

Multilayer packaging with its own material cycle

# Reusable without washing

IQpak, a newly developed three-layer polypropylene packaging, combines the advantages of reusability and material recycling. High standards of sustainability, hygiene and flexibility of use combine with minimal use of materials. IQpak can save up to 70% of carbon emissions compared to conventional packaging.

**S**o far, no alternative to plastic is available for food packaging. Goods packaged in plastic stay fresh for a long time, which helps to reduce food waste. In addition, lightweight plastic packaging contributes directly to the conservation of resources.

Although much of today's packaging is designed with minimal material input, the sheer volume of packaging in the food sector continues to grow worldwide. Between 2011 and 2021, packaging waste increased by more than 20% in the EU alone. At 236 kg per capita, Germany's packaging waste volume in 2021 was significantly higher than the EU average of 189 kg. Studies including one conducted by McKinsey in 2018<sup>1</sup> suggest that an increase of up to 80% is expected worldwide by 2030 compared to 2018.

Solutions that reduce the amount of plastic used and at the same time return recyclable materials to the loop are equally urgent for the food industry and for waste management.

The individual components that make up food packaging are often difficult to separate. That applies especially for multilayer films and even more complex composites, for example for beverage cartons. In order to improve recyclability, product development is increasingly focused on packaging solutions with monomaterials.



**Processing technology center** at the Fraunhofer LBF in Darmstadt. LBF specialists used the chill-roll process to produce films of different thicknesses for the handling and content layers of the IQpak system. *Photo: Fraunhofer LBF*

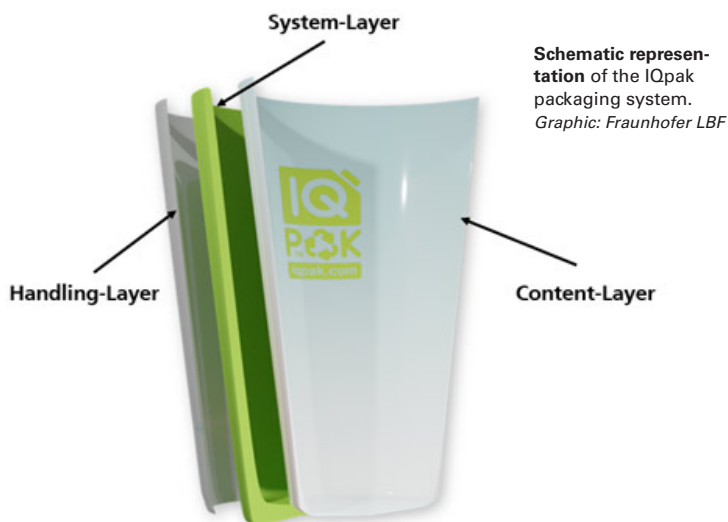
## Life cycle assessments of reusable packaging

However, this method does not significantly reduce the amount of material used. Milk cartons, food cans and yoghurt pots are discarded straight after use and, even after several sorting steps, can only be partially processed into recyclates and returned to the material cycle. This not only wastes valuable resources, but the production and disposal of packaging also

generates additional carbon emissions. In order to drastically reduce packaging waste, we need functioning reusable systems.

### FOOTNOTE

<sup>1</sup> [https://www.mckinsey.com/de/~media/mckinsey/locations/europe%20and%20middle%20east/deutschland/news/presse/2018/2018-12-19-plastikmuell/181219\\_pm%20plastikmuell\\_mckinsey.pdf](https://www.mckinsey.com/de/~media/mckinsey/locations/europe%20and%20middle%20east/deutschland/news/presse/2018/2018-12-19-plastikmuell/181219_pm%20plastikmuell_mckinsey.pdf).



The core problem in making reusable systems sustainable is cleaning. Currently, water is typically used for washing. However, washing plastic packaging hygienically comes with its own major problems. The washing process requires large amounts of water and energy, plus aggressive washing lyes. In addition, use and cleaning put a strain on the packaging material so that this type of reusable packaging often only survives a relatively small number of circulation cycles. Obviously, the fewer circulations, the smaller the ecological advantage.

