actionable)	Principles
JRC Plastic LCA	Extensive LCA-based method for plastics Includes recycling, material recovery and microplastic emissions	Other metrics associated with environmental chemical hazards	1, 3, 5, 6
Recyclability By Design	Design guide on material selection and combinations Guidelines and recommendations for increasing recyclability of the packaging	Other metrics associated with environmental chemical hazards	5
RecyClass	Evaluates and ranks the recyclability of a plastic packaging based on state-of-the-art EU technology	Other metrics associated with environmental chemical hazards	3, 5

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE Principles and hence reduces effort later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following to calculate the amount of toxic chemicals in your packaging:

- Materials
- Laboratory analysis
- Test reports
- Safety data sheets
- Food contact materials.

The best approach is to collect data from your own operations and from suppliers. There is a lack of generic information on chemical substances used in different product materials so there are almost no generic databases available.

When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

4. Databases

We advise you to ask your suppliers for primary data on the substances present in the packaging materials. Only a few generic databases are available for specific sectors.

The following databases can provide you with more information on toxic chemicals, regulations and tools for safer chemistry. Your enterprise software can also run checks for product and packaging compliance and marketability against international and national standards. Check if you have access to these product compliance tools.

Pharos	Plastics Europe LCI database	Granta CES/ Material universe	GreenScreen tool

5. Making assumptions when assessing the principle

You should document any assumptions made based on secondary data sources and make them explicit. This supports the analysis of the five other SPHERE principles and helps interpret results.

Below is an example of possible assumptions for principle 5:

- Rule applied: top three chemicals reported as present in a material by scientific research;
- For multi-layer packaging, inertness score applied on the layer in direct contact with food; however, for the CoC presence score, consideration of all intentionally used chemicals contained in all the different material layers.

Important note

It can be challenging for companies to collect data on chemical composition beyond regulatory requirements. As such, it might not be feasible to evaluate principle 5 due to the additional data required. The non-assessment of this principle will not affect the overall framework results.

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. 'no CoC used in packaging', referring to (for example):

- A best-in-class reference that is known to your colleagues;
- Restricted substances list from a customer or sector organization;
- Levels set by legislation;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

Sphereal chooses to work on principle 5 to prioritize the packaging option with the least chemical impact. Looking for specific CoC, using inert materials and ensuring reliable supplier data is the recommended approach to avoid harmful substances.

Table 21: Principle 5 information

Metric	The **overall CoC score** evaluates if there are any toxic chemicals present in the packaging and how likely are these to be released.
Unit	This score is dimensionless and ranges from **2 to 20**, with 2 being the worst and 20 being the best result.
Methodology	Applied the UP Scorecard methodology to track the presence of harmful chemicals on food packaging.
Data sources	Used the FCCmigex database to determine potential presence of food contact chemicals.
Collected data	No data on chemical composition beyond regulatory requirements was available.
Assumptions	Used the following assumptions to set the proper scope for analysis: • Due to the absence of primary data, **Sphereal** performed desk research on the top three chemicals reported to be present in each of the materials included in the five packaging options. The company then assumed that these substances were present in its actual packaging.
Thresholds	**Packaging option 1** (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the **reference** product to set the overall CoC score threshold for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 22: Principle 5 results

Principle 5: Avoid harmful substances – results			
Option	**Descriptive name**	**Materials**	**CoC score (2-20)**
1	Bag in a box (current)	PE bag in virgin carton box	**2**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**2**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**2**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**2**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**2**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**2**

Conclusion

After the assessment of all packaging types, **Sphereal** realizes that all options perform badly on the CoC Score. No option is favorable since at least one of the substances assumed as present for each packaging option is listed in tier 1. In this case, **Sphereal** should perform a laboratory analysis or ask suppliers for additional information. Note that if information is missing on all listed chemicals from tiers 1, 2 and 3, it is not possible to draw any solid conclusions, making it important to drive full disclosure from suppliers in the future and not just compliance reports. Once the actual chemical composition is known, **Sphereal** can start working with suppliers to remove priority substances from its products.

Principle 6: Minimize the drivers of biodiversity loss

About the principle

SPHERE Principle 6 is about measuring the biodiversity impacts of packaging. This is a less developed practice compared to other SPHERE principles as it is not possible to directly assess species extinction rates. It is, however, apparent that material production, energy use and packaging waste impact natural life and thus biodiversity.

Principle 6 quantifies the drivers of biodiversity loss beyond the ones covered by other principles (e.g., climate change and harmful chemicals).

1. What are you measuring?

Water footprint and land use are the recommended metrics to measure for principle 6. These overview metrics are expressed in m³ (water footprint) and with points (land use). The metrics help you capture relevant drivers of biodiversity loss for the packaging in scope. Alternatively, you can select one or more of the actionable metrics below. We use land and water consumption as examples, and plan to include other metrics as science evolves in a future iteration of the **SPHERE** framework.

To ensure consistency, we advise you to calculate the same metric for all packaging options.

Overview metric	• Water footprint • Land use
Actionable metrics	• Land consumption • Water consumption

2. Methodologies to choose from

To obtain accurate information on a product's land use and water footprint, it is necessary to conduct an LCA.

For land use, you can base your assessment on the LANCA[11] model to calculate the Soil Quality Index. This indicator reflects the amount of land used and transformed to perform an activity.

For water footprint, refer to the ISO 14046 water footprint standard on how to assess consumptive water use.

Table 23 shows an overview of other tools and guidelines you can use to evaluate different aspects related to biodiversity and includes additional principles covered by the methodology.

[11] Beck, Tabea & Bos, Ulrike & Wittstock, Bastian & Baitz, Martin & Fischer, Matthias & Sedlbauer, Klaus. (2010). LANCA Land Use Indicator Value Calculation in Life Cycle Assessment - Method Report.

Table 23: Methodologies and tools for principle 6

Methodology	Description	Metrics (overview/actionable)	Principles
ReCiPe	A method for the impact assessment (LCIA) in an LCA Translates emissions and resource extractions into a limited number of environmental impact scores	*Land use* Land consumption Water consumption	6
SPICE	Focuses on packaging for cosmetics (primary, secondary and tertiary packaging)	Resource depletion Water consumption	1, 3, 6
Environmentally Extended Input-Output Analysis (EEIOA) Extended Input- Output Analysis (EEIOA)	Identifies economic drivers of any environmental impact Tracks how impacts "move" from sector to sector	Other metrics associated with biodiversity loss	1, 3, 6
JRC Plastic LCA	Extensive LCA-based method for plastics Includes recycling, material recovery and microplastic emissions	*Land use* Resource depletion Water consumption	1, 3, 5, 6

You can choose other methodologies to:

1. Perform a more complete analysis; going the extra mile often offers more overlap with other SPHERE principles and hence reduces effort later on;
2. Be specific for a sector or product category;
3. Align more closely with your company's existing efforts.

