OCEAN WISE

Reducing EPS marine litter in the North East Atlantic

Set of Recommendations for Policy Makers

Oceanwise answer to the need for improved legislation to reduce the impact of EPS/XPS and other foamed plastics in the Ocean

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Overview

The OceanWise project – Reducing EPS marine litter in the Northeast Atlantic, cofinanced by INTERREG Atlantic Area, aimed to propose, and test options to manage Expanded Polystyrene (EPS) and Extruded Polystyrene (XPS) adequately, in a life cycle thinking approach. The project goals focused on the identification of the products made of EPS and XPS which need to be managed in their life cycle due to their potential risk of leakage to the environment resulting in marine litter, by proposing, and testing plausible solutions to be managed during use and end-of-life and, when necessary, to be replaced by less impacting materials. Participatory methods with the aim of generating new and best practices in the use, manufacturing, recycling, and uptake of EPS and XPS were also conducted during the project. The last goal is to propose updates to public policies and establish best practices for the industry.

During the OceanWise project, EPS/XPS life cycle players identified several issues which hamper both the circularity of products made of EPS/XPS and their usage with a reduced environmental impact – such as for example the reduced separate collection systems for fish boxes, the difficulty in keeping EPS/XPS in the Technosphere, and lack of information about best environmental alternatives to EPS/XPS. Other issues found highlighted the difficulty in keep using EPS/XPS in specific applications due to the high risk of these products' degradation and of the ocurrence of dissipative losses to the environment, leading to negative environmental and health impacts. Existing alternatives on the market are not completely proven to be better than EPS/XPS, which may confuse players in terms of what the best environmental solution should be.

> To reach a sustainable economic use of EPS/XPS, it is necessary to increase recycling (not downcycling), reduce dissipative losses during the entire life cycle, and it is essential to reduce the use of EPS/XPS when other solutions with a lower environmental and human health impact are available, proven by standardized methods.

Therefore, this Policy-oriented document intends to propose the update of a specific European legal document – the SUP Directive 2019/904[1]. SUP Directive aimed to regulate the use of plastics which were more commonly found in European beaches, in such way that plastic litter of single-use plastics could be reduced. However, the OceanWise project identifies two main issues that require revision of the terms of the SUP Directive: for one, XPS was not considered in the Directive, and also the fact that measures existing for EPS products are insufficient. With this revision process, OceanWise project hopes to make the SUP Directive more robust and capable of enabling high-quality recycling of EPS/XPS, reducing its use and preventing environmental and human health impacts.

To achieve this, OceanWise project believes the revision should follow six objectives:

1. Identification, quantification, and monitoring of materials with foamed properties – the materials family where EPS/XPS belongs;
2. Life cycle management of foamed materials to avoid losses from Technosphere;
3. Safe and Sustainable by Design of foamed materials and products;
4. Standardization of methods for the assessment of foamed materials and alternatives materials;
5. Financing R&D on foamed plastics materials and its alternatives.
6. Voluntary agreements and information instruments to boost changes in society concerning foamed plastics.

Although the legal document intended to be improved is the SUP Directive, the OceanWise project is aware that other policy instruments should be used to impulse an environmentally sound management of EPS/XPS, including voluntary agreements and information instruments. Best practices on the management of EPS/XPS, including policy instruments, are detailed

[1] European Parliament and Council, 2019. Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. *Official Journal of the European Union*, L 155, 1-193.

proposal of such policy instruments is detailed in the *Practical Guide for the Management of EPS and XPS* document of OceanWise project.

1. Identification, quantification, and monitoring of materials with foamed properties

SUP Directive clearly identifies the EPS as one of the materials to have restricted use due to its prevalence in the marine environment. However, many other foamed plastics materials are found in marine litter, which includes XPS, XPP, foamed PVC, polyurethane (PUR), at least. The variety of foamed plastic requires the adoption of the term "foamed plastics" instead of identifying the polymer. If only the polymer is identified, the risk of changing the polymer and keeping producing foamed products is high, and this is not an option for reducing the impact of plastics in the marine environment. It is important to note that although the OceanWise project focused its work on EPS and XPS due to their extensive presence in European beach monitorings, other foamed plastics ought equally to be taken under consideration, as they represent potentially similar risks to the marine environment;

A possible definition of foamed plastics[2] was collected from Britannica encyclopaedia. Also, other definitions existing in Science Direct for foamed plastics[3] which can also be considered.

