

# PET – from ‘recycling’ to ‘recycling and reuse’ champion: state of play December 2023

## Aim of this paper

The European Commission promotes the following hierarchy in its packaging policies: REDUCE consumption, REUSE and RECYCLE. This supports the ultimate goal of the EU to be climate neutral by 2050. This is a goal shared by the European PET industry.

Over the last decades, PET has helped to:

- Reduce the weight of packaging: Bottles are now significantly (up to 50%) lighter than before. [Chapter 1, 10,11]
- Increase collection & recycling: All over the EU, PET bottles are increasingly collected and recycled, which led to an EU-wide recycling rate of 61% in 2020. [Chapter 2, 1]
- Promote ‘reuse’: PET packaging can play a vital role by avoiding the use of material through reuse systems.

The following state of play document was developed by the Petcore Europe Reuse Working Group to show the potential that PET packaging has in terms of reuse and how reuse solutions can complement single-use recyclable packaging in a circular economy of PET in Europe.

**A smart mix of different systems and types of packaging is needed** that depends on the characteristics of each market, and reuse can play a more or less important role. The overall objective should be **to use packaging in the most circular way possible** while **keeping the environmental impact as low** and the **packaged goods as safe** as possible. Any shift to reuse needs to be preceded by extensive impact assessments and the transition must be well managed considering the many changes required along the value chain.

Today, a **policy shift towards reuse** can be observed in several EU member states with measures diverging strongly between countries which could endanger the EU single market. In certain member states, such as Germany, reuse already plays an important role. Moreover, not all regions can move at the same speed to implement reusable solutions. However, **if EU countries implement policies to foster reusable packaging, this should be done in a consolidated manner and with cross-border alignment.** In parallel, EU mandates for reuse and refill should not demotivate markets that are well advanced and exceed the EU quotas.

## Table of Contents

1. What is PET and why does it matter? .....	2
2. When does reuse become pertinent in addition to recycling? .....	4
3. Best practice examples of reusable PET packaging .....	6
4. DRS: An effective collection tool for single-use and refillable PET bottles .....	8
5. Considerations regarding the environmental footprint of PET packaging solutions .....	9
6. The road towards more reuse and recycling.....	11

## 1. What is PET and why does it matter?

PET (Polyethylene Terephthalate) was first developed for use in synthetic fibres by British Calico Printers in 1941. The patent rights were then sold to DuPont and ICI who in turn sold regional rights to many other companies. Today there is a number of large corporations across the globe producing PET resins.

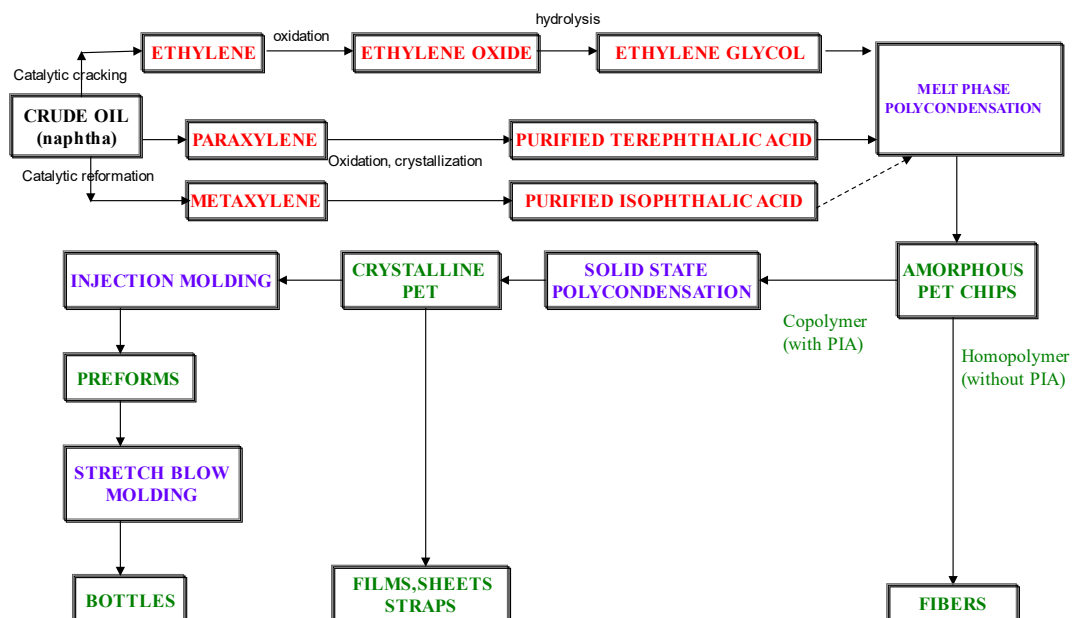
Although originally produced for fibres, PET began to be used for films and sheets (packaging, X-ray and photographic film etc.) in the mid-1960s. In the early 1970s, the advent of Solid State polycondensation brought about the ability to commercialize bi-axially oriented, rigid bottles that resulted in **light bottles with very good mechanical performance**.

