Best Practice for the reduction and life cycle management of expanded polystyrene (EPS) and extruded polystyrene (XPS), as a means to reduce EPS and XPS becoming marine litter

OSPAR Agreement 2024-10[1]

(as referenced in Appendix 1 of OSPAR Recommendation 2024/04 on the management of expanded polystyrene (EPS) and extruded polystyrene (XPS) fish boxes in ports, to prevent release of EPS/XPS into the marine environment)

[1] English only

TITLE	BEST PRACTICE FOR THE REDUCTION AND LIFE CYCLE MANAGEMENT OF EXPANDED POLYSTYRENE (EPS) AND EXTRUDED POLYSTYRENE (XPS), AS A MEANS TO REDUCE EPS AND XPS BECOMING MARINE LITTER
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CONCEPT IDEA	**DIREÇÃO-GERAL DE RECURSOS NATURAIS, SEGURANÇA E SERVIÇOS MARÍTIMOS (DGRM):** SANDRA MOUTINHO
AUTHORS	**CENTIMFE – TECHNOLOGICAL CENTER FOR THE MOULDMAKING, SPECIAL TOOLING AND PLASTIC INDUSTRIES:** ANA PIRES JOÃO CASEIRO
REVISION	**DIREÇÃO-GERAL DE RECURSOS NATURAIS, SEGURANÇA E SERVIÇOS MARÍTIMOS (DGRM):** SANDRA MOUTINHO **SOCIEDADE PONTO VERDE:** JOÃO LETRAS PAULA NORTE SUSANA ÂNGELO **UNIVERSITY COLLEGE CORK (UCC) - MAREI:** SONYA AGNEW **CEDRE:** CAMILLE LACROIX **CETMAR:** JULIO MAROTO **REPAK:** MAEVE THORNBERRY

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1. Introduction

1.1. Frame of reference

This practical guide specifically considers best practice guidelines for the reduction and management of EPS / XPS in the marine environment. This collection of best practice has predominantly been drawn from the final reports of the OceanWise project, an INTERREG co-financed project which ran between 2018-2022, and was led by Portugal and Ireland, with support from France, Spain and the United Kingdom.

The best practice guidelines thus fulfil OSPAR's role to draw attention to actions that OSPAR agrees need to be taken by others in areas near water bodies (including packaging of electronics/ insulation; handling of waste). The OceanWise project was initially set up under Action 49 of OSPAR's first Regional Action Plan on Marine Litter (2014-2021). This work is now presented to complete OSPAR's work under Action A.4.2 of the Second Regional Action Plan on Marine Litter (2022-2030).

1.2. Definitions

This OSPAR BEP document recognises the following definitions.

"biobased plastics" means fully or partially made from biological resources, rather than fossil raw materials. They are not necessarily biodegradable or compostable. It is important to examine the full life cycle of biobased plastics, to ensure that they are beneficial to the environment beyond the reduction in use of fossil resources. This includes changes in land use.

"biopolymer" means polymers occurring in nature and used without chemical modification.

"**Expanded Polystyrene (EPS)**" means a lightweight plastic material made of polystyrene foam and consisting of small hollow spherical balls that are expanded through a moulding process; EPS is the most commonly used plastic foam in everyday life. It is used by many industries, including in the transport of food (mainly seafood and vegetables' boxes), transport of sensitive goods (packaging and packaging filling), construction of aquatic floating pontoons, fishing and recreational boating (floats), in construction (insulation and lightweight building blocks), amongst others. Its most remarkable property is that it consists of 95%-98% air;

"**Extruded polystyrene (XPS)**" means a plastic material manufactured using extrusion of polystyrene: a continuous process which results in a closed-cell structure with a smooth skin on the top and bottom of the board. Its main use is in construction as an insulation material. It is also used for disposable food packaging;

"**Life cycle**" means the succession of stages that a product goes through during its existence, starting from development and ultimately ending in decline;

"Life cycle assessment means" the act of measuring the environmental impact of a product or service throughout its life cycle;

"**Polystyrene (PS)**" means a hard, stiff, transparent synthetic resin produced by the polymerization of styrene. It can be used to produce hard plastic materials but also foam plastic materials by its expansion or extrusion;

"**Styrene**" is the monomer that is polymerised into polystyrene. It is classified as harmful to health[2]

1.3. Introduction to EPS and XPS as a source of marine litter

Expanded polystyrene (EPS) and extruded polystyrene (XPS) are two types of foams of the polymer polystyrene (PS) and are abundantly used in manufacturing and construction. Both foams consist mostly of air, which makes them very lightweight and good insulators. Their compressive strength also makes them very useful for packaging fragile items and for producing protective gear like helmets.

Over the recent decades, the global use of plastics has increased drastically. Polystyrene is recyclable, but polystyrene foams are mostly being landfilled or incinerated. They are also easily dispersed due to their brittleness and lightweight attributes, creating an enduring impact on the environment.

EPS and XPS are mostly (95-98%) composed of air, which makes them lightweight and provides high thermal insulation properties. Both foams are highly water resistant, strong, with high compressive strength and block rigidity. They can also be easily moulded into different shapes and have high design versatility. These characteristics make EPS and XPS a common choice for the packaging, protection and transport of food, goods, and pharmaceutical products. Chemicals are added during production to give specific properties to the PS. Despite being recyclable, polystyrene is not widely recycled.

While most of the plastic waste from the production process is recycled in the same production unit, in 2020 around 34.6 % of the plastic waste collected was recycled, 42.0 % was used for energy recovery and 23.4 % was deposited in landfills, at the European Union countries[3]. Landfilling and incineration are still common for plastic packaging waste and a large amount also ends up in the environment and oceans.

All litter found in the marine environment is harmful. There is a risk that polystyrene litter, which includes EPS and XPS products, could be particularly detrimental to human health.

In 2016, the European Association of Plastics estimated the consumption of EPS in Europe to be 335,000 tonnes in 2015, of which 290,000 tonnes were produced in Europe, with a further

[2] Substance Information - ECHA (europa.eu)

[3] Plastics Europe, 2021.Plastics – the Facts 2021. Plastics Europe. https://plasticseurope.org/wp-content/uploads/2021/12/Plastics-the-Facts-2021-web-final.pdf. Accessed 15 September 2022.

45,000 tonnes imported from outside the EU[4]. European Association of Plastics Recyclers (EPRO) estimated that 27 % (90,450 tonnes) was recycled, 40 % (134,000 tonnes) was recovered, and 33 % (110,550 tonnes) was sent to landfill[3].

All litter found in the marine environment is harmful. There is a risk that polystyrene litter, which includes EPS and XPS products, could be particularly detrimental to human health.

Despite the advantages of EPS already highlighted (lightweight, inexpensive, mouldable and has great insulating properties (thermal, shock absorbent and holds liquids)), it is a serious marine litter problem. In the oceans, it breaks down into tiny fragments. These are eaten by plankton, fish, and seabirds and as such enter the food chain.

Marine litter is any solid manufactured or processed material – plastic, metal, wood, rubber, glass, and paper – that ends up in the ocean. There are several ways for litter to reach the sea. It can be deliberately discarded or unintentionally lost on beaches, on shores or at sea. But it also can be transported by rivers, draining or sewage systems or winds. By 2050, an estimated 99% of seabirds will have ingested plastic[5]. Scientists say that marine litter harms over 800 marine species, causing serious losses to countries' economies[6]. Some of them eat it, and others become entangled in it and die as happens in marine turtles[7]. Plastic waste is one of the biggest threats to the world's oceans, being estimated 11 million tonnes of plastic leak into the ocean each year[8]. In February 2017, UNEP launched the Clean Seas campaign with the aim of engaging governments, the public, civil society, and the private sector in the fight against marine plastic litter. In 2022, the campaign focused on the impacts of hazardous chemicals and microplastics on humans and marine ecosystems and the importance of limiting their spread[9].

Despite the advantages of EPS already highlighted (lightweight, inexpensive, mouldable and has great insulating properties (thermal, shock absorbent and holds liquids)), it is a serious marine litter problem. In the oceans, it breaks down into tiny fragments. These are eaten by plankton, fish, and seabirds and as such enter the food chain.

While it can be stated that any EPS/XPS which ends up as marine litter poses a potential threat or hazard to marine life, the risk of EPS/XPS products becoming marine litter varies significantly between the applications (construction, packaging, component, or products).