> Foamed plastics[1]: "resin converted into a spongelike mass with a closed-cell or open-cell structure, either of which may be flexible or rigid, used for a variety of products including cushioning materials, air filters, furniture, toys, thermal insulation, sponges, plastic boats, panels for buildings, and even lightweight beams. Under appropriate conditions almost any thermosetting or thermoplastic resin can be converted into a foam."
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> Foamed plastics[2]: "foamed plastics are a new type with the properties of lightweight, heat preservation, sound absorption, and quakeproof"; "are expanded materials with a cellular structure that have various identification names such as plastic foams, cellular foams,

[2] Britannica, The Editors of Encyclopaedia, 2021. *Foamed plastics*. https://www.britannica.com/technology/foamed-plastic. Accessed 17 November 2022.
[3] ScienceDirect, 2022. *Foamed plastics*. https://www.sciencedirect.com/topics/materials-science/foamed-plastics. Accessed 21 November 2022.

expandable foams, structural foams, blown foams, sponges, and microcellular foams. They may be flexible, semi-rigid, or rigid. The usual process involves the introduction of a dispersed gas and subsequently cooling or curing. This technique can make most plastics into foams using most plastic processing methods. Many different products are produced ranging from film or sheet to moulded shapes. Many different properties can be obtained based on plastics used [thermoplastic (TP) and thermoset (TS)] and the foam density."

Besides the definition of foamed plastics, it is also mandatory to identify the different types of foamed plastics. The existing resin identification code is not capable of answering to the diversity of existing polymers nowadays, which does not allow a correct monitoring, traceability, and circularity of those materials. **A new approach to the identification of resins, particularly to foamed plastics could be made through a new code of resins or through digital passport included in the European Union Ecodesign for Sustainable Products Regulation (ESPR)**[4].

Besides identification, another missing aspect in SUP Directive is the quantity of foamed plastics put on the market. It was very difficult for the OceanWise project partners to determine the flow of such materials at any level, since there is no database or registration on its amounts, on related to the products made of those materials. **A standardized procedure to report the amounts of foamed plastics, at European level, would improve the control and monitoring of those materials. Such monitoring could be helpful to identify potential losses to the environment.**

Also, the application as soon as possible of the ESPR for foamed plastics products would also be beneficial for this monitoring. **The digital passport with the traceability will be very useful to monitor the flow of such materials and products in the economy and potential releases to the environment, as well as to help boost the potential value for recycling of potentially less harmful and safer plastics.**

[4] European Commission, 2022. Proposal for Ecodesign for Sustainable Products Regulation. European Commission. https://environment.ec.europa.eu/publications/proposal-ecodesign-sustainable-products-regulation_en. Accessed 21 November 2022.

Finally, the monitoring of foamed plastics in the environment, as defined in the Commission Decision 2014/848 – Good environmental status of marine waters, and at the Marine Strategic Framework Directive 2008/56/EC is still not considered, neither for microplastics (only marine litter). **There is a huge need to characterize and identify sources of foamed plastics pollution which could be achieved by developing and updating existing monitoring protocols for plastic litter.** Other initiatives are already in course concerning monitoring of microplastics, namely the proposal of Directive amending Directive 2000/60/EC for water policy[5], which should be in accordance with the other monitoring activities proposed to marine environment.

2. Life cycle management of foamed materials to avoid losses from Technosphere

To achieve a circular life cycle of foamed plastics it is important to fight the "steady increase in plastic waste generation and the leakage of plastic waste into the environment, in particular into the marine environment"[6]. Only with a life cycle management perspective, where all life phases of foamed plastics are known, and management and adequate responsibilities are given to the life cycle players will it be possible to aspire to such SUP Directive intention.

Also, **the use of foamed plastics should be limited to situations where the degradation is nearly null.** This situation is for long-life single use applications (such as insulation material for construction), or short-life single use or reusable, both in Business-to-Business flows (B2B).

In this respect, the OceanWise project proposes several measures according to the issues found during the project:

[5] European Commission, 2022. Proposal for a Directive of the European Parliament and of the Council amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy. European Commission.https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022PC0540&from=EN. Accessed 21 Novemebr 2022.

[6] European Parliament and Council, 2019. Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. *Official Journal of the European Union*, L 155, 1-193.

i. **To include more applications of foamed plastics besides plastics single-use**

SUP Directive focus on single-use plastic products, which "include a diverse range of commonly used fast-moving consumer products that are discarded after having been used once for the purpose for which they were provided, are rarely recycled, and are prone to becoming litter."[4] However, other applications and uses of foamed plastics are causing marine litter problems. **The buoys used in fishing, pontoons made of foamed plastics, construction near coastal area using foamed plastics and surfboards, are not single-use items but are responsible for the occurrence of foamed plastics in the marine environment.** Also, in single use application there is a focus only in the immediate consumption, however that does not apply for instance to fish boxes waste generated at fish markets (the same concerning EPS boxes used for vegetableas and fruits). Indeed, they are not for immediate consumption, but used for transportation. There are several legal initiatives in various countries but not a European Directive **regulating those uses and it should be fixed in SUP Directive**.

ii. **To restrict/forbid the single use application not attached or untied application, in Business to Consumer (B2C) flow (*e.g.*, packaging, beads and peanuts for packaging, boxes)**

The restriction of single-use applications untied, loose, as a single object without being attached to any support (*i.e.*, not a component of a product) such as for packaging, beads and peanuts for packaging, and boxes, ought to be forbidden to avoid leakage into the environment. This approach is justified by the difficulty in establishing circular flows for such products, which does not occur in B2B situations. Producers and distributors should provide phase-out measures to replace foamed plastics from packaging. In addition, food contact packaging with foamed plastics should be replaced by proven safer and more sustainable, and circular materials which don't brake and flake so easily.