PET's attributes as a **strong but lightweight** form of a clear polyester make it **the ideal polymer for soft drinks, juices, alcoholic drinks, water, edible oils containers, household cleaners, vehicle parts, clothing, as well as other food and non-food applications**. Being a polymer, PET consists of long chains of repeating units containing only the carbon (C), oxygen (O), and hydrogen (H) elements.<sup>1,2</sup>

### Structure of PET

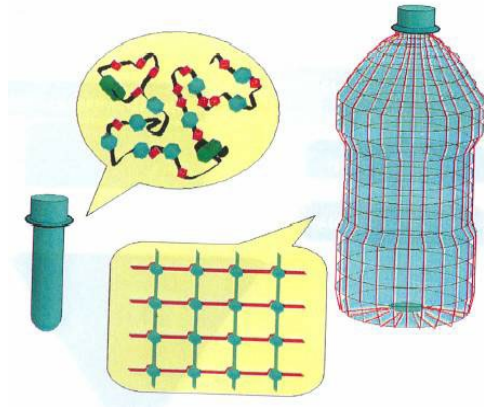


## Polyethylene Terephthalate production flowchart<sup>9</sup>



Today, bottles represent the most significant use of PET resins for packaging. PET bottle manufacturing starts with raw materials (paraxylene, metaxylene and ethylene). These raw materials are then used to manufacture ethylene glycol, terephthalic acid (PTA) and isophthalic acid (IPA) that are reacting to obtain the Copolymer PET resin. Their sources are from the refinery industry mainly, but as technology progresses, they may also be produced using renewable sources and recycling technologies/material. The resin, in the shape of small cylinders called pellets, is melted, and injected into a mould to make a

preform. The preform (shaped like a ‘test tube’) is shorter than the final bottle, but with thicker walls. The preform is then blow-moulded. During the blow-moulding phase, high-pressure air is blown into



the preform allowing it to take the exact shape of the mould. The final product is, due to the molecular structure of the material, a **transparent, unbreakable, resealable, and lightweight bottle.**<sup>3</sup>

The strength of the material contributes to the success of PET. Indeed, carbonated soft drinks can generate pressure inside the bottle reaching up to 6 bar. Another advantage of the material lies in its physical properties that allow for great freedom in design. PET’s major use (approx. 70%) is for packaging of carbonated soft drinks, fruit juices, dilutable drinks and bottled water. Light, durable, safe and with a smaller carbon footprint than alternatives.