[4] OceanWise, 2022. Seven findings on EPS. OceanWise. https://www.oceanwise-project.eu/_seventeen-findings-on-eps/. Assessed 22 November 2022.
[5] Wilcox, C., van Sebille, E., Hardesty, B.D., 2015. Threat of plastic pollution to seabirds is global, pervasive, and increasing. *Proceedings of the National Academy of Sciences*, 112, 11899-11904.
[6] Harlding, S., 2016. *Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity.* Technical Series No.83. Secretariat of the Convention on Biological Diversity, Montreal.
[7] University of Exeter, 2017. Marine turtles dying after becoming entangled in plastic rubbish. ScienceDaily. www.sciencedaily.com/releases/2017/12/171218154235.htm Accessed 14 September 2022.
[8] UNEP, 2021. *From Pollution to Solution. A Global Assessment of Marine Litter and Plastic Pollution*. UNEP, Nairobi.
[9] UNEP, 2022. Inside the Clean Seas campaign against microplastics. UNEP. https://www.unep.org/news-and-stories/story/inside-clean-seas-campaign-against-microplastics. Accessed 14 September 2022.

The research to date indicates that the likelihood of EPS/XPS products becoming marine litter increases when it is at the consumer end or whenever it is discarded in small quantities. There are already:

- Programmes in place to manage business-to-business EPS such as garden trays in the Netherlands (more about these programmes can be found in the OceanWise 5.5 report);
- Waste contractors working with their customers to manage their EPS waste (recycling their EPS waste rather than incinerating it); for instance, many of the Spanish supermarkets, that have particularly high volumes of EPS waste because of their sales of fish from fish boxes, have dedicated EPS compaction and collection services in place.

Projects to manage Business-to-Consumer EPS are less common. Some have been trialled without success. The business-to-business (B-to-B or B2B) supply of EPS has a better infrastructure in terms of reuse and recycling/end-of-life management. The business-to-consumer (B-to-C or B2C) has evolved into a much more complex supply chain and is a difficult area to tackle in terms of recycling due to factors such as:

- Lack of scale (insufficient amounts of EPS/XPS available for collection);
- Confusion about recycling symbols;
- Contamination (usually by food);
- Variations between the council and municipal approaches to waste segregation.

There is a need to find rapid solutions to minimize marine litter, and in this case, from EPS and XPS, especially best practices for the management of EPS and XPS, with a life cycle management perspective, which could ensure the avoidance of EPS and XPS losses into the environment.

1.4. OceanWise project

The INTERREG Atlantic Area co-financed OceanWise project (2018-2023) proposes feasible options to reduce, reuse, recycle, and recover expanded polystyrene (EPS) and extruded polystyrene (XPS), and develop alternative materials to achieve better environmental outcomes and reduce marine plastic litter in the European Atlantic. The outputs are well placed to provide input into the goals proposed by the EU Green Deal. The set of long-term measures proposed to reduce the impact of EPS and XPS products in the marine environment are based on resource efficiency, participatory methods, and circular economy principles, to generate new and best practices in the use, manufacturing, recycling, and uptake of EPS and XPS.

The fact that the project focuses specifically on EPS and XPS plastics should not raise the erroneous notion that the persistent presence of EPS fragments, and also XPS, as marine litter is more worrisome than that of other plastics. Indeed, the sources of marine litter are diversified and include several types of plastics. EPS/XPS are nonetheless in the top 10 items found on European beaches monitored for marine litter presence. As such, it has been understood by the technical groups (OSPAR Action Plan on Marine Litter, covering the

countries of all the North-East Atlantic coast from Portugal to Sweden) that this problem should be addressed. The reason for a dedicated approach to EPS and XPS plastics relates additionally to both the specificities of these very light materials once they are leaked to the environment as well as to the fact that their end-of-life treatment also contains particularities when compared to other, not foamed plastics.

Nevertheless, it is OceanWise understanding that EPS and XPS are not the only foamed plastics which ought to receive attention in their risk and potential harm as marine litter. Any other foamed plastics with equal characteristics (lightness, flakiness, high additives in their composition, and similarly high absorption and adsorption properties) ought to be equally observed and managed if their presence in the marine environment becomes persistent and significant. In this sense, the OceanWise approach and recommendations can be taken up likewise for other foamed plastics, although it is strongly recommended that the same methodology of detailed analysis of the specificities of each Industry be considered as was the case for EPS and XPS under OceanWise.

OceanWise was a consortium composed of 13 partners[10] from five countries – Portugal, Spain, the UK, France, and Ireland – including national public authorities, universities, scientific research centres, companies, and producer responsibility organizations.

1.5. Practical guide purpose and structure

OceanWise was a European project to boost solutions of Circular Economy as the way to solve EPS and XPS environmental problems such as marine litter. Several outcomes were obtained during the project, with valuable information to solve the problems of marine litter caused by EPS and XPS. The need to facilitate such knowledge reach the stakeholders effectively and understandably is the purpose of this guide.

The approach chosen to disseminate knowledge at the stakeholders is through the development of best practices for the management of EPS and XPS during their life cycle. To do so, a methodology was developed to reach those best practices:

- Review of the outcomes of the OceanWise project: through the analysis of documentation provided by the OceanWise team the best practices were surveyed.

[10] The OceanWise project consortium members: Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos – DGRM (Lead partner) (PT); Universidade NOVA de Lisboa – Faculdade de Ciências e Tecnologias – FCT (PT); Sociedade Ponto Verde – SPV (PT); Department of Housing, Planning, Community and Local Government – DHLGH (IE); Board lascaigh Mhara – BIM (IE); University College Cork, National University of Ireland /University College Cork – MaREi (IE); Repak Limited (IE); Centre de documentation, de recherche et d'expérimentations sur les pollutions accidentelles des Eaux – Cedre (FR); Université Bretagne Sud (FR); ICCI Sea Bird (FR); Centre for Environment Fisheries and Aquaculture Science – Cefasn(UK); Centro Tecnológico del Mar – Fundación – CETMAR (ES); Sustainability Innovation, Sociedad Limitada – Sustainn (ES); OSPAR Secretariat – Convention for the Protection of the Marine Environment of the North-East Atlantic (Associated Partner).

- Analysis of the best practices: the best practices were analysed qualitatively according to background, constraints, requirements, sectors to be applied and impacts of the best practice in terms of recycling rate, resources use, cost, technical and legal requirements, and human resources.
- Elaboration of factsheets: the factsheets of each best practice were elaborated to facilitate the assessment of the information, always including successful case studies identified by the OceanWise project.

2. Current situation of EPS and XPS management during use in the different sectors

Annually, the production of EPS and XPS in European countries is around 650,000 tonnes (including Germany, France, Spain, Netherlands, Denmark, and the UK)[11]. EPS is mostly produced for the construction sector, followed by the packaging sector. In the case of XPS, information to identify specifically the sectors where XPS is used is scarce, mostly because XPS information is mixed with PS information[9].

The number of different applications for EPS is significant, mainly due to its wide-ranging properties. The applications it is currently used for can be grouped under four main headings:

- Construction
- Packaging
- Components
- Products

2.1. Construction sector

The use of EPS in the construction industry is growing and the most common uses are:

- Thermal and acoustic insulation, using of EPS sheets for walls, ceilings, and floors in domestic, industrial and commercial buildings;
- Blocks buried in the ground for foundations of swimming pools, houses and buildings, and infrastructures such as roads and bridges, due to the ease of cutting and shaping and its shock absorbing qualities (earthquakes) and to absorb land movements;
- Non-load-bearing building facades (window surrounds, cornices, and decorative pillars).

In the presented cases, the risk of the EPS becoming marine litter is less likely since the EPS is either buried deep underground or inserted as a component into systems which then become part of the fabric of a building. It is only when the EPS blocks are being cut to fit infrastructure or building foundation requirements that there may be some leakage, either into local water courses/streams or carried away on the wind. Nevertheless, the amounts are likely to be very small in either scenario. There is however, some risk of waste EPS/XPS escaping during the demolition of buildings where EPS/XPS was a component, especially when this happens in coastal areas or near waterways.

[11] OceanWise, 2021. Expanded and Extruded Polystyrene Products and Applications. OceanWise. https://www.oceanwise-project.eu/wp-content/uploads/2022/06/5.2-summary-QC.pdf Accessed 22 November 2022.