3. Data collection

Among other factors, look for the following to calculate related biodiversity impacts:

- Water (in- and out-) flows
- Freshwater use
- Grey water
- Land occupation.

For water use, these impacts can differ greatly depending on region or specific locality.

The land-use impacts are more globally applicable and comparable. For example, switching to biobased packaging materials always requires the use of a certain area of land and therefore impacts assessed are more globally comparable in terms of subsequent decision-making and governance.

When comparing two or more packaging solutions, make sure to use similar data granularity to avoid false comparisons.

4. Databases

Below are some suggested trusted sources for emissions factors, in case they are not included in the tool you have selected to conduct the analysis.

Ecoinvent Database	Eora	Exiobase	Granta CES Selector

5. Making assumptions when assessing the principle

You should document any assumptions made based on secondary data sources and make them explicit. It is best practice to test the assumptions through sensitivity studies to understand how these affect the results. This supports the analysis of the five other SPHERE principles and helps in the interpretation of results.

Below is an example of possible assumptions for principle 6.

- Land use does not involve land transformation;
- All process water is returned to the original watershed at the same level of quality it had when it entered the operation.

Tip! Important considerations to take into account while evaluating this principle:

- Define the scope and goal before doing any analyses (company, business unit, product, functional unit, system boundary, and materials).
- Be careful when using generalized or high-level data to quantify your impacts. Some data only allows for rough calculations.
- It may be necessary to collect data from up- and downstream partners and to collaborate with colleagues throughout your organization.
- Your own enterprise software or environmental, health and safety systems may have information on the environmental metrics of your production facilities (e.g., land-use and water-use metrics).

6. Setting thresholds

For the eco-design analysis, you need a threshold to compare the results of the different SPHERE principles later on. You can view standard thresholds as an impact level you do not want to overshoot and performance thresholds as a performance goal to aim for.

You can set these targets yourself, e.g. '0.5 L of water per kg of product sold', referring to (for example):

- A best-in-class reference that is known to your colleagues;
- Water footprint intensity requested by customers;
- Levels set by legislation ;
- Suggestions made by NGOs or sector organizations;
- Internal targets set in previous sustainability strategies.

Your turn! Use this table as a repository for the information you need to run the analysis.

Metric	
Unit	
Methodology	
Data sources	
Collected data	
Assumptions	
Thresholds	

Case study

Sphereal wants to assess its impact on biodiversity loss and choose the packaging option with the least negative consequences. The following table summarizes the most important considerations for the assessment.

Table 24: Principle 6 information

Metric	**Water footprint** and **land use** were measured to account for both drivers of biodiversity loss.
Unit	Water use is measured in **m^3** and land use is measured with points.
Methodology	Applied an **LCA** considering a cradle-to-cradle approach and the circular footprint formula to account for reuse and recycling.
Data sources	Secondary data retrieved from the EcoInvent Database.
Collected data	Internal data collected for each packaging option: • Material types, composition and flows • Energy use
Assumptions	**Sphereal** made certain assumptions to allow for comparability of the chosen packaging options: • Transport distance from supplier to retailer considered to be 700 km. • Average transport distance from retailer to client is a 5-km round trip, split up by car (62%), van (5%), walking or biking (33%) with an average carrying load of 20 kg of goods (taken from the PEF methodology update);
Thresholds	**Packaging option 1** (PE bag in a virgin carton box) is the most common packaging used for cereal products. Thus, it is used as the reference product to set both the water and land thresholds for the analysis.

Results

After running the analysis for each packaging option, **Sphereal** obtained the following results.

Table 25: Principle 6 results

Principle 6: Minimize the drivers of biodiversity loss - results				
Option	**Descriptive name**	**Materials**	**Min. biodiversity loss (water) in m^3**	**Min. biodiversity loss (land) in points**
1	Bag in a box (current)	PE bag in virgin carton box	**0.0366**	**1.34**
2	Bag in a box with max. PCR content	PE bag in 100% post-consumer recycled carton box	**0.0315**	**0.82**
3	Stand-up pouch multi-material (cut to open)	Multi-material pouch made of OPP and PE	**0.0327**	**0.83**
4	Stand-up pouch mono-material (smart open)	Mono-material OPE pouch with easy-to-open seal	**0.0332**	**0.83**
5A	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable cotton pouch	**0.218**	**0.32**
5B	Bulk for consumer at retail	Delivered to retail with 5.5-kg PE bags and last mile by customer with reusable glass jar	**0.0337**	**0.91**

Conclusion

For water use, packaging option 2 is the best performer, while packaging option 5A performs worst due to cotton's high water footprint. However, when considering land use, packaging option 5A is now the best option, while the reference packaging (option 1) performs worst on this metric. With the results at hand, **Sphereal** realizes that it would be best to compare additional principles to complement this analysis before making any decisions for the new packaging solution.

PART III:
Acting on the results

PART III: Acting on the results

Once you have concluded the main analyses for the selected principles and for all packaging options, it is time to bring all the information together.

Portfolio analysis

Integrating results and making decisions

Integrating the results

The results of the portfolio analysis are crucial as they help detect impact hotspots, which in turn can provide the basis for eco-design approaches.

This analysis uses information not directly related to sustainability metrics, such as sales volume by destination country, to guide investments to areas with greater impact potential.

Creating an overview of results that allows for comparability is key to making informed decisions.