iii. **To forbid the use of short-life, reusable or long-life where foamed plastics can degrade or lost**

The degradation of foamed plastics occurs when exposed to climate conditions or erosion (water, soil, mechanical), leading to dissipative losses and leakages to the environment. For that

reason, those applications should be avoided. Applications include foamed plastics uses such as buoys, surfboard, pontoons, to name just a few.

iv. **To forbid the use of foamed plastics in economic activities near coastal areas and rivers**

According to Eurostat[7], an economic activity takes place when there is an input of resources, a production process, and an output of such process, like goods or services, and it can include capital goods, labour, or manufacturing. Economic activities are not capable of retaining leakages of foamed plastics into the marine environment, in particular untied, loose, as a single object without being attached to any support, or degradable applications (no matter the life timeframe, short or long). **Using the precautionary principle, the economic activities near coastal areas and rivers should not make use of lightweight such as foamed plastics, and the list of products made in plastics already identified in part E of SUP Directive.**

In the cases where foamed plastics are used not near coastal neither river areas, but the economic activity still **uses foamed plastics products and other lightweight plastics, a risk assessment to prevent the littering and accidental release of plastics into the environment should be provided to authorities**. For example, **construction sites using foamed plastics should indicate the use of foamed plastics products in the construction and a risk assessment of their release during the life cycle of construction should be provided, with the measures to prevent the occurrence of leakages and a proper foamed plastics waste management**.

v. **Proposal for extended producer responsibility for B2B applications, including packaging**

The other B2B or B2C situations where the product is reusable, or with a short-life single use or with a long-life, the application of extended producer responsibility (EPR) should be imposed. This would allow for an environmentally sound management of those foamed plastics products during the life cycle. The application of EPR is quite relevant for the cases of transboundary management of foamed plastics products, and EPR has been giving proves of being a correct approach, based on the experience for packaging waste management. In fact, in

[7] Eurostat, 2020. Glossary: Economic activity. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Economic_activity. Accessed 21 November 2022.

countries where packaging EPR exists, the foamed plastics packaging should be included in those EPR schemes.

vi. **EPR schemes should allow different possibilities to collect and recycle foamed plastics**

During the OceanWise project, barriers to collecting and recycling EPS/XPS were detected, namely at food service containers and fish boxes. In fact, there are several foamed plastics products without a separate collection system, neither including reverse logistics. Users must dispose it into residual waste containers, where it gets broken and lost into the environment, and some disposed of into landfills and incineration. **Separate collection systems for foamed plastics should be a reality, by delivering with now cost to the user or through a deposit refund-system**.

With this in mind, a proposal of rules to improve the SUP Directive may be:

In B2B:

a) The owner of the foamed plastics is responsible to send it for recycling.

b) Companies making use of and discarding EPS should instal separate collection, compaction by bricqueting when possible and reasonable depending on the waste volumes produced, and assure that EPS waste is sent for EPS dedicated recycling (a recycling scheme). This should be a reality on fish market at big markets, and sales for restaurants and retail stores. At sales areas with 400 m2 at least, the existence of a compaction service should be mandatory.

c) At construction sites outside coastal and river areas, there should be a separate collection system available for foamed plastics. Also, a risk assessment should be made at construction sites to elaborate measures to avoid the littering and accidental release of plastics for the environment.

In B2C:

a) Foamed plastics should be designed to fit separate collection containers available in the country where they are sold.

b) Municipalities should assure that waste managers provide separate collection services (containers, densification services (mobile, fixed)) to urban activities where waste of foamed plastics can be produced and send it to recycle.

c) We need to simplify licensing of used and waste foamed plastics separate collection in their different situations – used foamed plastic product and waste foamed plastics, non-hazardous, in such way that could facilitate the circularity solutions for the foamed plastic products and material itself. This would help remove barriers to the collection of used or waste foamed plastics non-hazardous through reverse logistics, separate collection, and other separate collection schemes. There are already many authorized waste managers. However, in the case of Reverse Logistics, Box Manufacturers and Distribution Logistics Platforms are the most interested in adopting reverse logistics systems. To do this they need to obtain the authorized waste manager license.

d) One measure to improve the management of XPS (in B2C) would be for the Material Recovery Facility waste separation companies to invest in optical material separation systems. There are still many that do the separation tasks manually and this does not allow a rigorous separation by type of material. In the same way, there are Material Recovery Facility companies that, even having the necessary means, do not make a fraction of PS because it is not profitable, and that is why the XPS wastes are not finally recycled.

vii. To establish recycling content targets for foamed plastics products when possible

Foamed plastics products have no recycling initiatives. To address this, a recycled content in products not for human contact, or recycling rate could be developed for specific products, initially. Those recycling measures should always consider safety legislation and cross-contamination prevention measures.