2.2. Packaging

The use of EPS in packaging is very widespread due to the advantages that it presents: low cost, effective in protecting items in transit, lightweight, provides temperature stability and doesn't leak the contents it holds in the case of moulded packaging structures. However, because EPS is composed of 98% of air, it makes little sense to transport it in its original form once it becomes a waste product. EPS may be used in a mould, in sheet format, in a tray, or flake/beans form. The use of EPS in packaging can be divided into several categories, as follows:

- Packaging of electronic goods: EPS is used in the shipment of bulk electronic goods such as smartphones, tablets and computers, leaving the responsibility for the management of that waste EPS with the distribution companies and retailers.
- Electrical/white goods: Large electrical items (TVs, washing machines) use EPS as part of their core packaging to protect delicate areas during transit. In this case, the consumer is responsible for its end-use management. If the discarded EPS is placed in the mixed municipal waste bin, which is destined for incineration or landfill, the risk of becoming Marine Litter is deemed to be quite low, given the management systems that ensure all waste received for landfill or incineration is correctly treated.
- E-Commerce: The rise of online shopping allows items to be delivered directly from the manufacturer to the consumer. In a 2018 report, it was stated that the increase in the packaging volume was 19% in three years, while the increase in the weight of the imported goods is estimated 13% in the same period. This indicates that the amount of packaging volume per item is higher for orders placed online.
- Pharmaceutical: EPS is used to package medicines, drugs, and medical devices in transit, as well as to transport organs at specified temperatures. The waste is managed directly by clinics, hospitals, and pharmacies, and, as in the case of single-use organ boxes, may be treated as hazardous waste.
- Fish and seafood processing: EPS fish boxes are generally used on a B2B basis, where fish farmers transport fish to their clients (fish processors, markets, and fishmongers). The larger operators are likely to have a sufficient volume of EPS to arrange good waste management practices or on-site recycling. On the other hand, the smaller players may struggle to manage the EPS they collect, and the services offered by their local municipal council and/or their waste management company may determine how much of it becomes marine litter.
- Fresh fruit and vegetables: the EPS in use in this sector of the agri-food business is in markets, both wholesale and retail, where buyers purchase in bulk.
- Seed/plant trays: traditionally, the plant industry used EPS trays for transporting young plants from nurseries to retailers. Often, the same trays are used to sell the plants to the public, so these become part of household waste to be managed. At the industry level, some countries have schemes that capture a large proportion of the EPS trays, so there is potential for some of this EPS to become marine litter if poorly managed.

Despite new requirements which might arise from the upcoming EU regulation on packaging and packaging waste (PPWR), the use of EPS and XPS in packaging should always be based on eco-design principles and should consider the impact during the full lifecycle of the packaging.

2.3. Components

The components category can be divided into automotive and other consumer goods components. The use of EPS in the manufacture of vehicles is hard to determine, but the use of EPS allows to obtain lighter automotive vehicles that can protect the passengers. The main application of EPS in this industry is in bumpers, side-impact protection schemes, seats and headrests and dashboard structures. The EPS in this application is unlikely to become marine litter so the recycling and reuse practices of the EPS suppliers to the car component manufacturers is a more important area of research.

General consumer items, such as bicycle helmets and baby seats, tend to be reusable often and are unlikely to be disposed of carelessly. Even if they are disposed of poorly, the structure of the items guarantees that the EPS contained therein is likely to remain intact, at least for a considerable period, presenting, therefore, a low risk of becoming marine litter.

On the other hand, items such as surfboards and bodyboards use EPS as the main component, as it is cheap, and has flexibility, shock-absorbency, and water-resistance qualities. However, if these items have poor quality, they are easily left on beaches and allowed to drift out to sea. There they can break even further into small pieces and will dissipate very quickly into the marine environment.

2.4. Products

Nowadays, EPS and XPS are largely employed in disposable products such as beverage cups and takeaway food containers, widely used at events, outdoor festivals, and in places like hospitals and prisons. If these events/services are available near the coast, there is some probability that these items may end up in the sea. Other uses for EPS include moulds, forms, and voids, for use by the manufacturers of items such as tubing and bespoke components for engineering uses and electrical equipment.

Marine uses include pontoons in harbours and flotation devices used in the fishing, aquaculture, and recreational boating industries. Their very presence in or near the water means that EPS used in these applications must be in the high-risk category of becoming marine litter, if not in the entirety of the EPS buoy at least in its flaking fragments. The use of EPS can also be used in hydroponics, the intensive growing of plants in an environment with little or no soil.

4. Best practices for the life cycle management of EPS and XPS to avoid marine litter and improve its circularity

The goal of using best practices is as follows: instead of aiming to reach an abstract ideal state, the user is inspired by existing practices that are already up and running in another location. The best practices identified during the OceanWise project are practices that bring better results than the current situation and thus can create a positive impact. Conditions and requirements of the implementation are also identified. Such is needed to ensure that best practices can reach the best possible impact.

All best practices identified in the OceanWise project are operations-focused practices. Policy recommendations, such as regulation, market-based instruments, information, and voluntary instruments were also produced by the project, and they represent the background needed to make operations-based best practices work successfully.

The list of operational best practices is listed in Table 1 below.

Table 1. Best practices for EPS and XPS management from the OceanWise project

Life cycle stage of EPS/XPS	Category of measures
A. Design of products in EPS/XPS	A.1 Substitution of EPS/XPS by biopolymers in specific situations A.2 Substitution of EPS/XPS for fossil plastics in specific situations A.3 Design for durability A. 4 Ecodesign tools and methodologies
B. Production or manufacturing of products	B.1 Good cleaning practices in Industry
C. Usage phase of products	C.1 Repurpose of EPS fish boxes in supermarkets
D. End-of-life management of EPS/XPS products	D.1 Waste management in public events D2. Reverse logistics systems or take-back systems in B2B and B2C D3. Commercial waste collection D.4 Dedicated EPS collection points D.5 Compacting D.6 Recycling (EPS fraction in waste sorting facilities) D.7 Awareness campaigns

Each best practice has been described in an individual factsheet (which are presented in **Annex 1** of this report). These factsheets contain introductory information which stakeholders can use to implement these practices. The factsheets intend to be a starting point to help

stakeholders with the implementation of potential solutions for their business, clients, supply chain, and the entire life cycle of EPS and XPS, with a focus on the use and waste phases. Each factsheet contains the following information:

1. Background

This section provides the reader with the essential context needed to understand the issue at hand and its significance. The content of the background varies depending on the type of practice so that it is truly relevant to the practice being explained. In most cases, it contains relevant information that provides the stakeholder with a basic understanding of the problem.

2. Action

A clear and concise description of the practice. Basic instructions to let the stakeholder know what is required to implement the best practice.

3. Examples

Each best practice includes real examples found during the OceanWise project so that the user can visualise how it has been implemented in other situations. Whenever possible, the impacts and outcomes of implementation have also been included. These examples include illustrative pictures and elements to facilitate the understanding of best practices.

4. You should consider that…

In this section, stakeholders are provided with a description of the main conditions required for the application of each best practice, as well as potential issues that are important to the success of the implementation. The requirements needed to be fulfilled to make the best practice successful are also highlighted in this section.

5. Sectors where the best practice can be implemented

Not all best practices can be implemented in all economic sectors which the OceanWise project was devoted to. For that reason, careful identification of the sectors where best practice can be implemented is also presented in this section of the factsheet.

6. How good is this action?

According to the nature of each best practice, the potential benefits that can be achieved with their implementation have been divided into the potential of EPS or XPS become marine litter, the recycling rate of those materials, extension on the use of EPS/XPS, cost of the best practice, technical requirement, legal requirement, and human resources needed to implement the best practice.

Final remarks on best practices for EPS and XPS environmentally sound management to avoid marine litter.

The implementation of best practices must the followed by adequate evaluation of the performance of the best practice. Key performance indicators are useful tools to help monitor performance and serve as a benchmark against other territories or over time.

Annex 1

Best practice Fact Sheets

A. Production or manufacturing of products

A.1. Good cleaning practices in Industry

Background

All the stakeholders throughout the whole EPS/XPS chain generate sweeps: a fraction of dirty and small EPS waste. These sweeps are present in all phases, from the manufacture of packaging, through the transport of grinded EPS, and in the recycling/recovery companies themselves.

If sweeps are not managed properly, they can be carried away by the wind, rainwater or cleaning water, leaking into the environment.

Suggested Action

Promote the adherence of all companies involved in the EPS and XPS cycle to Operation Clean Sweep (OCS), as well as its certification (as well as by Circular Economy) by an independent entity.

Example

OPERATION CLEAN SWEEP OCS
https://www.opcleansweep.org/
This is a global initiative of the plastics industry to reduce possible leaks of microplastics, in the form of pellets,flakes or resin powder into the environment. It is a voluntary program aimed at any company related to the production, transport, storage, and transformation of plastic raw materials.
Although OCS was created to avoid the environmental problem generated by pellets of plastic raw materials, it is a flexible program that incorporates companies that use these raw materials (pellets) and generate other pollutants such as the sweepings of the EPS processes. In fact, the OCS has already adhered to several companies from the EPS sector.