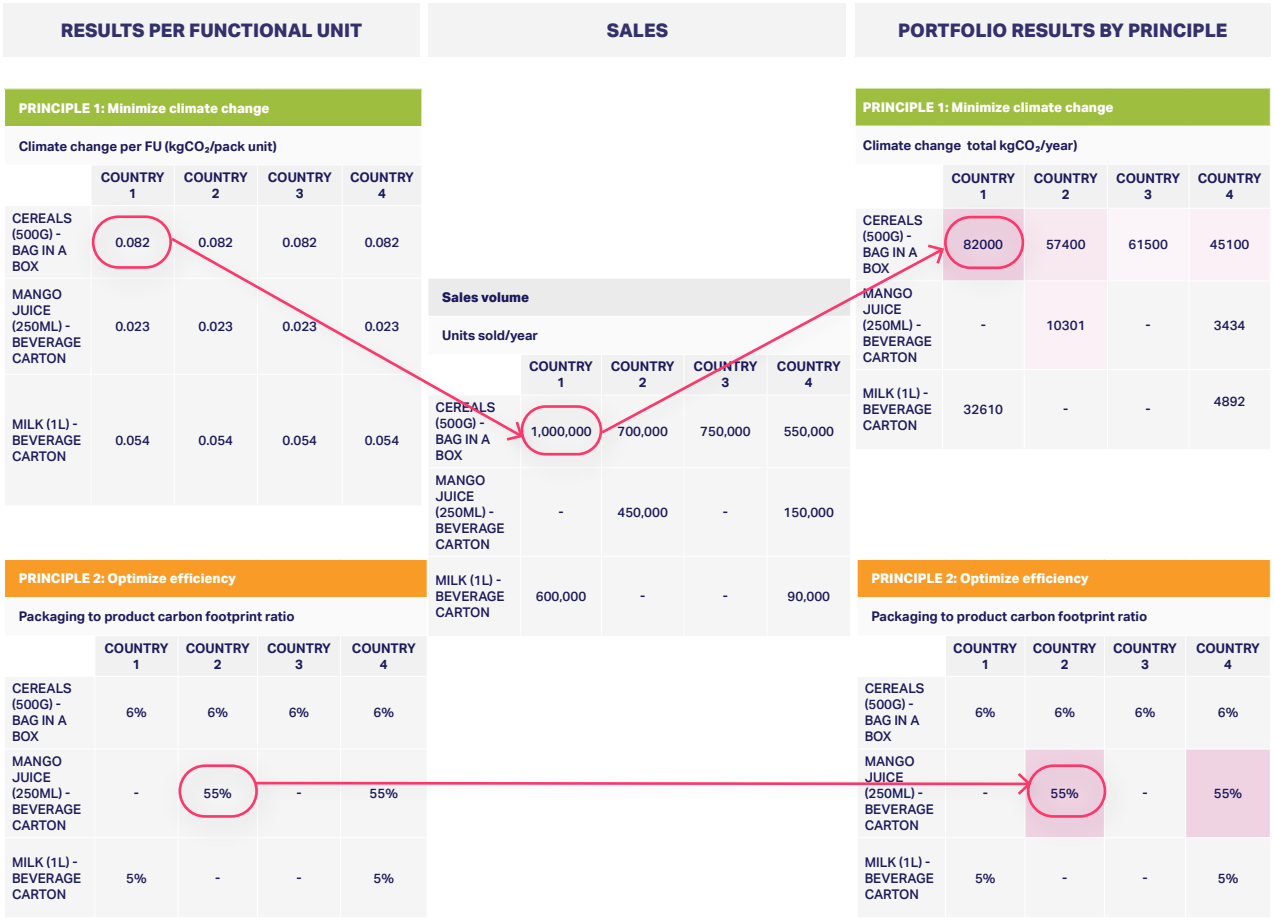
The following section describes step-by-step how to integrate and interpret the results for a portfolio analysis.

Comparative matrixes

Depending on the approach taken during each principle assessment, you may need to make further calculations to be able to compare final results between regions and packaging options.

1. Compile the results of all of the principles by country and packaging option.
2. Refer to market share table 2, built during part I (see page 10).
3. Create one table per principle to evaluate the magnitude of each impact on a regional basis:
    a. For principle results expressed in absolute values per functional unit (e.g., kgCO_2eq, grams mismanaged, etc.), multiply each packaging option result by its respective sales volume per country.
    b. For results expressed in relative values (e.g., dimensionless score or %), perform comparisons between countries directly. No further calculations are needed.
4. Highlight or color code the cells with the highest impacts to identify hotspots.

Figure 3: Visualization of the comparative matrix process steps for Sphereal



Note: In general, final results are highly dependent on market share. However, any assumptions made about regional differences will affect the granularity of the analysis (e.g., recycling rates or end-of-life scenarios).

Portfolio analysis case study

Sphereal is looking to improve the sustainability performance of its Food & Beverage department, which consists of breakfast cereals, mango juice and milk. While it is already working on making products as sustainable as possible, the company wants to focus on reducing the environmental impacts of its packaging as well.

To focus efforts more holistically on a company level, **Sphereal** wants to identify which packaging in its product portfolio has the highest total environmental impacts. Once it has identified the priority packaging, the packaging design team will propose new packaging solutions for specific products. Accordingly, this approach supports the company in aligning its packaging strategy with its overall sustainability strategy goals.

Defining the scope and objectives

Analysis type: Since the objective is to prioritize which packaging to address across **Sphereal's** product range, it will perform a portfolio analysis.

Table 26 summarizes the product category, functional unit, and most relevant features for each type of packaging.

Table 26: Portfolio analysis overview of product category, functional unit and the most relevant features for each tape of packaging

Option	Product category	Functional unit	Packaging features
1	Cereals	500 g	PE bag in virgin carton box
2	Mango juice	250 ml	Beverage carton
3	Milk	1 L	Beverage carton

Geographic market share

Sphereal sells these products in Egypt, Poland, Thailand and the USA. The following table shows market share per product:

Table 27: Portfolio analysis of sales volume per product (units sold/year)

	USA	Egypt	Thailand	Poland
Cereals (500 g) – bag in a box	1,000,000	700,000	750,000	550,000
Mango juice (250 ml) – beverage carton	-	450,000		150,000
Milk (1 L) – beverage carton	600,000	-		90,000

Results

Sphereal chose to assess all six principles from the SPHERE framework and obtained the following results.

Figure 4: Overview of partial results of the portfolio analysis

Principle 1: Minimize climate change

Climate change total $kgCO_2$/year

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	0.082	0.082	0.082	0.082
MANGO JUICE (250ML) - BEVERAGE CARTON	0.023	0.023	0.023	0.023
MILK (1L) - BEVERAGE CARTON	0.054	0.054	0.054	0.054

Principle 2: Optimize eifficeny

(Packaging to product carbon footprint ratio)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	6%	6%	6%	6%
MANGO JUICE (250ML) - BEVERAGE CARTON		55%		55%
MILK (1L) - BEVERAGE CARTON	5%			5%

Principle 3: Maximize Circularity

Circularity (0-100%)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	31%	31%	31%	31%
MANGO JUICE (250ML) - BEVERAGE CARTON	57%	57%	57%	57%
MILK (1L) - BEVERAGE CARTON	56%	56%	56%	56%

Principle 4: Optimize End of Life

MWI (in grams mismanaged per pack)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	0.52	8.28	5.44	0.98
MANGO JUICE (250ML) - BEVERAGE CARTON	0.25	4.02	2.64	0.52
MILK (1L) - BEVERAGE CARTON	1.42	19.52	12.83	2.57