**PET is approved as safe for use in direct food contact** in the EU<sup>4</sup>, by the US’s FDA<sup>5,6</sup> and health agencies across the world. PET’s continued use in the food, beverage, pharmaceutical and medical sectors is proof of this valuable material’s **safety and versatility**. **Repeated studies, regulatory approvals and testing show that PET is safe.**

PET is a well-known polymer packaging material across the globe. On top of its very good mechanical properties, it also shows **significant environmental advantages** vs alternate beverage packaging materials.<sup>7</sup> For instance, PET generates up to 75% less CO<sub>2</sub>eq than glass or aluminium single-use beverage packaging (per 500ml packaging).<sup>5</sup> **LCA studies show that, depending on the accompanying conditions** (transport distance, logistics, energy mix), **in one specific market a single-use recyclable PET bottle can be best in class**, yet in **another market** this could be the case for a **reusable PET bottle.**

<sup>6</sup>

Aluminium is recyclable and can be remade into packaging. However, the process of producing and recycling aluminium is highly resource intensive. To make cans, aluminium must be processed to much higher temperatures that result in higher emissions, and even cans made with recycled aluminium release more CO<sub>2</sub>eq per ton than bottles made from recycled PET. Also, to date, there is no viable reusable aluminium packaging in the market.

Glass also requires very high temperatures to be made or remade from existing glass. The material is also significantly heavier than plastic, weighing up to 10 times more and resulting in a significantly larger carbon footprint for transport. This means that **reused or recycled PET bottles produce lower transport emissions** than reusable glass bottles as they are much lighter.

While raw paper and cardboard are biobased and biodegradable, food containers made with these materials are multilayer with plastic and aluminium, making them not circular.<sup>8</sup>

## Key take-aways of this chapter

- PET's attributes as a **strong but lightweight** form of a clear polyester makes it the ideal polymer for soft drinks, juices, alcoholic drinks, water, edible oils, household cleaners, vehicle parts, clothing, and other food and non-food applications. Being a polymer, PET consists of long chains of repeating units only containing the carbon (C), oxygen (O), and hydrogen (H) elements.
- PET is safe for food contact either as virgin PET, refillable/reusable PET or recycled rPET.
- PET's unique characteristics bring it to a leading position supporting and promoting the circular economy.

## 2. When does reuse become pertinent in addition to recycling?

In this paper, only primary packaging solutions in the business to consumer area are covered. We can differentiate between refill at home, refill on the go as well as return from home and return on the go solutions. Further details can be found in chapter 3.

According to ISO 18603, the reuse of packaging is any operation by which packaging is refilled or used for the same purpose for which it was conceived, with or without the support of auxiliary products present on the market, enabling the packaging to be refilled. An auxiliary product is a product used to support the refilling/loading of reusable packaging. An example of an auxiliary product is a PET detergent pouch used to refill a reusable container at home.

30-40 years ago, Deposit Return Systems (DRS) for reusable PET bottles were common in Northern Europe and Germany but have switched, in some cases, to DRS for recycling for practical and CO<sub>2</sub>eq emission reasons. While reuse will play a major role in the future, the collection and recycling of single-use packaging remains an important element related to circularity.<sup>1</sup>

Reuse is a priority not only at the EU level where the **Packaging and Packaging Waste Directive review aims to improve packaging design to promote reuse and recycling**. The **Waste Hierarchy** laid out in the Waste Framework Directive in 2008 clearly puts **reuse** on the agenda as a **priority** in the circular economy. At the same time, a **policy shift towards reuse** can be observed in several EU member states on a national level.

- In France for example, the Circular Economy Law and Climate Change Law set out **general reuse targets for packaging** (5% by 2023 and 10 % by 2027)<sup>2</sup> as well as specific targets for retailers to dedicate 20% of their space to refill/reuse in storefronts larger than 400 m<sup>2</sup> by 2030.<sup>3</sup>
- In Austria, **reuse targets for beverages**: 25% (2025); 30 % (2030) have been confirmed. In the country, retailers are to fulfil reusable quotas for beverages in minimum 90% of their storefronts larger than 400 m<sup>2</sup> by the end of 2025: beer and bottled water each 15%; juice, soft drinks and milk each 10 %.<sup>4</sup>
- Also, Spain is planning **reuse measures with ambitious targets** laid down in a draft. According to the draft Royal decree, the hotel and restaurant sectors are to meet the following quotas:
  - Bottled water: reuse quota of 50% in 2025 and 60% in 2030.
  - Beer: reuse quota of 80% of in 2025 and 90% in 2030.
  - Soft drinks: reuse quota of 70% in 2025 and 80% in 2030.
  - Other beverages: reuse quota of 50% in 2025 and 60% in 2030.