You should consider that…

- Many stakeholders of the EPS value chain have adopted specific protocols to tackle the sweep problems, acquiring specific equipment for collection. However, measures may be insufficient and due to their voluntary nature, many stakeholders do not implement measures
- Certification of environmental quality systems, which include the correct management of the sweepings among its requirements and obligations, should guarantee that companies are establishing controls to achieve it

Requirements to implement this action:

- Promotion of ISO14001 certification for Environmental Management that, through specific protocols, tackles the environmental problem generated by pellets and sweeps
- Improving the perimeter of factories and external storage areas
- Having a rainwater harvesting system isolated from the public sewer
- Blowing of trucks and containers before use
- Acquisition of industrial sweepers
  Using big bags that close at the top or containers with lids/canvas to avoid blowing in the wind, etc. at collection points

Sectors where this action makes sense:

- Fishing and aquaculture - Yes
- Consumption products – Yes
- Takeaway, catering – Yes
- Restaurants (fish food, seafood) - Yes
- Supermarkets - Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low
- Cost – low
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Low

B. Use phase of products

B.1. Repurpose of EPS fish boxes in supermarkets

Background

From a circular economy perspective, the products should have a short use of raw materials, a long-life time and, when it reaches the end-of-life time, be recycled in a closed loop. EPS and XPS are not different, meaning that measures that could extend product lifetime respecting technical and legal requirements should be implemented.

One of the circular economy life extension measures is repurposing, specially indicated for the products which are single-use products due to food-safety requisites.

Suggested Action

The owners of EPS and XPS products can be creative and find repurpose solutions for their EPS and XPS products. Repurpose means that the product is used for a different function than it was originally produced for.

Example

EPS FISH – BOXES REPURPOSED TO KEEP VEGETABLES COOL IN THE FOOD MARKET In food markets, where refrigerators are not available, the way to keep fruit and vegetables cool is through the repurposing of EPS fish boxes, which are filled with water with ice. *(Photo credit: Noel Hillis Photography)*	

You should consider that…

Maybe there is an absence of legal issues for the repurpose measure which is intended to be made

Requirements to implement this action:

- Be aware that the repurpose of EPS and XPS can have limitations concerning food contact
- After repurposing, EPS and XPS must be sent for recycling

Sectors where this action makes sense:

- Fishing and aquaculture - No
- Consumption products – No
- Takeaway, catering – No
- Restaurants (fish food, seafood) – Yes (if it is not for direct contact with food)
- Supermarkets – Yes (if is not for direct contact with food)

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – High
- Cost – Low
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Low

C. End-of-life management of EPS/XPS products

C.1. EPS/XPS Waste management in public events

Background

Temporary events for the public such as sports events, festivals or similar create a significant amount of waste in a short period of time. EPS/XPS can be quite used, not only for packaging but also for other products that may also have a single use. If not managed appropriately, EPS/XPS waste can reach the aquatic environment and impact negatively, especially when these events are held close to the sea or to waterways.

Suggested Action

The legal entity authorizing the event must impose rules (including restrictions) on the use of EPS/XPS in the temporary event. Specific market instruments can be used to motivate event organizers to provide corrective measures to avoid EPS/XPS littering

Example

"SÊ-LO VERDE" – PROGRAM FOR SUSTAINABLE MUSIC FESTIVALS IN PORTUGAL The Environment Ministry in Portugal developed the Sê-lo Verde Program, to support the adoption of environmental best practices in public events, mostly music festivals. Environmental best practices should promote the reduction of resource use, efficient use of resources and energy, minimize waste generation and pollution, increase awareness in the audience and monitoring of best practices implemented.	

"ECOEVENTOS" – ENVIRONMENTAL GLOBAL FACILITIES (EGF) – EGF.PT EGF is the main municipal waste manager in Portugal. They launch the EcoEventos (eco-events) program to support public events all over the country which include at source separation of waste, waste generation monitoring, and implementation of environmental best practices	ecoeventos EGF

You should consider that…

There are several measures to implement to reduce waste generation at events, like reusable cutlery, drinking glasses and dinnerware. In this case, legal requirements on the reuse of cutlery may exist

Requirements to implement this action:

- Have in mind that the legal requirements for the alternative solutions to EPS/XPS can be demanding

- Talk to national or local authorities concerning alternative solutions to the use of EPS/XPS in the event

Sectors where this action makes sense:

- Fishing and aquaculture - No
- Consumption products – No
- Takeaway, catering – Yes, when applied to events
- Restaurants (fish food, seafood) – Yes, when applied to events
- Supermarkets – No

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Low
- Extension on the use of EPS/XPS – Low
- Cost – Low to medium
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Medium

C.2. Reverse logistics systems or take-back systems in business-to-business (B2B) and business-to-consumer (B2C)

Background

Many EPS and XPS waste generators including consumers, stores, and restaurants, have no separate collection system dedicated to EPS and XPS waste. However, EPS and XPS are highly recyclable, especially if no contamination occurs.

EPS and XPS are very light and can fragment into small pieces, which can make it difficult to be separated in sorting plants. Also, it can have huge dimensions (consumer goods packaging), making it difficult to be disposed of in recycling drop-off containers.

Suggested Action

Introduce a take-back service for EPS, XPS or both to offer to consumers (citizens) and stores and other EPS and XPS producers inside the urban limits.

Under these systems, the consumer or the store can deliver the EPS or XPS to the supplier, at no cost. Then, the EPS/XPS waste is delivered to a recycler, making new product or secondary raw material. The supplier offers such service to their clients and takes responsibility for his or her obligations as a producer by creating an effective disposal collection system from the market. Furthermore, it will help to have EPS and XPS waste with a higher quality to be recycled.

This is only applicable to EPS waste. EPS manufacturers are very interested in offering their customers a waste collection system, that is to say: reverse logistics. However, XPS as domestic waste – e.g. for foodstuff gets through the existing SCRAPS (ECOEMBES, SPV, etc.) to the Material Recovery System companies, which are the companies responsible for separation. Perhaps for other sectors where the XPS can be used for another purpose, a reverse logistics system would be necessary and possible

Example

CASE STUDY: CURRYS PC WORLD TAKE BACK SYSTEM (UK) This Company, one of the largest retailers of electrical and electronic goods in the UL, has a system in place at all its depots. White and other goods, which are delivered direct to consumer homes, are stripped of their packaging, including any EPS used, which is then backfilled in the truck to the depot. The EPS is compacted into briquettes and then sold to a recycler. Customers can also go to the store and deliver TV packaging, which includes EPS packaging. Customers can use the polystyrene recycling scheme of Currys PC World for free because EPS is not included in most kerbside pick-up services.	

"With this EPS recycling scheme, our intention is to make 100 % of our won label plastic packaging reusable or recycle by 2023. It is a great example of the innovative work we do to reduce our impact on the environment." http://greenretail.world/2021/08/18/polystyrene-recycling-currys-pc-world-stores-to-take.back-tv-packaging.	

You should consider that…

- Your supplier will have to hire the services of a waste operator who receives the EPS/XPS and recycles it (it can be the same waste operator).
- As an alternative, product manufacturers must be licensed as Authorized Waste Managers to be able to run the take-back system and transport EPS/XPs waste.
- The collection and recycling must be discussed between the stakeholders, including Producer Responsibility Organizations and others imposed or defined by national regulation.
- Current food safety and health legislation do not allow to transport of used boxes (EPS waste) in the same vehicle that transports new food contact boxes. This limits collection efficiency, increases cost and jeopardises the economic viability of this model.
- Long and expensive administrative procedures at the regional and municipal levels (fees, environmental bonds) can difficult the implementation of reverse logistics/take-back systems.
- Adaption of the infrastructure to specific requirements which also requires a considerable investment.
- The logistical problems from EPS management, due to low density and high volume, would entail high expenses, being necessary to run a cost-benefit analysis of such practice.
- Any Reverse Logistics System would have to be profitable to last in time and, therefore, it would only be possible when collection points and destinations are not far from one another

Requirements to implement this action:

- Talk with your supply chain (suppliers) and see how they can help you to implement such a take-back system.
- Keep your customers informed of this new service.
- Authorities should simplify the procedures related to obtaining a non-hazardous waste manager license for these companies and reduce the time to achieve it
- EPS associations should promote measures and specific protocols like cleaning and disinfection. Also, a CEN/ISO Standard for food safety and health authorities, to make the system profitable can also be a possibility

Sectors where this action makes sense:

- Fishing and aquaculture – yes
- Consumption products – yes
- Takeaway, catering - no
- Restaurants (fish food, seafood) – yes, if they are all in a specific area
- Supermarkets – yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low to medium
- Cost – Medium to high
- Technical requirement – Low
- Legal requirement – Medium
- Human resources – low

C.3. Commercial waste collection system for EPS/XPS in the municipality (markets, fish auction markets, small supermarkets , fishing ports, “fish-restaurants hotspots”): door-to-door or drop-off-points

Background

EPS represents a considerable fraction of the commercial waste of fish traders, and therefore it naturally requires specific selective collection systems. Also, many retailers in urban centres generate commercial/industrial EPS waste:

- Some municipalities have waste taxes to allow retailers to dispose of their waste in municipal solid waste containers ~~MSW),~~ where all kinds of materials are mixed.