Principle 5: Avoid harmful substances

Harmful chemicals (score from 2 to 20)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	2	2	2	2
MANGO JUICE (250ML) - BEVERAGE CARTON	2	2	2	2
MILK (1L) - BEVERAGE CARTON	2	2	2	2

Principle 6: Minimize biodiversity loss

Water footprint (m3/pack unit)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	0.036	0.036	0.036	0.036
MANGO JUICE (250ML) - BEVERAGE CARTON	0.002	0.002	0.002	0.002
MILK (1L) - BEVERAGE CARTON	0.004	0.004	0.004	0.004

Principle 6: Minimize biodiversity loss

Land-use change (m2e*year/pack unit)

	USA	EGY	THA	POL
CEREALS (500G) - BAG IN A BOX	1.270	1.270	1.270	1.270
MANGO JUICE (250ML) - BEVERAGE CARTON	0.059	0.059	0.059	0.059
MILK (1L) - BEVERAGE CARTON	0.154	0.154	0.154	0.154

Notes:

- For principles 1, 2 and 6, **Sphereal** assumed transportation distances and end-of-life scenarios were equal for all countries. Thus, it evaluated each packaging type once. This is why each packaging type has different emissions but they do not vary between countries. It applied this short-cut method to facilitate the analysis. For a more rigorous analysis, evaluate each packaging type using country-specific data.
- The company used country-specific data to estimate principles 3 and 4. This rigorous approach brings more granular results, allowing to account for the regional context where the company sells the product.
- For principle 5, the company assumes packaging materials come from the same supplier. Thus, the impacts are equal for all countries. For all products, it found at least one chemical in tier 1.

Integrating the results

Multiply the absolute values of the results for principles 1, 4 and 6 by the respective sales volumes to express the magnitude of the impacts.

The absolute value for principle 5 and the relative values for principles 2 and 3 can remain as they are as those results do not need to be multiplied.

Apply a color code to each principle to identify which packaging has the highest impact per environmental category. Red indicates the highest and green lowest impact in the respective categories. Shades of these colors indicate a tendency towards the proportion of impact.

Case study

Figure 5 shows the final results of **Sphereal's** portfolio analysis.

Figure 5: Overview of portfolio analysis results

Principle 1: Minimize climate change

Climate change total kgCO_2/year

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	82000	57400	61500	45100
MANGO JUICE (250ML) - BEVERAGE CARTON		10301		3434
MILK (1L) - BEVERAGE CARTON	32610			4892

Principle 2: Optimize eifficeny

(Packaging to product carbon footprint ratio)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	6%	6%	6%	6%
MANGO JUICE (250ML) - BEVERAGE CARTON		55%		55%
MILK (1L) - BEVERAGE CARTON	5%			5%

Principle 3: Maximize Circularity

Circularity (0-100%)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	31%	31%	31%	31%
MANGO JUICE (250ML) - BEVERAGE CARTON		57%		57%
MILK (1L) - BEVERAGE CARTON	56%			56%

Principle 4: Optimize End of Life

MWI (in grams mismanaged per pack)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	516000	5797400	4078500	536800
MANGO JUICE (250ML) - BEVERAGE CARTON		1807650		78300
MILK (1L) - BEVERAGE CARTON	849000			231660

Principle 5: Avoid harmful substances

Harmful chemicals (score from 2 to 20)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	2	2	2	2
MANGO JUICE (250ML) - BEVERAGE CARTON		2		2
MILK (1L) - BEVERAGE CARTON	2			2

Principle 6: Minimize biodiversity loss

Water footprint (m3/pack unit)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	36200	25340	27150	19910
MANGO JUICE (250ML) - BEVERAGE CARTON		758		253
MILK (1L) - BEVERAGE CARTON	2628			394

Principle 6: Minimize biodiversity loss

Land-use change (m2e*year/pack unit)

	COUNTRY 1	COUNTRY 2	COUNTRY 3	COUNTRY 4
CEREALS (500G) - BAG IN A BOX	1270000	889000	952500	698500
MANGO JUICE (250ML) - BEVERAGE CARTON		26604		8868
MILK (1L) - BEVERAGE CARTON	92198			13830

Making decisions

The portfolio analysis enables you to screen different packaging solutions from a company-level perspective. This allows you to take additional factors, such as sales volumes, into account. The portfolio analysis offers insights in the trade-offs between the different SPHERE principles and thus helps to prioritize sustainability topics and portfolio items.

What are the results telling you?

The results show hotspots of impact per principle and sales area. They offer areas of attention in meeting sustainability targets, legislative barriers or other things that have helped define the thresholds set. They typically help guide efforts for certain countries or packaging solutions to meet the overall company environmental sustainability objectives.

How to act on priorities?

When you have identified the priority packaging solutions or sales areas, we suggest you look back at the analysis for more guidance on where you can reduce impacts. If, for example, packaging option 1 has the best performance on climate change but the worst on circularity, this can be due to the volume of products sold, the local energy mix or local waste management infrastructure.

After applying a portfolio analysis, priority packaging can benefit from a complementary eco-design analysis in order to find areas for improvement at a packaging level. You can apply both analyses in an iterative process to address all hotspots, continuously improving the environmental performance of your packaging portfolio.

Additionally, you could step up collaboration and data gathering on the priority sales regions or packaging solutions. It is often easier to manage high-impact metrics in collaboration with stakeholders.

Case study

Sphereal concluded a portfolio analysis of SPHERE in a final comparable overview. After a quick review based on color coding, the company recognized that cereal packaging shows the highest impact in four of the six principles assessed. Once it evaluated each principle in detail, it found that different reasons influenced the results:

Due to the high sales volume in the US, small changes in the packaging used in this market can have a big overall impact on climate change and biodiversity loss (principles 1 and 6).

The packaging's material composition and the local waste management infrastructure influence both circularity and end-of-life scores (principles 3 and 4). To improve these metrics for its cereal packaging, **Sphereal** could consider introducing recycled materials with high recyclability rates or reusable systems.

Whatever the causes, this analysis indicates that the company can have the biggest impact if it focuses its efforts on improving its cereal packaging. Moreover, to ensure that it improves its cereal packaging performance, **Sphereal** could conduct a follow-up eco-design analysis for the proposed solutions.