Furthermore, retailers will have to ensure the availability of reusable packaging.

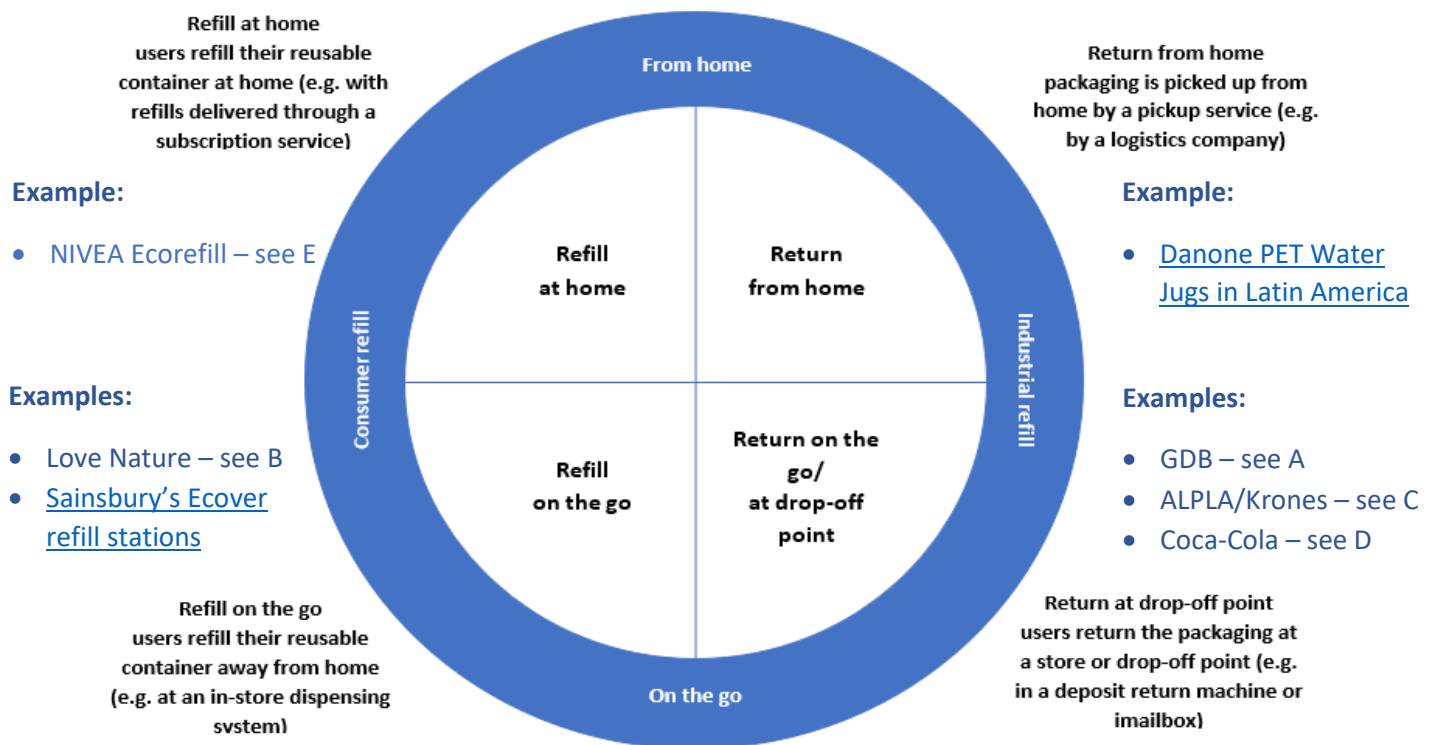
Even though the PET industry supports the scale-up of reuse systems in addition to recyclable packaging solutions, **undifferentiated reuse quotas should be looked at with caution**. Legislation should be evidence-based and always favour the least complex, most environmental-friendly, and most recyclable packaging solution. At the same time unharmonized “island solutions” all over Europe should be avoided.