- EPS boxes cannot be deposited in the EPS schemes containers as these are not household packaging. The EPR schemes do not cover commercial/industrial waste.

- Even though the rest fraction is sometimes transported to sorting plants, the EPS on the rest fraction is dirty and mixed with many materials in small pieces. Sorting this fraction is expensive and with low-quality results, so it is mostly used in energy recovery or landfill.

- A high number of EPS commercial waste escapes the recycling/valorisation flow.

- Directive n.º 2018/852 on packaging and packaging waste imposes the application of EPR to commercial and industrial packaging. Current EPR schemes for packaging in EU countries must adapt to provide an adequate collection system for EPS/XPS packaging from these sources

Suggested Action

- Introduce a commercial waste collection system for EPS/XPS at specific high production places in the city: markets, fish auction markets, and small supermarkets. To do so, provide differentiated containers for the EPS and XPS waste in places where the production is high or by incorporating this fraction in the door-to-door collection for activities with a high generation of this waste.
- Consider the option of incorporating EPS in a mobile selective collection with adapted trucks with a regular weekly collection agenda in different areas to improve the recycling of EPS.
- To have this best practice implemented is important to consider legal requirements in the municipality, and other policy instruments.
- Consider the option to have some sort of EPS densifier – a compactor or a shredder to reduce the monetary and environmental cost of transportation to recycling facilities, as well as the room taken up by the waste awaiting collection.

Examples

BILLINGSGATE FISH MARKET (UK)

One of the largest fish markets in the UK, Billingsgate, has been operating an on-site compacting system for several years. On average, the fish market processes at least 900,000 EPS fish boxes annually, all of which are sent to mainland Europe for recycling into new products.

How it works: Each day, the buyers of the fish (restaurants, hotels, fish shops and a small number of domestic consumers) decant the fish they've purchased from the EPS fish boxes into other reusable containers which they have brought themselves. They leave the EPS fish boxes behind, although occasionally they take the fish away in the EPS fish boxes but return the empty fish boxes the following day.

The used EPS fish boxes are collected from various drop-off points around the site and taken to the recycling area. The boxes are not washed before to being compressed; the Billingsgate staff do, however, ensure that there are no fish or fish scraps left in the boxes. The EPS fish boxes are thrown manually into a hopper which feeds the machine, the air is compressed, and a solid block or briquette is produced.

The blocks, about 90 cm in length, and about 40cm in diameter are stacked on pallets, nine to a pallet. It takes between 350-400 boxes to make one block; taking an average of 375 boxes, and an average weight of 40 kg per block, Billingsgate Fish Market is compacting and sending for recycling in the region of 900,000 EPS fish boxes every year.

Once a load of 36 pallets has built up, their EPS waste management company, Regent Hill, takes it away and currently it is shipped to Spain. Regent Hill pays the Market for the compressed EPS, with a market price varying between £240 and £350 per tonne. They sell about 100 tonnes per year, so the yield is in the region of £30,000 per annum, taking an average price of £300 per tonne. The revenues of EPS cover its costs as the EPS would have to be disposed of if not recycled, incurring either landfill charges or incineration gate fees

BEWISYNBRA (PT) BEWiSynbra offers plastic foam packaging solutions and insulation systems for buildings in Europe. Over the past three years, the Portuguese branch has held meetings with OceanWise partners and co-developed the idea of improving the recycling of EPS fish boxes in Portuguese ports. By installing EPS recycling centres, BEWi centralizes the collection of EPS fish-box waste to optimize transport. To further optimize this process, BEWi delivers vertical compactors to some fish ports to crush fish boxes and transport them more efficiently. Through their innovative recycling process, EPS and XPS waste is transformed into polystyrene beads that can be used in multiple applications.	

You should consider that…

- In a door-to-door system, the collection can be more expensive and take much time.
- In a drop-off system you need more space to implement it.
- Still in drop-off: It will require a large investment to provide specific infrastructures (containers, briquetting machines, or densifiers etc) for the separate collection.
- Implementation of any collection system would face the issue of EPS low density and collection costs.
- Depending on the type of EPS and EXPS – packaging or non-packaging – the existence of an EPR can be applied or not. In the cases where there is an EPR scheme, the collection cost is partially supported

Requirements to implement this action:

- Talk with the market manager, or with the local association of your economic sector to understand if this solution would be possible
- Talk with a recycler interested in implementing the collection system (to densify the plastic, and collect at the recycling plant)

Sectors where this action makes sense:

- Fishing and aquaculture - Yes
- Consumption products – no
- Takeaway, catering – no
- Restaurants (fish food, seafood) – yes
- Supermarkets – yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium to high
- Extension on the use of EPS/XPS – Low

- Cost – Low
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Low

C.4. Dedicated EPS collection points for municipalities

Background

The properties of EPS and XPS makes them difficult to be deposited in drop-off containers on the street if they have big dimensions. In fact, only central markets of big European cities have specific areas to deposit and manage waste, including EPS. A dedicated area for EPS deposition allows EPS to be recyclable, avoiding their energy recovery and landfill disposal.

Suggested Action

Create a specific area for EPX/XPS waste with big dimensions for municipalities, services, and commercial activities.

Depending on the EPS/XPS products, the infrastructure and equipment can be partially or totally financed by the municipalities and EPR schemes (in the case of packaging waste). A private waste management company can also be a possibility, to oversee the management by administrative concession.

Example

URBAN EPS CAGES (PT) For years, in the Portuguese fishing port city of Setúbal, the restaurants near the docks have asked for a solution for the white coat of waste from fragmented EPS fish boxes that spread on the seafront on windy days, because there's no place to deposit the boxes that bring fresh fish and seafood to restaurants every morning and get discarded by lunchtime. The existing drop-off containers in the area were too small for the size of EPS boxes, which led to the boxes being deposited on the ground next to the recycling bin. Until the municipality's urban hygiene department created dedicated EPS cages. The cage has a maximum capacity of about 100 boxes and the daily volume deposited there is about ¾ of the total volume of fish boxes that would otherwise be left in the open air waiting for the waste management trucks to pick them up	

You should consider that…

- The deposit cage must be covered and closed, to avoid EPS/XPS from blowing effects and flying away.
- Collection of the waste must be in accordance with the waste generators.
- Consider the inclusion of a mobile compactor to optimize the travelling of EPS/XPS to recycling and increase space to have EPS and XPS in the recycling centre.
- If EPS/XPS products are not covered by an EPR system, the municipality has to find a buyer for the material.

Requirements to implement this action:

- Local authorities should talk with the stakeholders about which activities generates this type of waste (EPS/XPS) and discuss with them the existence of the recycling centre area for this waste
- Keep waste generators informed of the recycling centre and other measures to avoid mismanagement of EPS/XPS
- Facilitate legal requirements to the transportation of EPS and XPS into the recycling centre (if there is any constraint)

Sectors where this action makes sense:

- Fishing and aquaculture – Yes
- Consumption products – Yes
- Takeaway, catering – No
- Restaurants (fish food, seafood) – Yes
- Supermarkets – Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low
- Cost – Low
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Low

C.5. EPS boxes densification or compaction into briquets

Background

EPS and XPS are light and occupies a lot of space, because they are mostly made of air.

Such features make them difficult to be temporarily stored at the place where waste is made.

Suggested Action

Compact EPS boxes into briquets through the subcontract of a company that compacts on-site and provides assurance that compacted material is recycled.

Example

WASTEMATTERS (IE) "WasteMatters" is a mobile EPS fish-box compacting company in Ireland which offers on-site compacting services to fish processors. Trucks equipped with an EPS compactor go to fish-processing companies and process thousands of fish boxes per visit and then export the briquettes to mainland Europe to be recycled and processed into new products such as insulation boards, garden furniture and coat hangers	

You should consider that…

- There can be a space limitation of the lines at sorting plants, not being capable to include one more waste type to be sorted
- Sorting plants are very automated, being difficult to change or adapt rapidly
- EPS breaks too much in sorting plants, not being easy to be sorted (manually or mechanically

Requirements to implement this action:

- Waste operators ought to be capable of providing this service.
- Talk with your association or representatives, municipalities, authorities, and other actors to see if this service could be provided, including the transportation to a recycler

Sectors where this action makes sense:

- Fishing and aquaculture - No
- Consumption products – Yes
- Takeaway, catering – No
- Restaurants (fish food, seafood) – Yes

- Supermarkets - Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low
- Cost – Medium
- Technical requirement – Medium
- Legal requirement – Low
- Human resources – Medium

C.6. Implementation of the EPS fraction in waste sorting facilities

Background

Rest fraction and plastic packaging fraction containers managed by Municipal Waste Management System are sent to sorting facilities, where they are processed separately. Most of these companies have advanced sensor technology (near-infrared, visual spectrometry) to sort some plastics by polymer, but not PS/XPS/EPS. EPS is not separated to be recycled, being sent to energy recovery or landfilling, with considerable environmental impacts (*e.g.*, space in the landfill, gaseous emissions from incineration).