Eco-design analysis

Integrating results and making decisions

Integrating results

For the eco-design analysis, you need a threshold to compare results between the different packaging options. We use threshold as a generic term; it can be science-based targets, best-in-class values or self-declared goals. A threshold can be seen as a baseline value to compare to and a boundary that you don't want to overshoot. Each principle that you compare different packaging options to has its own threshold. In Figure 6, we use packaging option 1 as an internal self-declared threshold, meaning the reference for you to compare alternatives to, as companies often use an existing packaging solution as a baseline.

The following section will take you through how to integrate and interpret the results, step-by-step.

Build a table to compile data

1. Build a table to compile all the results by principle and packaging option.
2. Specify the units used by principle and, optionally, list the metrics evaluated. This helps double-check that the analysis is consistent.
3. Color code each result based on the set thresholds.

You can use different color codes for the results depending on the granularity you need.

As shown in Figure 6, you can use green for results that perform better than the threshold and red for unsatisfactory results that overshoot the boundaries, while adapting the opacity of the color based on how much the values deviate from the threshold. Options that deliver the same results as option 1 remain uncolored. Color results that deviate less than 20% from the threshold with less opacity. In turn, cells with a high opacity highlight values that deviate more than 20% in either direction from the threshold.

Figure 6: Data compilation for Sphereal example eco-design analysis

Option	P1 – Minimize climate change (kg CO_2eq)	P2 – Optimize efficiency (%)	P3 – Maximize circularity (%)	P4 – Optimize end of life (g)	P5 – Avoid harmful substances (CoC score – 2-20)	P6 – Minimize biodiversity loss (water) (m^3)	P6 – Minimize biodiversity loss (land use) (points)
1- Bag in a box (reference/ standard threshold)	0.082	6%	31%	3.6	2	0.04	1.27
2 – Bag in a box w/ max PCR	0.075	5%	61%	3.7	2	0.03	0.75
3 – Stand-up pouch multi (cut)	0.082	6%	28%	5.1	2	0.03	0.76
4 – Stand-up pouch mono (no cut)	0.084	6%	29%	5.0	2	0.03	0.76
5A – Bulk for consumer (add. cotton pouch)	0.053	4%	71%	2.2	2	0.22	0.26
5B – Bulk for consumer (add. glass jar)	0.176	12%	98%	2.2	2	0.03	0.80

Alternatively, you can use a simpler color code as in Figure 7 below. Results that deviate less than 20% from the thresholds are colored in orange, while results that perform significantly better or worse are colored in green and red, respectively.

Figure 7: Data compilation for Sphereal example eco-design analysis

Option	P1 – Minimize climate change (kg CO_2eq)	P2 – Optimize efficiency (%)	P3 – Maximize circularity (%)	P4 – Optimize end of life (g)	P5 – Avoid harmful substances (CoC score – 2-20)	P6 – Minimize biodiversity loss (water) (m^3)	P6 – Minimize biodiversity loss (land use) (points)
1- Bag in a box (reference/ standard threshold)	0.082	6%	31%	3.6	2	0.04	1.27
2 – Bag in a box w/ max PCR	0.075	5%	61%	3.7	2	0.03	0.75
3 – Stand-up pouch multi (cut)	0.082	6%	28%	5.1	2	0.03	0.76
4 – Stand-up pouch mono (no cut)	0.084	6%	29%	5.0	2	0.03	0.76
5A – Bulk for consumer (add. cotton pouch)	0.053	4%	71%	2.2	2	0.22	0.26
5B – Bulk for consumer (add. glass jar)	0.176	12%	98%	2.2	2	0.03	0.80

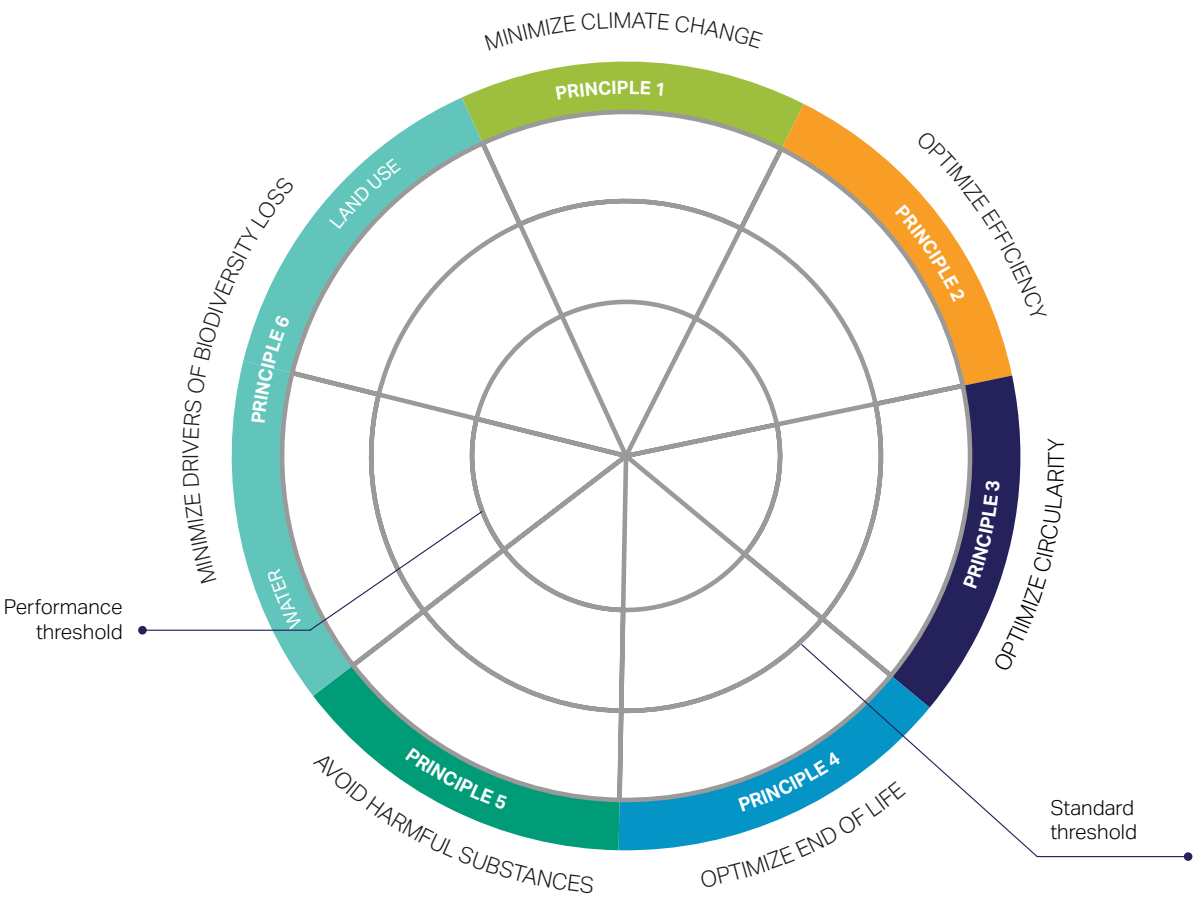
This color coding will prove useful for the wheel representation.