In Germany, reuse solutions have been around for several decades. According to data from ReLoop<sup>8</sup>, between 2016 and 2020 the **reusable share of PET beverage bottles (water, soft drinks and juices) in Germany remained high at around one third**. At the same time the share of reusable PET beverage bottles in terms of all reusable beverage containers including glass was around 40 %. This shows a **continuous market acceptance of reusable PET bottles** with the German end consumers. These numbers could lead us to believe that **PET can play a crucial part in a reuse revolution** also in other parts of the **EU**, helping to achieve a **climate-neutral continent by 2050**. Recent studies by GVM<sup>7</sup> point out that **reusable beverage packaging can reduce material consumption** if the number of circulations of each packaging is high enough. With **reusable PET bottles**, the **waste avoidance potential generally materialises faster** than with reusable glass bottles. However, a too high proportion of reusables for obvious transportation and CO<sub>2</sub><sub>e</sub>q emission reasons does not only bring advantages. The transport effort in such a scenario increases considerably.<sup>7</sup> Moreover a reusable PET bottle is thicker than a single use (for obvious packaging stability reasons). This shows that decisions whether to go for reusable or single-use packaging should be made case by case considering all relevant criteria.

### Key take-aways of this chapter

- **Reuse** has become a key element to consider and proceed with **at the EU and at national level** which manifests itself by a **policy push**.
- Reuse quotas should be looked at with caution. **Legislation** development and implementation should be **evidence-based** and always favour the least complex and most environmental-friendly packaging solution. **In one specific market, a single-use recyclable PET bottle can be best in class, in another market this could be the case for a reusable PET bottle.**
- **PET can play a crucial part in a reuse revolution** helping to achieve a **climate-neutral continent by 2050**.

### 3. Best practice examples of reusable PET packaging



*This Reuse Model is based on the work of the EMF with further clarification whether the consumer refills the packaging or returns it for industrial refill. The model covers only primary packaging in the B2C area. Secondary and tertiary packaging as well as B2B applications are not covered explicitly. This model intends to help better understand the different reuse systems possible for PET end-consumer packaging.*

Today, there are **already several best practice examples of reusable PET packaging** available, including refill at home, refill on the go as well as return from home and return on the go solutions. The following are just some of the many examples available:

#### A) Cooperative of the German Mineral Water companies (GDB) PET-refillable Systems

GDB's refillable PET systems celebrate their 25th anniversary in 2021. Today they are an integral part of the refillable pools of German mineral water companies. **Around 2 billion PET bottles were filled in 2020.** According to GDB, they have a **return rate** of around **99%**. Refillable PET bottles are filled an average of 20 times, the maximum number of trips is 25. The associated crates in the system record an average of around 100 trips. There are bottles of different sizes in the system: 0.5- and 0.75-liter bottles for soft drinks, 0.5-liter, 1.0-liter bottles and, with a very small market share, 1.5 liter-bottles for mineral water.<sup>1</sup>

The GDB refillable system is a **system of pool bottles**. In such a system the same standardized bottles and crates are used by different mineral water companies throughout Germany. The system is therefore particularly efficient, as it **causes little**

#### Return at drop-off point



**sorting efforts** during return and transport routes can be significantly shortened. An **empty bottle does not have to be returned to its place of origin but is simply brought to the nearest mineral water company**, which also uses this type of bottle. In addition, the predominantly medium-sized mineral water companies achieve cost advantages through the size of the joint system.<sup>1</sup>

Importantly, although the GDB system can be hailed as a best practice, it is important to understand that **some characteristics are specific to Germany** and not easily replicable by other Member States.