Suggested Action

Implement the separation of EPS at sorting plants, also named material recovery facilities (packaging sorting plants). In this process, workers separate the EPS that appears at the sorting line. The separated EPS is balled or densified and sent for recycling. Administration and material recovery facilities should analyse measures to incorporate PS selection, such as subsidies, acquisition of sensor sorting systems (near infrared and visual spectrometry), and investment in waste recycling.

Example

PORTUGUESE GREEN DOT SYSTEM (SOCIEDADE PONTO VERDE) Sociedade Ponto Verde manages the packaging waste management system in Portugal. Packaging waste is collected from drop-off points in most country and are sent to sorting plants (or material recovery facilities). In these units, plastic packaging from the yellow drop-off bin is sorted into several polymers, including EPS. EPS sorting is made by the workers, even if it is a facility with several automated devices. EPS is then sent for recycling, in Portuguese recycling units	

You should consider that…

- There can be a space limitation of the lines at sorting plants, not being capable to include one more waste type to be sorted
- Sorting plants are very automated, with reduced human intervention)

Requirements to implement this action:

- Municipalities should consider talking with the municipal solid waste operator to see the options for this action to be implemented.

- EPS breaks too much in sorting plants, not being easy to be sorted (neither manually nor mechanically)
- The quality of EPS sorted in sorting plants may be low, even though MRFs are highly equipped.
- Sorting equipment for EPS and XPS exists – sensor technology - but it is expensive.
- Because EPS and XPS waste from the domestic sector is disposed of at drop-off points, the material breaks very easily and the separation rate at sorting plants can be quite low
- Producer responsibility organizations like SPV should consider this best practice in the sorting plants that they support

Sectors where this action makes sense:

- Fishing and aquaculture - Yes
- Consumption products – Yes
- Takeaway, catering – Yes
- Restaurants (fish food, seafood) – Yes
- Supermarkets - Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low
- Cost – Medium to high
- Technical requirement – Medium
- Legal requirement – Low
- Human resources – Medium

C.7. Awareness campaigns

Background

Education and awareness-raising measures among EPS/XPS waste producers have the potential to improve the management of EPS/XPS waste and to reduce losses of EPS and XPS to the environment.

Suggested Action

Implement awareness campaigns near the places and actors where EPS/XPS waste is generated. This imposes dedicated awareness campaigns for a specific audience, information contents and expected results.

Examples

A PESCA POR UM MAR SEM LIXO CAMPAIGN – http://www.marsemlixo.com/ This is a project devoted to raising awareness of plastic litter near fishing activities. The project includes the implementation of plastic waste collection activities in the fishing boats and recycling logistics. In parallel, several awareness campaigns are developed to help fishermen to adopt best practices during fishing activities	

BEACH CLEANING CAMPAIGN – INTERNATIONAL COASTAL CLEANUP ® https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/ Several campaigns occur all over the world to clean up beaches and coastal areas, raising awareness of the pollution caused by terrestrial and aquatic economic activities.	

You should consider that…

- To have a medium- and long-term effect, awareness campaigns must be repeated throughout time
- Awareness campaigns must be organized focusing on the audience and the expected results
- Awareness campaigns can occur with other instruments like recognition awards, to motivate the audience
- Gamification can be a strategy for awareness campaigns directed to public

Requirements to implement this action:

- Like any other campaign, there is the need for a good planning phase, where goals are set, the time frame, audience, information to be shared and marketing strategy are all needed
- Remind to divulge the results of the awareness campaign near the audience

- Training in industrial and commercial sectors can also be linked to the awareness campaign

Sectors where this action makes sense

- Fishing and aquaculture - Yes
- Consumption products – Yes
- Takeaway, catering – Yes
- Restaurants (fish food, seafood) –Yes
- Supermarkets - Yes Supermarkets - Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low
- Cost – Low
- Technical requirement – Medium
- Legal requirement – Low
- Human resources – Medium

D. Design of products in EPS/XPS

D.1. Design for durability

Background

Many products with aquatic application as a low resistance to the environmental conditions, having a high risk of breaking and get released into the environment.

Many producers have adopted design configurations to allow EPS/XPS products to be more resistant to water conditions

Suggested Action

Combine application of protective materials to increase durability of EPS/XPS products.

Example

BUOYS COVERED WITH HARD PLASTIC SHELLS https://www.qdwaysail.com/ To increase durability of polymer foam buoys, fabricants have put plastic covers or shells for floats or buoys. Other alternatives for marker buoys and mooring buoys for leisure boats are either inflatable or foam-filled and have a shell or hard PE	

You should consider that…

- It is important to ensure that the use of several materials in the same product may not allow a correct recycling at the end of the life of the product.
- If those products are new on the market, products are still too expensive comparatively with the business as usual.

Requirements to implement this action:

- Application requirements
- Skills to handle those products

Sectors where this action makes sense:

- Fishing and aquaculture – Yes (including recreation boating)
- Consumption products – No
- Takeaway, catering – No
- Restaurants (fish food, seafood) – No
  Supermarkets – No

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium, because EPS will not get damaged, being easily collected to be recycled
- Extension on the use of EPS/XPS – Medium to high
- Cost – medium
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Low

D.2. Use of Ecodesign methodologies to support decision making about EPS/XPS

Background

According to the European Commission, 80 % of environmental impacts result from design[12]. It is mandatory that tools like life cycle assessment (LCA), carbon footprint, and other assessment methods like plastic leakage, and microplastics release could be used to minimize the environmental impact of EPS/XPS products during their life cycle.

Several alternative materials to EPS/XPS are also in place in the market, therefore increasing the need for good assessment and understanding of how good those alternatives can be, *i.e.*, how they can contribute to minimising aquatic impacts without compromising other impacts like climate change, acidification, eutrophication, and how those impacts minimized in a particular phase of the life cycle will not increase impacts on another life cycle phase (typically, in the end-of-life phase). One important issue is microplastics, and methodologies to assess their impact to human health and environment are still in development.

More than one assessment methodology should be applied to support decision-making of materials, producers, compounders, product manufacturers, and consumers.

Also, the Ecodesign for Sustainable Products Regulation proposal will require that products are ecodesigned, including requirements related to circularity and low environmental impact.

Suggested Action

- Use of environmental assessment methodologies available for EPS and XPS, or for plastics in general to help with the ecodesign of products.
- Using or conducting LCA studies and environmental risk assessment studies to substitute EPS and XPS products for biopolymers or plastics available and which are proven for the same utilization/ purpose/functionality. Such LCA should be part of a design for the environmental process of the traditional EPS or XPS product.
- Also, circularity assessment tools may be applicable to help the designers to conceive products durable, resistant, and recyclable