Wheel representation

To visually compare the overall performance between each packaging option, you can use the wheel presented in Figure 7.

A dedicated wheel figure separated into seven segments represents each packaging option. The first five segments represent one of the five principles respectively, while segments six and seven correspond to principle 6 on biodiversity loss: one for water use and another for land use. Additionally, three circles cross the segments from the center to the outside.

Figure 7: Canvas to build a wheel representation



These circles and their associated color coding show the performance against the thresholds set:

- Inner circle – green: represents a better performance (less environmental impact) than the standard threshold;

You can decide how to assess the performance by setting a percentage of deviation from the standard threshold that is meaningful to you. For instance, you can decide to mark values that deviate less than 20% from the standard threshold as orange whereas results that deviate more than 20% from the standard threshold are either significantly better (green) or worse (red). We suggest using a visualization similar to the planetary boundary representation for ease of interpretation, as shown in Figure 8.

In Figure 8, we chose a simple overview provided by three circles. You can choose to be more detailed and visually depict a more accurate deviation from the threshold, adding circles as you add granularity to the results of the performance of your packaging (e.g., 10%, 20% and 30% deviation from the standard threshold values). Similarly, you can adapt at which percentage of deviation you decide to color each layer for your values. In this case we chose 20% but you are free to set your own preferences.

Note: These figures help summarize results visually. However, one limitation is that they do not provide detailed information on the magnitude of each environmental impact.

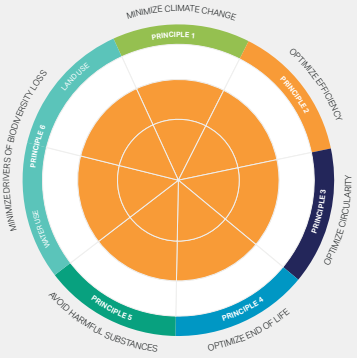
With all the wheel figures together, you can easily compare the trade-offs between each packaging option. For example, one might have a smaller climate impact, while another could outperform on circularity or biodiversity loss.

Case study

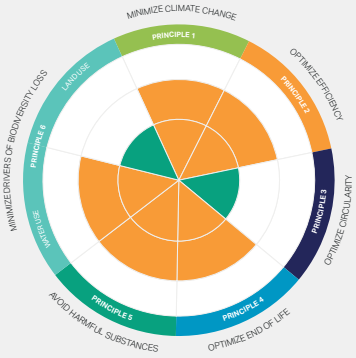
Sphereal created a visual representation of all packaging options results through wheel figures. By putting them together, the company can easily compare the overall performance and identify the best available solutions.

Figure 8: Wheel representation overview for **Sphereal** packaging options

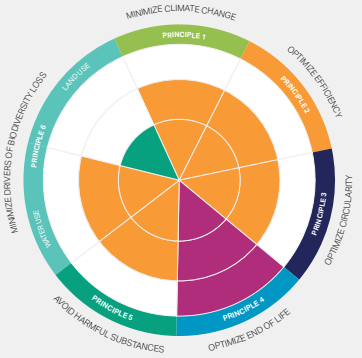
Option 1:
Bag in a box (reference)



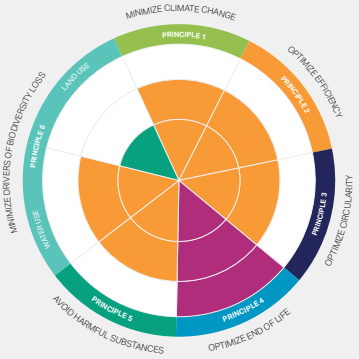
Option 2:
Bag in a box, maximum PCR



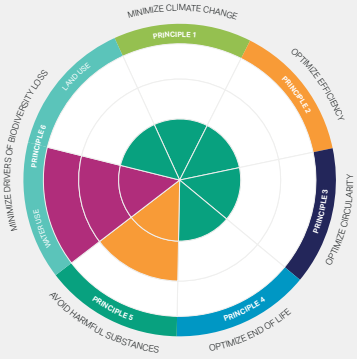
Option 3:
Stand-up pouch multi (cut)



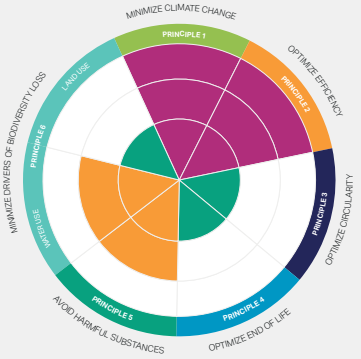
Option 4:
Stand-up pouch multi (cut)



Option 5A:
Bulk for consumer (add. Cotton pouch)



Option 5B:
Bulk for consumer (add. Glass jar)



Key: green – within performance threshold; orange – within standard threshold; red – beyond thresholds

With these figures, **Sphereal** can easily identify the high-level trade-offs offered by each packaging solution. Its desired performance value was a 20% environmental impact decrease for all principles. Option 5A (bulk PE bag with cotton pouch) shows the least environmental impacts on almost all the principles assessed. However, this option is more water-intensive than the current packaging, so this impact category overshoots the boundary set by the reference product. While option 5B (bulk PE bag with glass jar) also shows an improvement on several impacts, it performs worst in the climate change and packaging efficiency categories.

Build a bar graph to compare results

A bar graph provides a detailed visualization of the environmental impacts associated with all packaging options.

Since each principle uses different units, it is necessary to apply a simple calculation to normalize results (and make them comparable).

1. For each principle, select the threshold as a basis for calculations.
2. Divide the result of each packaging option by this number and show the new calculation as a percentage (%).
3. Repeat steps 1 and 2 for each principle.

