COMPARATIVE LCA OF FISH BOXES

2025

Study context and objectives

PPWR reuse targets

The Packaging and Packaging Waste Regulation mandates:

- At least 40% of packaging must be reusable within a reuse system by 2030
- At least 70% of packaging must be reusable within a reuse system by 2040

Study purpose

To evaluate and compare the environmental, economic, and social impacts of different types of packaging for transportation of fish.

Study methodology

A life cycle analysis carried out in 2025 by independent Belgian RDC Environment compares packaging made of four different materials for transporting fresh fish. The analysis has been carried out in:

ISO compliant

Follows ISO 14040/44 and PEF-compliant methodologies

Functional unit

Transport and protect fresh fish on ice in direct contact with packaging during EU distribution to deliver 1 kg of fish fit for consumption.

System boundaries

Cradle-to-grave assessment covering raw material sourcing, box and ice production, transport logistics, reuse (if applicable), and end-of-life.

The analysis includes full-system inputs and outputs: **transport, insulation requirements, spoilage risk, washing (where applicable), and disposal or recycling under steady-state operation**. The results show that the choice of packaging affects both product quality, transport efficiency and environmental footprint.

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The study compared four different packaging materials

EPS PACKAGING

Current industry standard with 25kg capacity. Weight: 600g.

CARDBOARD PACKAGING

Corrugated box with PET coating for water resistance. Weight: 1271g. Requires ice to be packed in watertight bags.

REUSABLE PP PACKAGING

Double-wall technology for better insulation. Weight: 4412g. Used up to 60 times.

REUSABLE HDPE PACKAGING

Weight: 2960g. Used up to 60 times.

For fish farmers, this analysis is not just about materials, but how to
ensure product quality, meet regulatory requirements and reach distant markets – without increasing emissions.

The results of the analysis vary depending on the transport distance, which is the critical factor

PERFORMING OPTIMALLY

-Has environmental or cost disadvantages

- High environmental impact and risk of food waste

DISTANCE *(KM)*	 EPS	 LAMINATED CARDBOARD	 INSULATED PP REUSABLE PACKAGING	NON-INSULATED REUSABLE HDPE	COMMENTS
0 – 200					All formats can work under optimal conditions (short return, low waste, many reuse cycles).
200 – 500					Cardboard and HDPE have a higher climate footprint due to a greater need for ice and a higher risk of waste.
500 – 900					HDPE drops out due to temperature loss over ~720 km.
900 – 1250					Reusable boxes have an increased environmental impact due to return transport and washing.
1250 – 2800					EPS is the only packaging that is recommended over 1250 km.

Results assume steady-state systems with optimized conditions for each format. Real-world deviations in reuse cycles, return logistics, or spoilage rates may shift relative performance.

EPS PERFORMS OPTIMALLY WITHIN ALL DISTANCE INTERVALS

Key factors affecting environmental performance

Distribution distance

For distances below 200 km, all boxes have similar environmental impacts. As distance increases, single-use EPS becomes more advantageous due to better insulation properties.