The applications of foamed plastics require the use of flame retardants and additives, which can be harmful for human health and to the environment, if not managed properly when reaching the end-of-life. **The cross-contamination during recycling must be prevented. This can be achieved by the implementation of ESPR as soon as possible, namely the traceability measures considered in the Regulation**.

viii. Extended the plastic fee to plastic products which could be recycled

On January 2021, the EU introduced a levy on non-recycled plastic packaging waste. **The same levy could be extended to non-recycled plastics (non-packaging).** This measure would impulse the recyclability and other circular solutions for plastics products which are going to landfill and energy recovery. Nevertheless, extending the levy should consider the existing economic situation, and the levy paid should be used to finance circular solutions to foamed plastic products, specifically.

3. Safe and Sustainable by Design of foamed materials and products to gain circularity

Safe and Sustainable by Design criteria are defined by the Chemical Strategy for Sustainability (in the context of EU Green Deal), which promote a holistic approach that integrates safety, circularity and functionality of chemical, materials, products, and processes, minimizing their footprint and allowing their circularity[8]. In this respect, foamed plastics materials need to be safer and more sustainable to lower their impact on the human health and the environment. **The composition of foamed plastics should embrace Safe and Sustainable by Design criteria, to reduce the presence of toxic and harmful substances found in EPS/XPS during the OceanWise project.**

Therefore, **the phase-out of contaminated foamed plastics with hazardous and harmful substances (including flame retardants) whilst managing end-of-life products as hazardous waste should be added to SUP Directive. A digital platform should also be provided to foamed plastics players where they could identify which chemical substances exist in their products and their hazardousness**, helping them to find substances to replace the most potentially

[8] Caldeira, C., Farcal, R., Moretti, C., Mancini, L., Rauscher, H., Rasmussen, K., Riego Sintes, J. and Sala, S. 2022. Safe and Sustainable by Design chemicals and materials Review of safety and sustainability dimensions, aspects, methods, indicators, and tools, EUR 30991 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-47609-2, doi:10.2760/68587, JRC127109.

harmful for human health and the environment. A good example is the PRIO platform from KEMI Swedish Chemicals Agency[9].

Safe and Sustainable by Design should not only focus on foamed plastics. **Alternative materials, to replace foamed plastics (fossil origin or biobased, and biodegradable) should also embrace Safe and Sustainable by Design criteria**, to ensure that the replacement is being made in an environmental sound manner.

4. Standardized methods for the assessment of foamed materials and alternatives materials

Many EU policy instruments already focus on the assessment of environmental impacts of products, namely through life cycle assessment (LCA), risk assessment, carbon footprint, and others. During the OceanWise project, it was notorious the lack of regulation on which, how, and when to use those assessment methodologies, and afterwards, to whom those results should be presented.

This is even more relevant for the assessment of biodegradable materials, which intend to replace fossil plastics for two reasons: they can be biodegradable (which solves the issue of plastic pollution in the environment) and they can be produced from biological sources (plants or food waste, making plastics from renewable sources, consuming CO_2 during the process, which can bring a contribution to the mitigation of greenhouse gases in the atmosphere). The reasons pointed out need to be demonstrated and comparable to the business-as-usual material or product, to make clear their advantages in terms of environmental impact.

The existing methodologies and tests to assess biodegradability are not robust. There are three CEN norms for biodegradability – EN 13432: Requirements for packaging recoverable through composting and biodegradation, EN 14995: Plastics - Evaluation of compostability - Test scheme and specifications, and EN 17033: Biodegradable mulch films for use in agriculture and horticulture. The first two norms intend to show biodegradability in composting and anaerobic digestion plants; however, the tests are not in line with composting and anaerobic digestion

[9] KEMI (Swedish Chemicals Agency), 2021. PRIO – a tool for substitution. https://www.kemi.se/prioguiden/english/start. Accessed 17 November 2022.

facilities existing in EU countries, because facilities run processes in a small period of time. Also, the EN 13432 considers that "plastics are biodegradable if 90 per cent of them have decomposed into particles smaller than two millimetres in less than twelve weeks"[9]. Such definition does not limit the release of micro and nanoplastics, and the standard omits about the effects in the long term in the environment[10]. **There is a huge need to improve CEN norms devoted to such type of technology, and for other products besides packaging.** Also, the CEN norm does not **address completely the micro and nanoplastics occurrence** (their occurrence is not in line with biodegradability). At last, even in those cases when biodegradability occurs, there is still missing **information concerning the impacts related to the release of additives and substances added to the polymer, and their release into the environment should be safe and sustainable at soil and aquatic environment (freshwater and marine).**

In this respect, CEN should increase their effort to **develop standards and norms to assess biodegradability, biobased plastics definition and composition and compostable plastics requirements, making clear that fossil plastics should not be biodegradable in any circumstance** (based on a precautionary principle, if are not in a renewable cycle existing in the planet, it should not be added to a cycle, having the risk of changing it (increasing carbon in a complex cycle already affected, resulting in the climate change).