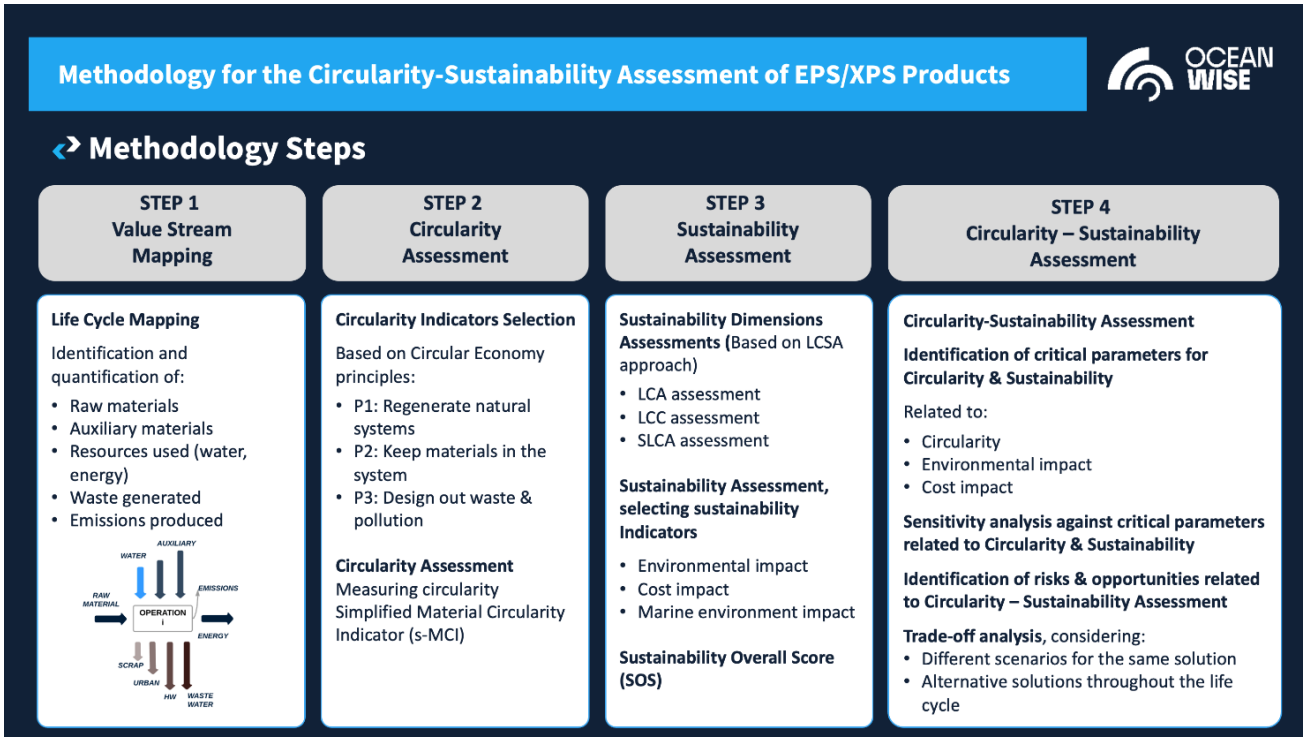
Examples

CIRCULARITY ASSESSMENT OF EPS/XPS PRODUCTS AND APPLICATION (SUSTAINN)

The OceanWise project aimed at developing a methodology to perform a circularity assessment of EPS/XPS products and applications. The goal of the methodology is to develop the most sustainable (economic, social, environmental) and circular alternatives for the targeted applications. This

[12] https://op.europa.eu/en/publication-detail/-/publication/4d42d597-4f92-4498-8e1d-857cc157e6db

methodology is based on a two-step approach: the first is related to the sustainability assessment of the actual product; and the second phase is focused on solutions trade-off analysis.



OCEANWISE MARINE IMPACT ASSESSMENT TOOLKIT (V1.0) OF ASSAYS TO ASSESS POTENTIAL GLOBAL IMPACT OF PLASTIC MATERIALS ON THE MARINE ENVIRONMENT

The OceanWise project intended to give more information to understand how the impact of plastic in marine environmental can be estimated and how decisions should be supported by credible information. CEDRE, one of the partners of OceanWise project, developed a "Marine Impact Assessment Toolkit" (v1.0) with 48 assays to be selected to assess the potential environmental impact of plastic materials on the marine environment Those assays are divided by three categories: weathering, transfer of hazardous chemicals and toxicity on marine organisms. The methodology mandates the user to select a minimum of 8 assays in the toolkit: 2 assays of weathering type, 3 from transfer of chemicals and 3 from toxicity on amine environment category. Then, after selecting a minimum of two materials, the user will conduct the assays selected, attribute the scores defined in the toolkit and make an average, obtaining the total Impact Score. The lower the Impact Score, then the lower is the impact on the marine environment.

You should consider that…

- The use of data from other studies may not be directly applicable to your case study (there are significant variations in terms of geography and technology between studies to not be able to a such comparison).

Requirements to implement this action:

- Assessment methodology available

- You should have in mind that there is always data collection needed to ensure good representativeness of the results to the product.

- Skills in those methodologies
- Time and money
- Data to collect useful information

Sectors where this action makes sense:

- Fishing and aquaculture - Yes
- Consumption products – Yes
- Takeaway, catering – Yes
- Restaurants (fish food, seafood) – Yes
- Supermarkets – Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – Low
- Recycling rate of EPS/XPS – Medium
- Extension on the use of EPS/XPS – Low to medium
- Cost – Medium
- Technical requirement – Low
- Legal requirement – Low
- Human resources – Medium

D.3. Substitution of EPS/XPS by biopolymers in specific situations

Background

EPS/XPS products like single or small food items take-away trays, seeds trays, packaging trays and other packaging, fish boxes, floats, the insulation materials make them vulnerable to becoming marine litter.

There are growing numbers of new materials under development, that are often presented as potential solutions in the fight against plastic pollution. Those new materials include biopolymers and traditional natural polymers, *i.e.*, polymers occurring in nature and used without chemical modification.

Although these alternative materials are not a significant part of the market, they are growing in popularity. If they are to replace EPS/XPSat any time, there needs to be comprehensive life cycle analysis of this substitution to establish if it would result in beneficial outcomes for the marine environment. More robust standards and norms are needed to ensure that alternative biodegradable biobased plastics are, in fact totally biodegradable and there is no contamination by substances or microplastics for soil, water and air, for human health and ecosystems, in short and long terms. Additionally there is a need for a well-established waste management system to ensure the effective collection and environmentally sound waste management of these products. Namely

- if they are going to be compostable, a composting or anaerobic digestion destination should be in force;
- if they are biopolymer, a dedicated collection and recycling technology and scheme must exist.

For now, new materials are more expensive than traditional plastics but, as they are supposed to have a less environmental impact, they are gaining ground in the market and demand is expected to grow in the next years.

In the case of polymers occurring in nature, their use can be more limited but, even so, possible replacements are already occurring in packaging, mostly.

Most alternatives to traditional EPS are also expansible materials which may result in boxes like EPS boxes and are moulded in the same equipment as EPS. Nevertheless, a significant investment is needed to adapt traditional equipment to new materials.

Suggested Action

1. Compare alternative materials to the EPS/XPS considering technical requirements for the product to be designed, as well as whether the substitution would actually reduce marine litter or harm to the environment. The technical requirements should focus on functionality, as well as the destination when reaching the end-of-life phase. The risk of leaks into the environment and the impacts of such leaks should also be considered during the design. The existing biodegradability certifications(*) are still in their infancy and more information on the environmental and human health impacts is needed to support industries to make the right decision.
2. Before making any substitution of EPS/XPS, please verify if there is a separate collection system for your product and that it is efficient. Separate collections can be quite relevant in

B2B operations, where reverse logistics and separate collection systems exist for EPS/XPS products and packaging.

3. If your product has low or no circularity and you are not able to implement a circular solution, you can look for other materials to replace EPS/XPS which can be more circular and with proven reduced environmental and human health impacts.

(*)The certifications for biodegradability (soil, water, or in industrial processes such as composting and anaerobic digestion) are still in their infancy. The publication of the Policy Framework for Biobased, Biodegradable and Compostable Plastics can bring more clarity and assurance on how materials should be identified as biodegradable.

Examples

SEAclic box biobased – storopack.com
The winner of the Oceans Calling contest from the OceanWise project, Seaclic Box Bio-base, is made from a new and landfill compostable plastic that is certified by EN 13432* and comprises a very high share of renewable raw materials. One key benefit of this organic version of the SEAclic Box Bio-based is that it can be industrially composted together with food waste, without the need for prior cleaning.

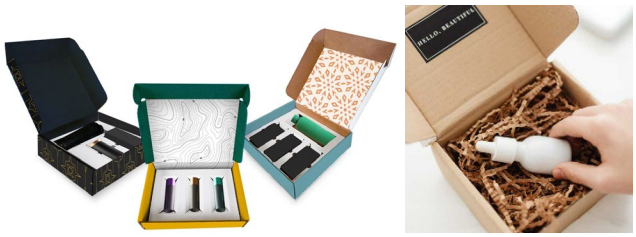
Kaneka Corporation - kaneka.co.jp/en/

- PHBH boxes based on a PHBH polymer. It is a biomass-based plastic (poly 3-hydroxybutyrate-hexanoate) obtained by bacterial fermentation of biomass.
- It follows ASTM D7081 standards (equivalent to EU EN 13432), so it is compostable under industrial conditions*.
- It is a versatile material that is already used by many single-use products such as cutlery, food packaging, straws, etc.
- This material can be processed/moulded on EPS processing equipment.

*The certifications for biodegradability (soil, water, or in industrial processes such as composting and anaerobic digestion) are still in their infancy. More robust standards and norms are needed to ensure that alternative biodegradable biobased plastics are, in fact, biodegradable and there is no contamination by substances or microplastics for soil, water and air, for human health and ecosystems, in the short and long terms. The publication of the Policy Framework for Biobased, Biodegradable and Compostable Plastics can bring more clarity and assurance on how materials should be identified as biodegradable.