Note: Reverse the logic behind the circularity and chemicals of concern score to match the direction of the other principles (the higher the score, the worse the performance). To normalize these results, apply the following formula:

% = (1-result) / (1-threshold) * 100%

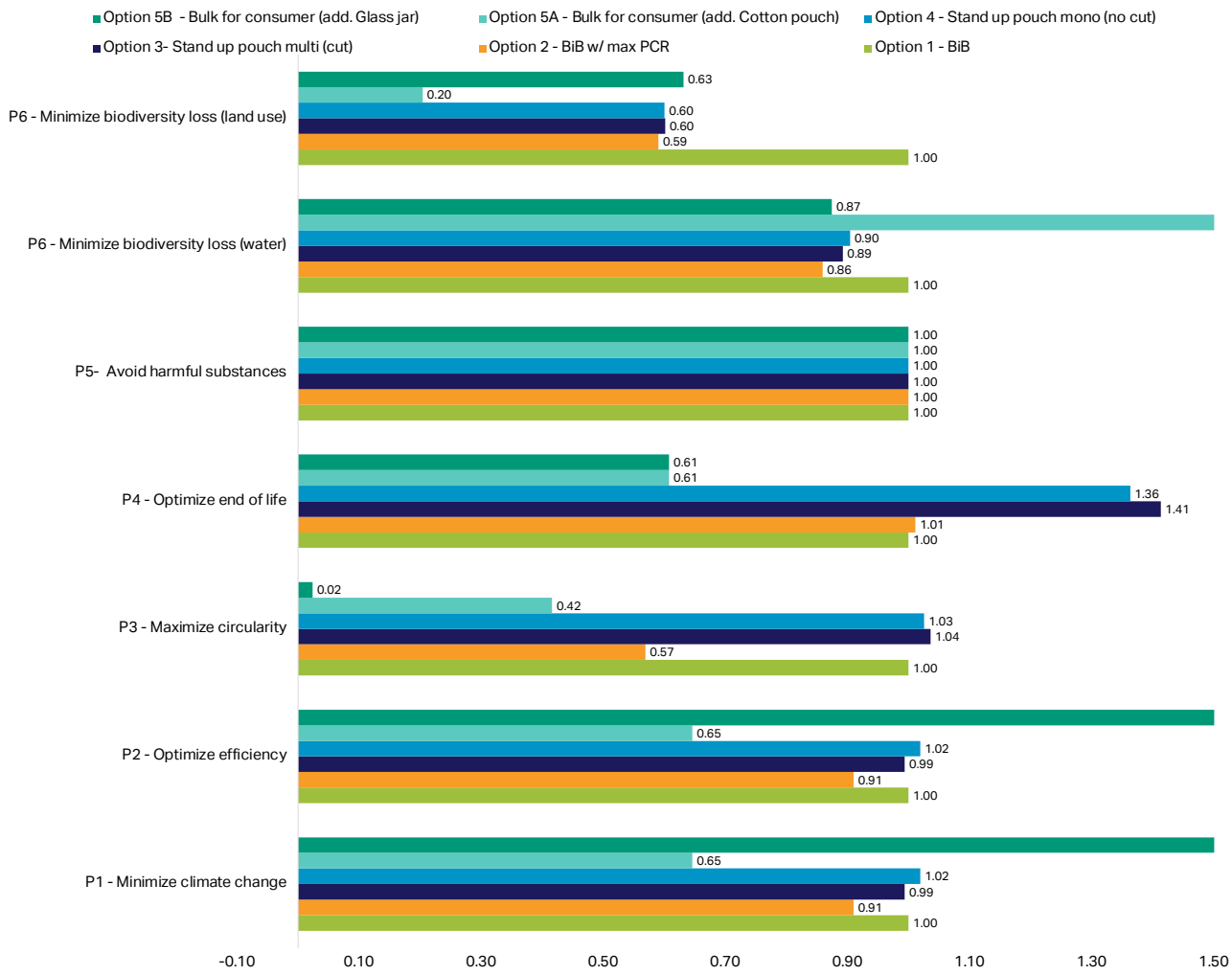
4. Build a second table with the normalized results.

Figure 9: Relative importance by Sphereal packaging option compared to packaging option 1 as a reference value

Option	P1 – Minimize climate change (kg CO_2eq)	P2 – Optimize efficiency (%)	P3 – Maximize circularity (%)	P4 – Optimize end of life (g)	P5 – Avoid harmful substances (CoC score – 2-20)	P6 – Minimize biodiversity loss (water) (m^3)	P6 – Minimize biodiversity loss (land use) (points)
1- Bag in a box (ref)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
2 – Bag in a box w/ max PCR	**91%**	**91%**	**57%**	**101%**	**100%**	**86%**	**59%**
3 – Stand-up pouch multi (cut)	**99%**	**99%**	**104%**	**141%**	**100%**	**89%**	**60%**
4 – Stand-up pouch mono (no cut)	**102%**	**102%**	**103%**	**136%**	**100%**	**91%**	**60%**
5A – Bulk for consumer (add. cotton pouch)	**65%**	**65%**	**42%**	**61%**	**100%**	**602%**	**20%**
5B – Bulk for consumer (add. glass jar)	**213%**	**213%**	**2%**	**61%**	**100%**	**88%**	**63%**

5. Build a bar graph to better represent results
    - Use the x axis to present all packaging options grouped by principle (clustered column chart).
    - Use the y axis to show values ranging from 0% up to a maximum value where the chart can still be read. Note that some results may be overwhelmingly larger than the reference product. To see the specific values, add data labels to the chart.

Figure 10: Bar chart overview of results for Sphereal



Now you can compare the actual performance of each packaging option per principle.

Making decisions

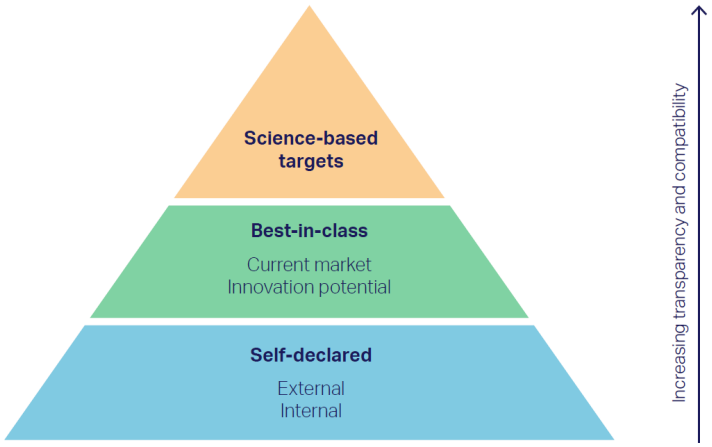
The eco-design analysis enables you to compare different packaging solutions on all the SPHERE principles for environmental sustainability.

This allows you to prioritize certain packaging over others if it meets your thresholds or simply performs better on the principles that are core to your sustainability strategy.

What are the results telling you?