Credit: Genossenschaft Deutscher Brunnen

#### B) LOVE NATURE AND KAUFLAND 100 % rPET reusable bottles

Together with the Henkel brand "Love Nature", the German Grocer Kaufland is setting up stations where customers can refill bottles they have purchased over and over again. **The bottle bodies are made of 100 % recycled PET and are fully recyclable.** When making their first purchase, customers can simply take an empty bottle from the station, fill it, weigh it and then pay at the checkout. **When refilling, the cleaned bottle brought from home is refilled and weighed - at the checkout, customers then only pay for the filling.**<sup>2</sup>

#### Refill on the go



Credit: Kaufland

#### C) REUSABLE PET BOTTLES FOR SENSITIVE BEVERAGES

In the beverage packaging market, returnable PET containers currently play a rather small role. A joint research project of ALPLA and Krones brought to light that this could change in due time. Based on the findings of the project, ALPLA and Krones developed a **reusable PET bottle that provides an optimal environment for sensitive products such as juice and milk** in the cold chain. Due to their lightweight the developed **bottles are an environmentally sound packaging solution with an advantage over glass bottles:** Over the course of several cleaning cycles, the alkaline cleaning medium visibly roughened the surface of the glass bottle, whereas nothing comparable could be observed with the PET containers.<sup>3</sup>

#### Return at drop-off point



Credit: ALPLA

#### D) Coca-Cola Reusable PET Bottles outside the EU

Outside the European Union, Coca-Cola has been successfully running **reuse models with reusable PET bottles for several years.** In **Brazil** for example, customers pay a deposit fee when purchasing soda in a refillable bottle by receiving a discount on their next purchase when they return the empty bottle to the store – a reward feature that ensures a **return rate of above 90%.** The bottles last **up to 25 cycles and are recycled at the end of their lives.**<sup>4</sup> A similar system can be found in **South Africa**, where a pilot project has been started in November 2019 and gradually rolled out.<sup>5</sup>

#### Return at drop-off point



In **Germany** reuse models with reusable PET bottles are in the market for several years.

Credit: ALPLA

#### E) NIVEA Eco-Refill

NIVEA offers reusable PET hand soap bottles that can be refilled by the customer by adding warm water and a refill tab to generate hand soap. The bottle is made of recycled material and is especially designed to be re-used.<sup>6</sup>

#### Refill at home



Credit: NIVEA

For all given best-practice examples and other reuse and refill solutions, consumer safety and hygiene remain the highest priority and those systems need to take this factor into account. According to a statement issued by the Cooperative of the German Mineral Water companies (GDB) the processes for cleaning refillable glass and PET-bottles, which have been established and continuously developed for decades, have always taken hygienic aspects into account with regards to potential contamination with bacteria or viruses. During the industrial cleaning process, refillable bottles are submerged for about 10 minutes in 1.5 to 2 percent caustic soda, which is heated to 60 ° C for PET or 70-75 ° C for glass. These sterilization procedures are established worldwide and are considered safe.

#### 4. DRS: An effective collection tool for single-use and refillable PET bottles complimentary to curbside collection

Deposit Refund Schemes (DRS) are a proven **tool to collect high quantities of beverage containers for closed loop high-quality recycling (rPET) and reuse**. These systems see customers pay a small deposit when they purchase a can or a bottle, which they get back when they return the container to a collection point for recycling. Typically established through legislation passed by state or national governments, DRS are known for their effectiveness, with **leading systems routinely recovering more than 90% of deposit containers sold**. DRS programmes are increasingly being developed across the world and in Europe where about 20 EU countries will be adopting them by 2025<sup>1</sup>. It will be determinant in achieving the EU recycled content objective for 2025 and 2030: by the end of 2020, 136 million people were covered by a DRS system in Europe. It is expected that by 2023 several countries, representing 130 million more people, will deploy DRS systems while the successful curbside system will continue to operate.