Fishing floats made of cork - https://corksolutions.com
Cork has been used for centuries as fishing floats in Mediterranean countries. Although their price can be higher compared to plastic floats, their use would reduce the release of plastic into the aquatic environment.

Moulded cellulose – MFT-CFK - moldedfiber.com This company produces moulded cellulose packaging as an alternative to EPS, for electronic components, mostly. Moulded cellulose is made of recycled paper including newspaper, kraft fibres and recycled paper plates. Moulded cellulose has the advantage of having high-temperature resistance, and excellent cushioning properties, and is a static neutral material.	

Customised cardboard inserts and cushioning - boxgenie.com Several companies produced corrugated cardboard with customized inserts for specific products. It can be a good solution for dry products, without the risk of water damage. Other products have paper/cardboard cushioning, using just one packaging material.	

Mycelium packaging – Ecovative.com This company produces materials based on mycelium, by up-cycling agriculture by-products. Their products can replace EPS/XPS packaging, by combining mycelium with hemp hurd, making it light, strong, and fire and water-resistant.	

You should consider that…

- Biobased plastics and biopolymers mayhave a certification as biodegradable, but may not biodegrade in composting and anaerobic digestion plants (in the existing industrial units, the time is quite reduced compared to the time defined in the standards) and even less so in the marine environment.
- When compared with traditional EPS, there may be some differences in the manufacturing process: variables, parameters, and equipment needed in each phase of the process.
- Manufacturing EPS and alternative material boxes at the same time may require huge investments in space, infrastructure, and machines to avoid contamination of materials, energy needs, cleaning, and water consumption.
- Storage facilities and logistics must be adapted to this new approach.

Requirements to implement this action:

- Talk with your material provider to see if there are alternatives to EPS/XPS that would be easier to manage at end-of-life, and that would have a reduced risk of environmental harm should the product be lost to the environment.
- Talk with operators of composting and anaerobic digestion plants and ask them which type of biobased plastics and biopolymers they take in their units.
- Establish that there are options for the collection and management of EPS/XPS substitutes to ensure circularity.

Sectors where this action makes sense:

- Fishing and aquaculture - Yes

- Mixing even small amounts of alternative materials with the EPS waste could decrease the recovery of EPS and XPS – they will have different collection and recycling schemes, thus a prior separation of both types of waste is necessary.
- BIOEPS is not recoverable. The end-of-life of these materials is composting or can be used as waste to energy and landfills. Companies and citizens must be aware and, therefore, biobased plastics and biopolymers must have label differentiation. Also, BIOEPS trademarks using EcoPure additive is fossil EPS with organic additive making it capable to biodegrade in landfills. This is not a best practice from a circularity point of view (https://www.goecopure.com/what-is-ecopure.aspx).
  Alternative products may not be recyclable (*e.g.,* paper products to replace XPS and EPS will most probably have a plastic or wax liner in cases where they are made for food contact, which may not be removable, making the paper not recyclable. This may not be the case for moulded cellulose packaging made for other packaging purposes. By current law, up to 8% polyethylene is allowed in recycled paper pulp. Thus, some producers make cardboard boxes with an internal plastic layer that represents 6% of the weight of the boxes, and as such claim recyclability of their cardboard boxes.
  - Consumption products – Yes
  - Takeaway, catering – Yes
  - Restaurants (fish food, seafood) – Yes
  - Supermarkets – Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – It depends. The substitution of EPS or XPS for biopolymers will need to ensure that it will reduce marine litter through marine biodegradation. Being home compostable or industrial compostable is not enough, because it can still reach the marine environment. This is currently still a challenge.
- Recycling rate of EPS and XPS – Low (there is the replacement of EPS/XPS)
- Extension on the use of EPS/XPS – Low (there is the replacement of EPS/XPS)
- Cost – Medium
- Technical requirement – High (there is the need to improve marine biodegradability test requirements)
- Legal requirement – High (there is the need for more legal instruments to regulate alternatives)
- Human resources – Medium

D.4. Substitution of EPS/XPS for fossil plastics in specific situations

Background

EPS/XPS products like single or small food or takeaway trays, seeds trays, packaging trays, fish boxes, and packaging, make them vulnerable to becoming marine litter. EPS and XPS substitution by other fossil plastic materials are occurring, namely by plastics less light and resistant, keeping the same functionality.

Fish boxes are one good example of this substitution. Packaging for fish can broadly be divided into five different material categories: (1) Single-use plastic EPS, (2) Single-use plastic other (corrugated PP), (3) Single-use corrugated cardboard, (4) Single-use corrugated cardboard with liner (insulation panels) and (5) Reusable hard solid plastic packaging.

Suggested Action

Compare alternative materials to the EPS/XPS considering technical requirements for the product to be designed. The technical requirements should focus on functionality as well as circularity, to ensure that alternative materials will be kept in technological cycle and not reach the environment.

Examples

TEPSA (SP) There are some companies (TEPSA http://www.e-tepsa.com/) commercializing plastic boxes for food use at very competitive prices. All the boxes are the same regardless of the customer, although the dimensions and design vary depending on the sector. The design allows them to be piled in such a way that once empty, they can be piled to reduce the space required and the transport costs. The boxes are owned by one of the members of the supply chain (*e.g.*, ship owners in fishing) and are used and returned. The users recover almost the whole price when giving the boxes back except for a small amount to pay for washing and disinfection. The broken boxes are returned to the initial seller (TEPSA) who even pays for them and recycle them making other plastic elements for non-food use. In this way, the cycle is completely closed in a sustainable manner.	

THERMOBOXES IN EXPANDED POLYPROPYLENE **https://thermo-future-box.com/en/** These boxes similar to EPS are made of expanded polypropylene. They have great shock and break resistance, better acid resistance, are dish-washer-proof and easier to clean compared to EPS and have a longer life.	

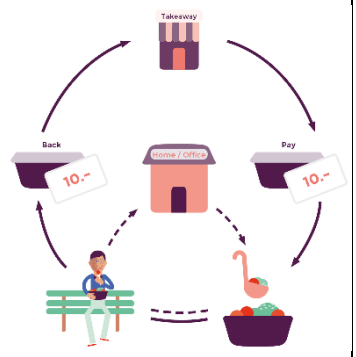
reCIRCLE UCC (IE and CH)

This is a project of the University of College Cork in Ireland based on the Swiss recircle social enterprise model. In Switzerland, the company manages a network of reusable dishes for takeaway restaurants. The restaurants enter a partnership and subscription with a recircle and can order products and hand them out to their customers. The customers pay CHF 10 for their reCIRCLE BOX, and can keep it if they want or return it to any partner. When they return the box, the CHF 10 are paid again to the customer.

At the University of College Cork, the scheme will introduce purpose-designed reusable boxes that can be used as alternatives to the single-use plastic containers (including EPS and XPS) or wrap currently provided. Boxes will be subject to a deposit or loyalty card system, with the deposits returned or accounts released on the return of the box.

This a best practice that was transferred into another country, making possible the goal of OceanWise: bring best practices and see how they can be put into practice in a different place and situation.

https://www.ucc.ie/en/eri/projects/recircle-ucc--demonstration-of-deposit-return-scheme-for-reusable-food-containers.html
https://www.recircle.ch/en/support



You should consider that…

- Implementation of the identified packaging alternatives leads to higher costs.
- There are technical packaging properties that cannot (yet) be matched, added packaging portfolio complexity and investments to adapt existing production lines to new packaging.
- Having different packaging
- solutions side by side leads to increasing complexity of operations.
- Alternative products may not be recyclable (e.g., paper products to replace XPS and EPS probably have a plastic liner which may not be removable, making the paper not recyclable).
- In the case of changing for a reusable option, it is important to have a deposit-return scheme working to ensure the return of the reusable product.

Requirements to implement this action:

- Talk with your material provider to see alternatives to EPS/XPS in traditional plastic that could be reusable and recyclable.
- Talk with waste operators or municipalities to know if there is a recycling destination for those EPS and XPS alternatives. If there is no recycling destination, it is not best practice to change the type of plastic.

Sectors where this action makes sense:

- Fishing and aquaculture - Yes
- Consumption products – Yes
- Takeaway, catering – Yes
- Restaurants (fish food, seafood) – Yes
- Supermarkets – Yes

How good is this action?

- Potential of EPS/XPS to become marine litter – It depends. If the traditional plastic that will replace EPS/XPS has a separate collection and a recycling destination, a replacement of EPS/XPS occurs, making the potential of EPS/XPS to become marine litter low.
- Recycling rate of EPS and XPS – Low (there is the replacement of EPS/XPS)
- Extension on the use of EPS/XPS – Low (there is the replacement of EPS/XPS)
- Cost – Medium
- Technical requirement – Medium
- Legal requirement – Medium
- Human resources – Low