The results show the performance of a packaging solution over the six SPHERE principles for environmental sustainability, which heavily depends on the thresholds that you set. In the **Sphereal** case study, we selected packaging option 1 as the baseline and therefore standard threshold. If the baseline you select is not realistic, the performance of alternative packaging options can be too positive; therefore we recommend you use the threshold setting hierarchy below. The portfolio analysis enables you to screen different packaging solutions from a company-level perspective. This allows you to take additional factors, such as sales volumes, into account. The portfolio analysis offers insights in the trade-offs between the different SPHERE principles and thus helps to prioritize sustainability topics and portfolio items.

Figure 11: Threshold setting prioritization



The results overview typically helps to select a specific packaging solution over another. The results can also help you to identify the high-impact principles for possible preferred packaging solutions. We advise you to go back to the analysis results within that principle and explore whether you can make changes to the packaging to get a more favorable result.

How to act on priorities?

After applying an eco-design analysis, your organization could benefit from a complementary portfolio analysis to identify priority packaging from a broad range of products. This can help you select which packaging to focus on next more efficiently. You can apply both analyses iteratively to address all hotspots, continuously improving the environmental performance of all your packaging solutions.

Case study

From the eco-design analysis, it becomes apparent that packaging options 5A and 5B (both the 5.5-kg bulk PE bag with reusable cotton pouch and glass jar) score favorably for land use, circularity and end of life. Depending on which material the customer uses, you can identify different trade-offs. When using a cotton pouch, five of the six principles perform the best but water consumption overshoots the boundary by over 600%. Moreover, when using glass jars, both climate change and packaging efficiency impacts present important issues.

While there is no straightforward way to judge which packaging option is better than the other, **Sphereal** weighs them considering their overall sustainability goals. For **Sphereal**, the top priorities are climate change and circularity. Thus, the reusable option with a cotton pouch is the preferred solution in the current analysis. However, the company could further evaluate and consider an additional packaging option using a reusable recycled plastic bag. It should also implement strategies to motivate consumer behavior to use cotton pouches.

If, after implementing a pilot project, it turns out that reusable options are best avoided due to uncertainty about consumer behavior and associated impacts, packaging option 2 (PE bag in 100% post-consumer recycled carton box) would be the next best option, performing favorably on 3 principles compared to the alternatives.

Glossary

Actionable metrics: measurements that can help you identify a tangible action to take and measure a part of the overview metric.

Carbon footprint: total amount of carbon dioxide (and other greenhouse gasses, weighted in carbon dioxide equivalents) emitted by all activities of an individual, company, event or other.

Cradle-to-gate: view or analysis of a partial product life cycle from manufacturer to the factory gate. Scoping the impact assessment of a beverage container this way would only consider the span from the production of the product until it reaches a supermarket. Impacts that occur afterwards are not part of this assessment scope.

Cradle-to-grave: view or analysis of a product from the beginning of its source-gathering processes, through the end of its useful life, to disposal of all waste products. Scoping the impact assessment of a beverage container this way would consider the entire journey, from production of the product until it is discarded after use.

Criteria: rules or principles for evaluating the relevance of certain metrics found in the literature (as well as their associated methodologies) to the framework.

Dataset: a collection of related data.

Eco-design analysis: a benchmark of different options for a single product category with the same functionality.

Functional unit: quantified description of a function of a product or service used as reference in calculating and comparing sustainability performance.

Framework: a document setting out procedures and goals to support the selection of the appropriate metrics, methodologies and data sources needed to evaluate a product design over its full life cycle.

Indicator: a specific output resulting from the evaluation of a metric based on a specific methodology.

Methodology: a structured guideline underlying the design and evaluation of a metric.

Metric: a measure of quantitative assessment commonly used for assessing, comparing and tracking the performance of one or more products.

Overview metric: provides a high-level picture based on a collection of other metrics.

Packaging taxonomy: packaging classification (e.g., food, non-food, product category, material type, function) that sets out coherent functional units for comprehensive sustainability assessments.

Portfolio analysis: screening of and identifying hotspots in a packaging portfolio from a company-level perspective (covering all functionalities, all geographies – plastic packaging as an example).

Primary data: refers to the firsthand data gathered by the company itself

Principles: a sub-component of the "packaging sustainability concept" that is quantitatively measurable using one or several metrics.

Proxy (data): practice of substituting a missing or inaccessible data with closely correlated available data.

Renewable content: content derived from sustainably grown bio-based resources that will replenish themselves through a natural process to replace the portion depleted by usage and consumption.

Secondary data: refers to data found in the literature (collected by someone else earlier)

Thresholds: values defined to determine the performance and outcome of the evaluation of each metric. Thresholds can be based on scientific targets, self-declared goals or market average performance.

Tool: facilitates the calculation of one or several metrics using a specific methodology, yielding one or several indicators.

DISCLAIMER

This report is released in the name of WBCSD. Like other reports, it is the result of collaborative efforts by WBCSD staff and experts from member companies. Participants of the workstream Packaging Sustainability Assessment reviewed drafts, ensuring that the document broadly represents the majority of Plastics & Packaging project members. It does not mean, however, that every member company of WBCSD agrees with every word

ACKNOWLEDGEMENTS

WBCSD Plastics and Packaging Project

Julie Cachat – Senior Associate, Circular Plastics & Packaging

SPHERE Framework Development Partners

Julien Boucher, Alexandre Bouchet, Sarah Perreard, EA Earth Action; Stefan Frehland, Quantis; Lukas Hoex, Mariana Revilla Llaca, Alejandra Mosig, Tim Schmütsch, South Pole.

About the Plastics and Packaging project

The way we produce and consume plastics and packaging presents an unprecedented challenge for climate, nature and people. Today, there is a growing demand to transform plastic value chains by shifting to circular business models and decarbonizing the plastic lifecycle, while protecting biodiversity and ensuring that no one is left behind. In our Plastics and Packaging project, we support businesses in accelerating their transition towards sustainable and circular plastics and packaging.

We enable this transition through the development, promotion, and harmonization of metrics and methodologies. This includes frameworks for packaging sustainability assessment and plastic disclosure & reporting; and a discussion platform on the UN Treaty on plastic pollution; Learn more about the Plastics and Packaging project here.

ABOUT WBCSD

WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future.

We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature and inequality sustainability challenge; by co-developing "how-to" CEO guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature and inequality challenges across sectors and geographical regions.

Our member companies come from all business sectors and all major economies, and our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability, united by our vision of a world in which 9+ billion people are living well, within planetary boundaries, by midcentury.

www.wbcsd.org

Follow us on Twitter and LinkedIn

World Business Council
for Sustainable Development

Geneva, Amsterdam, New Delhi, London, New York City, Singapore

www.wbcsd.org