**“DRS for reusable beverage plastic bottles” is not a panacea but can play a complimentary role in markets with “DRS for single-use recyclable beverage containers” and in markets with “curbside collection.”** Even though DRS are important tools for single-use recyclable PET beverage containers and are recognised as a solution to reach the increasingly ambitious EU targets for separate collection of PET bottles (90% by 2029) and recycled content (25% by 2025)<sup>2</sup>, it does not mean that DRS have to apply to countries such as Belgium where the curbside collection system is achieving good enough results.

DRS is a mechanism that can facilitate the adoption of a system for refillable (reusable) beverage containers. The collection infrastructure and other DRS functionalities can indeed be integrated and used for both single-use and reusable packaging with a deposit. For refillables in particular, the



implementation of a deposit on products is a key condition for a well-functioning system. This is already the case in several Member States (such as Germany, Estonia, Lithuania, Finland, Denmark, and Sweden). From the perspective of both consumers and retailers, there is a single point of return, and experience shows that in the context of general decline in refillable bottles, **the introduction of a DRS on single-use bottles has stabilised and halted the decline of refillables<sup>3</sup>.**

### Key take-aways of this chapter

- Legislated **Deposit Refund Schemes (DRS)** are a **proven tool** to collect high quantities of beverage containers for reuse and high-quality recycling.
- Although DRS for single-use and systems for refillables differ, the **creation of centralised deposit systems for single-use beverage containers creates good pre-conditions for the growth of refillables.**

#### 5. Considerations regarding the environmental footprint of PET packaging solutions

Petcore Europe firmly believes in an **evidence- and science-based decision-making process** to avert the enactment of non-scientifically supported policies that could severely hinder economic operators without bringing environmental benefits.

**Life Cycle Assessment (LCA)** is an **established method** which enables the industry to quantify environmental impacts and improve products, production processes, services etc. and therefore, to contribute to achieve EU's overarching goal of climate neutrality. LCAs can also provide clear and reliable information about environmental performances to both businesses (B2B) and consumers (B2C).

PET characteristics, like mechanical and pressure resistance at very low bottle weights, transparency, bottle to bottle recyclability, make it an ideal material for beverages. Many Petcore members create LCA studies to quantify the environmental impacts of their products or newly developed technologies along the PET value chain. A lot of them focus on the production and/or use of PET packaging. **Petcore's members offer both single-use and reusable PET bottles across Europe.** According to ALPLA<sup>1</sup>, PET either as single-use or as a refillable **demonstrates great environmental benefits versus other available primary packaging materials.** In addition, through effective collaboration with our value chain partners on separate collection, quality sorting and recycling, an increased uptake of recycled PET finds its way into the new bottles; "reusing", thus, the same material over and over. This **"reuse" in closed loop (i.e. beverage bottle becomes a beverage bottle)** reduces the material's environmental footprint and makes it comparable, from an LCA perspective, to refillable PET solutions.

Refill systems are present in many Member States and should be further promoted when they demonstrate an improved environmental, social and economic performance. Refill is often presented as the only solution to reduce carbon footprint and waste. However, studies<sup>1,2</sup> show that **refill systems are not necessarily the best option from an environmental perspective. A great number of elements must be looked at**, such as weight of the packaging, sales channel, transport distance, water use for cleaning purposes, Reuse loops, etc. Considering the above, the analysis needs to be conducted on a case-by-case basis and most probably the **ideal solution lies in the combination of single-use and refillable PET bottles.**

It must be pointed out, that different standards and methods for LCA reporting exist and the universal applicability of some of them leaves a lot of room for interpretation, which may affect the consistency and comparability of the results. Currently, there are more than 200 environmental labels active in the EU, and more than 450 active worldwide; there are more than 80 widely used reporting initiatives and methods for carbon emissions only. Some of these methods and initiatives are reliable, some not; they are variable in the issues they cover.<sup>3</sup> To tackle this issue, the European Green Deal states “Companies making ‘green claims’ should substantiate these against a standard methodology to assess their impact on the environment”.