The environmental impacts to human health and environment of biodegradable, compostable and biobased alternative materials to foamed plastics need to be improved. **Life cycle assessment (LCA) methodology is not yet capable to assess macro, meso, and microplastics impact on the ecosystems and in human health. This is a concern that should be considered when using LCA to compare materials and products made of polymers**.

Such concerns are not covered by SUP Directive. The Policy Framework for Biobased, Biodegradable and Compostable Bioplastics should be capable to provide an answer to all those concerns, to help increasing awareness and assurance, both to the producers and users, that the

[10] Steiner, T., Zhang, Y., Möller, J.N., Agarwal, S., Löder, M.G.J., Greiner, A., Laforsh C., Freitag, R, 2022. Municipal biowaste treatment plants contribute to the contamination of the environment with residues of biodegradable plastics with putative higher persistence potential. *Science Report* 12, 9021. https://doi.org/10.1038/s41598-022-12912-z.

alternative to foamed plastics is, in fact, the sustainable and safer one. **SUP Directive should refer to norms to be created in CEN to be the reference to make substitutions of foamed plastics by materials, as well as LCA**. **A set of criteria, like the ones elaborated in OceanWise by Sustainn, where life cycle sustainable assessment and circularity assessment criteria are used to compare alternative and conventional foamed plastics products.**

Again, OceanWise project demands for a **fast application of ESPR, as well to add to EPSR criteria for circularity assessment, human health, and environmental impact assessment of microplastics and mesoplastics, especially for products to be used in aquatic environments**. Those criteria should be mandatory for foamed plastics and alternative materials. **All the assessment made in the ESPR should be made by an independent entity to ensure confidence and transparency in the results.**

Besides the comparison with biobased and biodegradable alternative materials, **it is important that standardized methods exists for alternative plastics fossil based. There are solutions available on the market where replace foamed plastics by rigid plastics, which are safe to be reusable for food contact, for example. To increase awareness on reusable solutions, especially for food contact, it is mandatory to also establish Product Environmental Footprint Category Rules, to allow such comparison at take a conscious decision-making.**

After the standardization of environmental and human health impact of foamed plastics and alternative materials is done, **such assessment should be mandatory to be included into the product information, in accordance with ESRP. Circularity methodology assessment has to be considered, also.**

5. Financing R&D on foamed plastics materials and its alternatives

Research and development (R&D) are mandatory to the industry and academia to find alternative solutions to harmful substances, to increase knowledge on the environmental impact of actual and future materials and to improve the life cycle management of foamed plastics products. Financing those activities is essential to ensure better decision making not only for the

players of foamed plastics life cycle, but also to improve policy instruments that could regulate and force the players to act in a more circular and sustainable way.

Looking into the OceanWise project results, the activities requiring more financing through EU instruments are:

- Support producers to implement the ESPR;
- Develop CEN norms for safe biodegradability materials with biological source;
- Eco-label for marine use products criteria development;
- Elaboration of Product Environmental Footprint Category Rules for foamed plastics products and alternative products devoted to aquatic application and to food contact, allowing the comparison of those assessments;
- More support for the development of ecotoxicity studies of microplastics and chemical substances from foamed plastics and alternative materials used for food contact and its impacts on human health and environment;
- Subsidize the entrance on the market of innovative, bio-based materials that could replace foamed plastics in a more sustainable (environmental, economic and social) and circular perspective (less material, durable and recyclable);
- Financing markets for foamed plastics recycled or refurbished products (or other circularity solution for used foamed plastics, including cascade recycling);
- Finance separate waste collection system infrastructures;

The Directorate-General Research and Innovation **should consider the proposals of financing to help the EU regulations to be better and easily implemented and to help the economy to be more competitive and capable of implementing the Green Deal.** Policy making requires R&D support which cannot be done by industries. In other hand, industries need adaptation periods to find new ways to comply with Directives. Altogether, time, and financing, are capable to help companies to find solutions to the challenges proposed by regulatory instruments.

6. Voluntary agreements and information instruments to impulse changes in society concerning foamed plastics

Voluntary agreements related to plastic waste management are being developed all over by many countries. The most well known voluntary agreement is The Global Commitment, led by the Ellen MacArthur Foundation, in collaboration with the UN Environment Programme[11]. At a regional and local scale, voluntary agreements must also be arranged, through the creation of regional industrial symbiosis focused on foamed plastics life cycle, as well pacts at regional scale where industrial and urban activities actively contribute to the correct use of foamed plastics in a circular and low carbon perspective.

Concerning information instruments, awareness campaigns organized for the foamed plastics producers, distribution sector and consumers should be conducted and defined in SUP Directive.