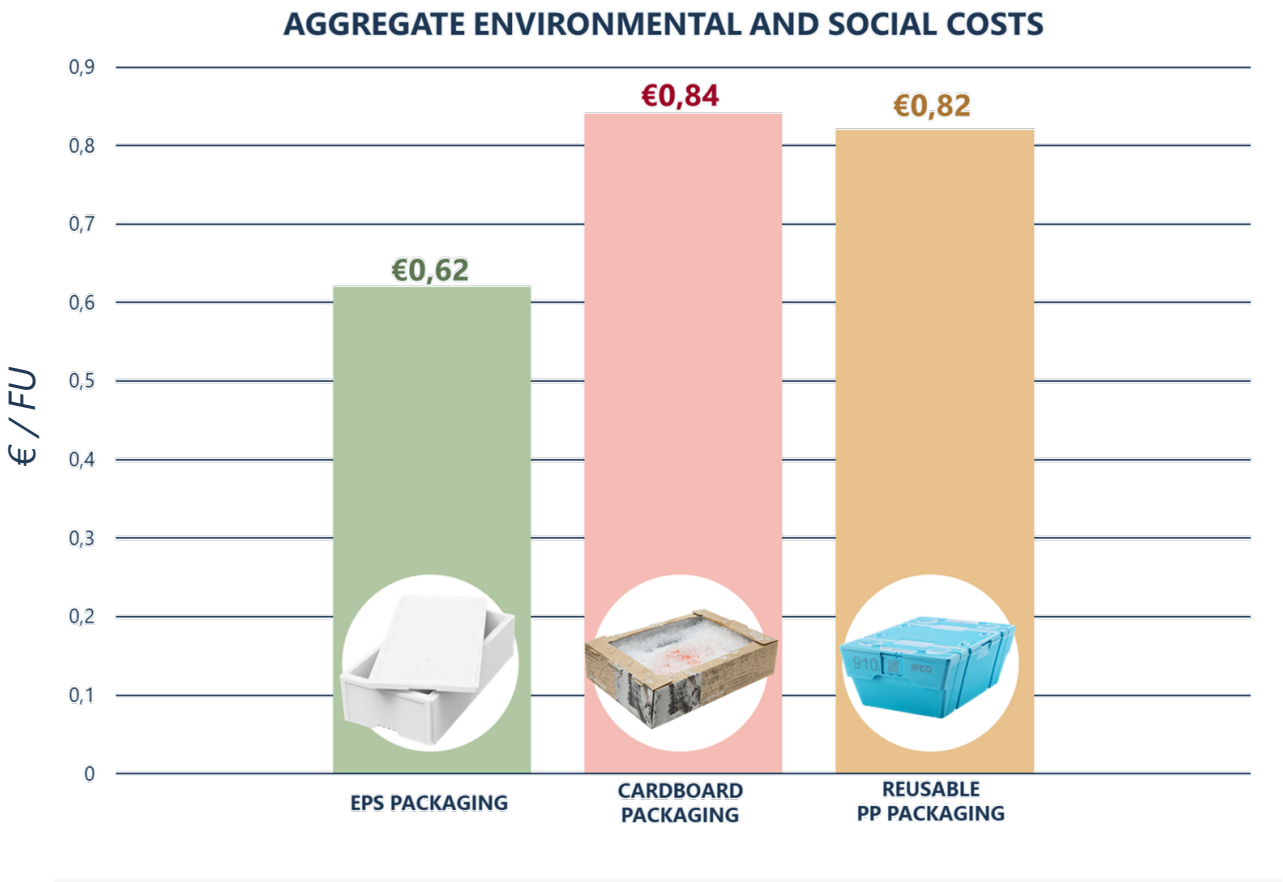
Insulation properties

Better insulation means less ice needed, leaving more space for fish. EPS boxes require less ice than cardboard boxes, allowing more fish per truck.

Return logistics

The burden of return transport for reusable boxes significantly impacts their environmental performance, especially at longer distances.

When all environmental and social costs are translated into actual costs, EPS has the lowest total.



All environmental and social effects are converted to one total value € / FU. The functional unit is defined as 1 kg of fish delivered under chilled conditions.

The analysis is based on ISO 14008 and the EU's guidelines for cost-benefit analyses, where a monetary value is given to effects such as:

- Climate impact (CO_2 equivalents)
- Resource consumption (energy, raw materials)
- Pollution and health (e.g. air pollution, water pollution)
- Waste management and disposal costs

EPS has the lowest cost (€0.62/FU) and is the most cost-effective packaging for transporting fresh fish.

Food safety considerations

Critical importance

Seafood is highly sensitive to temperature changes and spoilage, making reliable cold-chain logistics essential for preserving nutritional value.

Fresh fish is rich in protein, omega-3 fatty acids, vitamins, and minerals, playing a vital role in a healthy diet.

EPS Advantages

- Better temperature stability
- Minimal spoilage risk
- Food-grade certified packaging
- Avoids hygiene concerns linked to reuse
- Prevents microbial risks (e.g., Listeria)

Aggregated sustainability impact

Combined assessment

When combining environmental, economic, and social impacts, single-use EPS boxes outperform all alternatives for distribution distances above 200 km.

Reusable solutions

Switching to reusable boxes would reduce impacts related to production and end-of-life, but the increase in transport logistics impact is larger.

Cardboard alternative

Switching to cardboard boxes would increase transport impacts for long distribution distances due to poorer insulation requiring more ice and reducing fish capacity.

A regulation-driven change in box materials would lead to significant transition costs:

- Sunk costs from premature decommissioning of non-amortized capital (machines and facilities)
- Reduced economies of scale due to co-existence of standards
- Demand fluctuations for solid plastic boxes could result in building new production lines that might close shortly afterward

Key considerations for policymakers:

- Blanket targets for reuse may not reduce total environmental impact
- Return systems require tightly controlled conditions to be effective
- For the transportation of high-volume and high-value seafood EPS outperforms other material
- Any switch to alternatives would involve additional costs and impacts beyond those modelled
- Fish loss would outweigh any sustainability differences between box types
- The findings suggest that a one-size-fits-all approach to packaging reuse targets may not be optimal for all sectors. For fish distribution in Europe, particularly for longer distances, single-use EPS boxes demonstrate better overall sustainability performance.

The study models steady-state operation and does not include infrastructure readiness or transition costs.

(Steady state, meaning that all packaging types can be supplied fully)

THANK YOU