The consequence is that single-use solutions sometimes achieve a better ecological rating than reusable systems. This means there is an urgent need for new solutions.

### The three-layer solution ...

The IQpak packaging system offers an effective solution. The name says it all: „intelligently packaged“. The company Löning & Partner from Oldenburg in Lower Saxony, which specializes in returns logistics and recycling, developed the system in cooperation with the Plastics Research Division of the Darmstadt-based Fraunhofer Institute for Structural Durability and System Reliability LBF. The German Federal Environmental Foundation (DBU) supported the project „Smart and sustainable packaging system for system catering using the example of a returnable deposit cup“ from February 2023 to March 2024.

Right from the outset of the development project, the company and the research institute focused on the following

points: eliminating conventional washing processes, maximizing container circulation cycles, establishing practicable returns logistics with a deposit system and enabling transparent recycling of the materials used via a database system. The goal was to provide a solution that has clear ecological and economic advantages over conventional packaging.

IQpak relies on a material for which effective recycling strategies already exist. This material – mainly polypropylene – is assembled into a three-layer container that is equally suitable for food packagings and non-food applications.

### ... and a single base material

The main element of the packaging system is the system layer. With a thickness of around 1.5 mm, it forms the durable, structure-giving component. It ensures stability and robustness and guarantees a large number of cycles.

This system layer is manufactured in an injection molding process. In addition to conventional injection molding, foam injection molding is also possible in order to further reduce the weight or increase the thermal insulation properties. An NFC chip is integrated in the system layer. The chip enables each individual package to be uniquely assigned in the IQpak database. NFC stands for Near Field Communication.

To protect the valuable system layer, it is sandwiched between two layers of very thin plastic film. The handling layer is on the outside. Customers come into contact with this when using the packaging. The handling layer also allows customized

product information and design during each refurbishing process.

The content layer is inserted inside the system layer to provide a hygienic container for the filling product. A barrier layer is integrated in the content layer depending on the specific filling product.

In all cases, this is a monomaterial solution based on polypropylene with slight adaptations depending on the required functionality. The handling layer consists either of oriented polypropylene drawn over the system layer in a shrink-film sleeve process, or of polypropylene applied in a conventional thermoforming process. The specific design of the content layer, which is also made of polypropylene monomaterial, depends on the product it will contain.

A slight modification of the thermoforming process has already achieved a wall thickness of just 10 µm for the disposable components, i.e. the films of the handling and content layers. The current aim is to achieve average layer thicknesses of the two films of between 30 and 60 µm. The system layer is 1.5 mm thick.

Therefore, the IQpak system significantly reduces the amount of material used in production and recycling. The manufacturing process is also suitable for large-scale production, making it easy to scale up for a high degree of cost-effectiveness.

### Only the films are replaced

Both the handling and content layers are highly material-minimized disposable components that are recycled within the system after use. As the three layers are only connected to each other via slight undercuts with no adhesive intermediate layer, they can easily be separated from each other during the refurbishment process.

After mechanical recycling, the handling and content layers remain in the IQpak material cycle. Following a non-food application, they are processed into new handling and content layers. Single-variety collection would even enable targeted processing, making the use of recycled polypropylene (rPP) for the food sector a possibility in the future. This process would be a new departure in the packaging industry. The aim of the system is to keep all material in the IQpak cycle.

The core element of IQpak is therefore a reusable packaging system without the

usual washing process. The outer and inner film are automatically removed, recycled and reused, while the system layer remains clean throughout the entire cycle without any need for washing.

Since the outer layer protects the system layer during use, the circulation cycles of the system layer are theoretically infinite.