Several instruments ought to be considered, including:

- Ecolabels for recognition of ecodesign good practices;

- Dissemination of good practices for industrial sectors dealing with foamed plastics, as well creating awareness to consumers concerning how to manage foamed plastics' waste and alternative materials (in detail: bioplastics, biodegradable, compostable);

- Support industrial sectors to establish requirements for the management of waste EPS and XPS in their processes. Industrial sectors include typical users (fishing and aquaculture, packaging) but also non-typical uses like the automotive industry;

[11] Ellen MacArthur Foundation, 2022. The Global Commitment 2022. Ellen MacArthur Foundation. https://ellenmacarthurfoundation.org/global-commitment-2022/overview. Accessed 21 November 2022.

- National authorities should run information campaigns focusing on the need for the replacement of EPS/XPS whenever this is the best option (in line with the Biodegradability of Plastics in the Open Environment[12]);

- Prioritize the reduction, reuse and recycling of plastics before considering biodegradation;

- Limit the use of plastics which are biodegradable in the aquatic environments to specific applications/uses where collection from the open environment is not feasible (fishing nets, buoys);

- Do not consider biodegradable plastic for inappropriate waste management or littering;

All those instruments intend to gather all the players of foamed plastics life cycle, to work together in a short-term, with long-term consequences. Through the SUP Directive, all players can work together to understand the foamed plastics environmental problem and which solutions are available or need to be developed in a near future.

Conclusions

Although the European Union foamed plastics are still far from being safe, sustainable, and circular, it is consistently transitioning in that direction. Only by adopting ambitious measures will the EU be able to maintain its exemplary position, and regulatory measures are the most ambitious options to implement such measures, in the case through SUP Directive. The development of norms and standards at CEN can be time consuming and requires precious time, as well as being onerous, but without it, a consistent and robust solution for conventional foamed plastics and prevent misleading alternative materials to enter the market will not occur. In a short-term, the implementation of most regulatory measures presented can be costly when implemented; in the long-term they will reveal to be needed to achieve a safe, sustainable, and circular economy of those materials, as well to the economy.

[12] European Commission, Directorate-General for Research and Innovation, *Biodegradability of plastics in the open environment*, Publications Office of the European Union, 2020, https://data.europa.eu/doi/10.2777/690248

Annexes

Table A1. Impacts of the proposed policy measures to reduce environmental impacts from EPS/XPS.

Table A2. Rules on the use of foamed plastics depending on the economic flow.

Table A1. Impacts of the proposed policy measures to reduce environmental impacts from EPS/XPS

Objectives for SUP revision	Problem identified by OceanWise	Solution proposed by OceanWise	Proposed legal documents to be updated or revised	Impacts on SDGs (17 goals)	Impacts on Green Deal (8 thematic areas)	Impacts on Zero Pollution Action Plan (9 Flagships)	Impacts on Circular Economy Action Plan (7 key actions)	Chemical Strategy for Sustainability
1	Missing definition of foamed plastics which limits the application of SUP Directive to similar EPS materials	Propose a correct definition, which may include any type of foamed plastics. The definition of "plastics" to be used is the one from SUP Directive.	SUP Directive	11. Sustainable cities and communities 12. Responsible consumption and production 14. Life bellow water 15. Life on land	7. Biodiversity and ecosystems 8. Zero pollution, toxic-free environments	2. Supporting urban zero pollution action 3. Promoting zero pollution across regions	2. Key product value chains	
1	Missing data on the quantity (in volume) of foamed plastics put on the market, and which applications	Standardized procedure to report the amounts of foamed plastics, at European level (a CEN norm would be useful).	SUP Directive	14. Life bellow water 15. Life on land	7. Biodiversity and ecosystems	3. Promoting zero pollution across regions 4. Facilitating zero pollution choices	3. Less waste, more value	
1	Need to characterize and identify sources of foamed plastics pollution	Development of the new monitoring protocols and update of existing ones for plastic litter, to include foamed plastics. Also, contamination by hazardous substances should include additives and other added substances to plastics formulations.	Commission Decision 2017/848 – good environmental status of marine waters; Marine Strategic Framework Directive 2008/56/EC	6. Clean water and sanitation 12. Responsible consumption and production 14. Life bellow water 15. Life on land	8. Zero pollution, toxic-free environments	3. Promoting zero pollution across regions 7: Living Labs for green digital solutions and smart zero pollution	3. Less waste, more value	
1	Difficulty in identifying different types of foamed plastics	Improve polymers identification to include new polymers.	Waste Framework Directive, SUP Directive, ESPR	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	
2	Presence of single use EPS/XPS from food and beverage in the environment, with environmental and human health impacts	Restrict the use of single-use food and beverage made of foamed plastics through SUP Directive inclusion in article 5.	SUP Directive	11. Sustainable cities and communities 12. Responsible consumption and production 14. Life bellow water 15. Life on land	7. Biodiversity and ecosystems 8. Zero pollution, toxic-free environments	2. Supporting urban zero 3. Promoting zero pollution across regions	3. Less waste, more value 4. Making the circular economy work for people, regions, and cities	2. Stronger EU legal framework to address pressing environmental and health concerns