In 2013 the European Commission published the **PEF (product environmental footprint)**-guidelines that enable the conduct of reproducible, comparable, and verifiable life cycle analyses. This is achieved, among others, by establishing of detailed requirements for the identification of the environmental impacts associated with the material/energy flows, as well as the emissions and waste flows associated with a product throughout its life cycle and the environmental impact categories with mandatory characterization models per impact category.<sup>4</sup> From 2013 to 2018 there has been a pilot phase of PEFCRs, where various food and non-food sectors participated and defined their category rules. **Natural Mineral Waters Europe (EFBW at the time)** was one of the sectors which **defined its own (packed water PEFCRs)** and Petcore was greatly involved in its Steering Committee. The rules provided in the PEF method **enable to conduct PEF studies that are more reproducible, comparable, and verifiable, compared to existing alternative approaches.** However, comparability is only possible if the results are based on the same Product Environmental Footprint Category Rules (PEFCR).<sup>4</sup>

## 6. The road towards more reuse and recycling

As shown in the previous chapters, the **PET industry supports the scale-up of reuse systems in case they show sustainability advantages. PET packaging has an inherent potential in terms of reuse** which is showcased by the best practice examples in this paper. Indeed, due to its excellent environmental performance, PET packaging can play a vital role in achieving climate neutrality, not only through recycling, but also by reducing the weight of packaging and the introduction of reuse systems. However, a **clear and forward-looking regulatory environment** is essential for the road towards more reuse and recycling. Here are our recommendations to help achieve it:

- In the long-term a smart mix of different systems and types of packaging is needed. Depending on the characteristics of each market and consumer, reuse can play a more or less important role. The overall objective should be to use packaging in the most circular way possible while keeping the environmental impact as low and the packaged goods as safe as possible and as convenient as possible for the consumers. **Any EU target should therefore provide manufacturers with the flexibility to invest in the most appropriate packaging mix.**
- Any shift to an increased use of reusable packaging needs to be well managed, considering the changes required to the supply chains (new bottling lines, logistics, etc) and the related investments needed. **Manufacturers should also have the time to adapt to the changes and the methodology to calculate the achievement of any reuse target should be made available well in advance.**
- Even though the PET industry supports the scale-up of reuse systems, **undifferentiated reuse quotas should be looked at objectively and with caution.** Legislation should be evidence-based and always favour the least complex, most environmental-friendly, most recyclable packaging solution adapted to the local markets. A great number of elements must be looked at, such as weight of the packaging, sales channel, transport distance and efficiency, water use for cleaning purposes, recycled material content etc. **Tailored impact assessments should precede any decision on reuse at the EU or Member State level.** An analysis needs to be conducted on a case-by-case basis and most probably the **ideal solution lies in the combination of single-use and reusable solutions.**
- Optimized harmonized solutions regarding reuse policies all over Europe should be recommended to safeguard the EU single market. **If EU countries implement policies to foster reusable packaging, this should be done in consolidation and with cross-border alignment as well as consideration of lifecycle assessments.**
- **Deposit Refund Systems (DRS)** for single-use beverage containers create good pre-conditions for the growth of refillables and single-use recyclable containers. Such systems need to be tailored to national and/or local specificities, but they **must be further promoted in the EU and designed according to a set of universal principles and elements to ensure their effectiveness and cost-efficiency.**
- Finally, **consumer safety and hygiene remain the highest priority.** EU decision-makers need to take this factor into account, provide guidance and exempt from any reuse target applications where the safety of the product can't be guaranteed.

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