## Climate protection

The brief report<sup>2</sup> on the indicative environmental assessment prepared by the Institute for Energy and Environmental Research (Ifeu) in Heidelberg in summer 2023 confirms the ecological advantages of the IQpak packaging system. In the associated study, Ifeu compared a 500-ml reusable cup, as used in system catering or in the coffee-to-go sector and cleaned by rinsing according to the current state of the art, with the three-layer cup from the IQpak concept.

The study concluded that the IQpak cup directly reduces CO<sub>2</sub> emissions by 60% compared to the reusable cup. In other words, the energy required for recycling – processing and thermoforming – an IQpak container is less than half as emission-intensive as washing a reusable cup. And this CO<sub>2</sub> saving is achieved with every cycle.

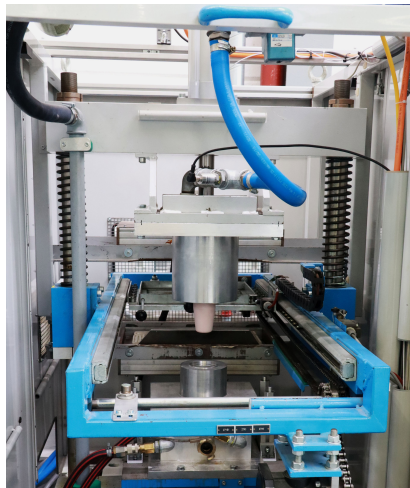
In comparison with conventional composite beverage cartons, which already perform very well in terms of carbon emissions, IQpak even achieves CO<sub>2</sub> savings in the region of 70% from a circulation frequency of 50 cycles. This calculation was carried out by Fraunhofer LBF on the basis of Ifeu data.

## Tracking by chip

There are also further benefits. The NFC chip integrated in the system layer allows individual packages to be assigned via a database. Information on the material and batch of each container is stored digitally in this database.



**A disassembled IQpak drinking cup dummy:** At the front, the thin films of the handling and content layers, at the back the thicker-walled system layer. The NFC chip is integrated in the base of the system layer for assignment in the database system. *Photo: Fraunhofer LBF*



**Typical thermoforming machine** for inserting the thin content layer into the stable system layer – a fast and mechanically simple process. *Photo: Fraunhofer LBF*

This enables the thin film layers of the content and handling layers removed during the recycling process to be sorted by type and sent for mechanical recycling in a targeted manner. The IQpak database system also makes it easy to assign a deposit value. The value of individual packagings can be variable (dynamic deposit) and can also be traded across borders (cross-border deposit). After the deposit has been returned, it is reset in the database via the NFC chip so that multiple repayments are impossible.

This digital recording would significantly simplify returns logistics, making it possible for retailers to handle returns in their own containers. This type of logistics is essential for IQpak, because the system is designed for very large quantities that would currently be almost impossible to manage with processes in the retail industry.

All players in the reusable cycle can access the IQpak database in order to use the data relevant to them. As all containers can be localized at any time, the pool size can be actively managed. As a result, the pool remains small and the circulation cycles increase. Naturally, the database does not collect any user information. Data privacy is guaranteed at all times.

IQpak therefore has the potential to replace a large proportion of conventional packaging. The system is a better, more sustainable and more cost-effective alternative to drinks cartons, containers for dairy products such as yogurt or ice cream, trays and various containers from the to-go sector such as coffee or soft drink cups and bowls. IQpak is the more sustainable, minimal-material reusable solution for almost all consumer goods in normal retail sizes.

[www.loe-up.de](http://www.loe-up.de), [www.lbf.fraunhofer.de](http://www.lbf.fraunhofer.de)

## FOOTNOTE

<sup>2</sup> [https://iqpak.com/downloads/ifeu\\_IQPAK\\_Kurzbericht\\_Aug\\_2023\\_V2\\_2.pdf](https://iqpak.com/downloads/ifeu_IQPAK_Kurzbericht_Aug_2023_V2_2.pdf).

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*Photo: Fraunhofer LBF*