Objectives for SUP revision	Problem identified by OceanWise	Solution proposed by OceanWise	Proposed legal documents to be updated or revised	Impacts on SDGs (17 goals)	Impacts on Green Deal (8 thematic areas)	Impacts on Zero Pollution Action Plan (9 Flagships)	Impacts on Circular Economy Action Plan (7 key actions)	Chemical Strategy for Sustainability
2	Cross contamination of EPS from different applications in recycling and other circular activities	Application, as soon as possible, of EU Ecodesign for Sustainable Products Regulation foamed plastics products, namely the traceability issue (article 8)		12. Responsible consumption and production	Area 3: Industry for a clean and circular economy Area 8: Zero-pollution, toxic free environment	3. Promoting zero pollution across regions	1. A sustainable product policy framework 2. Key product value chains 3. Less waste, more value	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns
2	Difficulty to ensure a transboundary management of EPS and XPS products. Only in some countries the management of packaging made of EPS and XPS (*e.g.*, included in Green Dot System)	Application of Extended Producer Responsibility, already in SUP Directive article 8, by adding more products in this article, namely the ones made of foamed plastics. Extension of existing PRO for packaging materials to also include foamed plastics.	SUP Directive, Packaging and Packaging Waste Directive, Waste Framework Directive	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy Area 8: Zero-pollution, toxic free environment	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	
2	Negative impact due to the presence of foamed plastics in the environment	The implementation of precautionary principle should be mandatory to prevent environmental and human health impacts. In fact, the type of use that foamed plastics products will have may lead to dissipative releases of plastics, due to its exposition to mechanic, solar, air, and water degradation. In Table 2 are identified the situations where foamed plastics should be forbidden and allowed, always considering an EPR scheme.	SUP Directive	6. Clean water and sanitation 12. Responsible consumption and production 14. Life bellow water 15. Life on land	Area 8: Zero-pollution, toxic free environment	3. Promoting zero pollution across regions	3. Less waste, more value	
2	Low circularity of foamed plastics products (in particular, foamed plastics products different from EPS)	Establish recycled content targets for foamed plastics products when is possible, always considering safety legislation and cross contamination prevention measures. Awareness campaigns for all actors of the life cycle of foamed plastics products.	Waste Framework Directive; Packaging Waste Directive; SUP Directive	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains	

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2	Barriers to collecting and recycling foamed plastics food service containers and other applications, in B2B situations	Foamed plastics products in B2B must apply the EPR scheme. This scheme must allow different possibilities to collect and recycle foamed plastics, including deposit-refund schemes, reverse logistics and separate collection.	Waste Framework Directive, Packaging and Packaging Waste Directive, SUP Directive	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	1. A sustainable product policy framework 2. Key product value chains 3. Less waste, more value	
2	Barriers to the collection of used or waste foamed plastics non-hazardous through reverse logistics, separate collection, and other separate collection schemes	Simplify licensing of used and waste foamed plastics separate collection in their different situations – used foamed plastic product and waste foamed plastics, non-hazardous, in such way that could facilitate the circularity solutions for the foamed plastic products and material itself.	SUP Directive, Waste Framework Directive	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	1. A sustainable product policy framework 2. Key product value chains 3. Less waste, more value	
2	Not all foamed plastics application are considered in SUP Directive	Extend the scope of SUP Directive to include the several applications of foamed plastics, namely divided by B2C and B2B, single use, short-life (includes reusable; time frame 1 to 10 years) and long-life (equal and more than 10 years).	SUP Directive	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	
2	Activities responsible for foamed plastics and other plastics littering are not fully addressed in SUP Directive, not preventing the occurrence of plastic litter	Proposal to article 5 of SUP Directive to include all economic and non-economic activities (tourism, sports, others) occurring near coastal areas and rivers, and forbid the use of light plastics, including lightweight plastic carrier bags (in accordance with article 3, n.º 1-C of 94/62/EC Directive) foamed plastics, and the list of the products made in plastics already identified in part E of SUP Directive.	SUP Directive	6. Clean water and sanitation 11. Sustainable cities and communities	8. Zero pollution, toxic-free environments	2. Supporting urban zero	3. Less waste, more value 4. Making the circular economy work for people, regions and cities	

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2	Forbid the use of recycled foamed plastics into direct contact with food in B2C and B2B	Forbid the use of foamed plastics in food contact products when there is safer, circular, and sustainable alternative.	Food Contact Plastics Regulation 10/2011, Recycled Plastic Regulation 2022/1616, SUP Directive	11. Sustainable cities and communities	7. Biodiversity and ecosystems 8. Zero pollution, toxic-free environments	2. Supporting urban zero	3. Less waste, more value 4. Making the circular economy work for people, regions and cities	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns 4. A comprehensive knowledge base on chemicals
3	Presence of toxic and harmful substances in the foamed plastics formulation	Investments to develop tools to help compounders and foamed plastics products manufacturers to comply with REACH Regulation and substitute potentially harmful substances by other safer and with lower human health and the environment impact (*e.g.*, the tool developed by KEMI – Swedish Chemicals Agency, named PRIO – a tool for substitution - https://www.kemi.se/prioguiden/ english/start). Another approach could be the elaboration of a regulation concerning put on the market additives and other substances to plastics formulations. Such regulation could be inspired in Biocidal Products Regulation.	SUP Directive could propose the elaboration of the regulation to plastics additives and other substances of plastics formulations.	14. Life bellow water 15. Life on land	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns 3. Simplifying and consolidating the legal framework 4. A comprehensive knowledge base on chemicals 5. Setting the example for a global sound management of chemicals

Objectives for SUP revision	Problem identified by OceanWise	Solution proposed by OceanWise	Proposed legal documents to be updated or revised	Impacts on SDGs (17 goals)	Impacts on Green Deal (8 thematic areas)	Impacts on Zero Pollution Action Plan (9 Flagships)	Impacts on Circular Economy Action Plan (7 key actions)	Chemical Strategy for Sustainability
3	Presence of contaminated foamed plastics with hazardous and harmful substances (including flame retardants)	Phase out the use of foamed plastics whilst managing end-of-life products as hazardous waste.	Waste Framework Directive, SUP Directive.	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy 8. Zero pollution, toxic-free environments	3. Promoting zero pollution across regions	1. A sustainable product policy framework 2. Key product value chains 3. Less waste, more value	2. Stronger EU legal framework to address pressing environmental and health concerns
4	Lack of regulation on standardized framework to assess circularity environmental, social, and economic impacts on products made of foamed plastics, as well as alternative materials	Apply the EU ESPR. The EU ESPR should include environmental impacts not yet covered by life cycle assessment (LCA) – microplastics impact assessment – and improve existing environmental impact assessment related to ecotoxicity on aquatic and terrestrial ecosystems. The EU ESPR also includes circularity indicators that should be tested to predict their applicability to foamed plastics products. Also, life cycle sustainable assessment methodologies should be considered in the sustainability assessment of foamed plastics and alterative materials. Any assessment – sustainability microplastics impacts and circularity - should be carried out by an independent entity to ensure confidence and transparency in the results. The Product Environmental Footprint and Ecolabel should be capable of addressing products made of alterative foamed plastics to increase their acceptance by the market and to guarantee safer and sustainable foamed plastics products as possible.	EU Ecodesign on Sustainable Products Regulation, SUP Directive	12. Responsible consumption and production 14. Life bellow water 15. Life on land	Area 3: Industry for a clean and circular economy 7. Biodiversity and ecosystems 8. Zero pollution, toxic-free environments	4: Facilitating zero pollution choices	1. A sustainable product policy framework 2. Key product value chains	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns 3. Simplifying and consolidating the legal framework 4. A comprehensive knowledge base on chemicals 5. Setting the example for a global sound management of chemicals

Objectives for SUP revision	Problem identified by OceanWise	Solution proposed by OceanWise	Proposed legal documents to be updated or revised	Impacts on SDGs (17 goals)	Impacts on Green Deal (8 thematic areas)	Impacts on Zero Pollution Action Plan (9 Flagships)	Impacts on Circular Economy Action Plan (7 key actions)	Chemical Strategy for Sustainability
4	Alternative materials *e.g.*, compostable, or biodegradable materials (fossil or biological source) often wrongly viewed as natural/sustainable replacement for foamed plastics products	Improve and create CEN norms on bio-based products, and biodegradability of bioplastics on environment (soil, freshwater and seawater), to ensure that there is a biodegradation at molecule level and not dimensional degradation, resulting on the release of microplastics, for conventional and new materials. Improve or create CEN norms on biodegradability, valid for the existing EU composting and anaerobic digestion processes, for conventional and new materials. Recommend in SUP Directive several methodologies and/or norms to make the circular assessment and environmental assessment of possible replacement materials for a specific product. Establish funding mechanisms for research and development of proven materials able to replace foamed plastics. The alternative materials that should be investigated are those that degrade in the aquatic environment and are really a solution	Policy Framework for biobased, biodegradable and compostable plastics; SUP Directive. Funding programs including Horizon Europe, Interreg, ERAMUS+ and EIT.	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy 8. Zero pollution, toxic-free environments	3. Promoting zero pollution across regions 4: Facilitating zero pollution choices	2. Key product value chains	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns
5	Inconclusive research on toxicity of microplastics from foamed plastics food packaging on food and its impact on human health when consumed and on environment when released	Funding mechanisms for research and development regarding risk assessment and to develop assessment methodology to be included in LCA methodology.	Funding programs including Horizon Europe, Interreg, Life+, ERAMUS+ and EIT.	12. Responsible consumption and production 14. Life bellow water 15. Life on land	7. Biodiversity and ecosystems 8. Zero pollution, toxic-free environments	3. Promoting zero pollution across regions 4: Facilitating zero pollution choices	2. Key product value chains	1. Innovating for safe & sustainable EU Chemicals 2. Stronger EU legal framework to address pressing environmental and health concerns

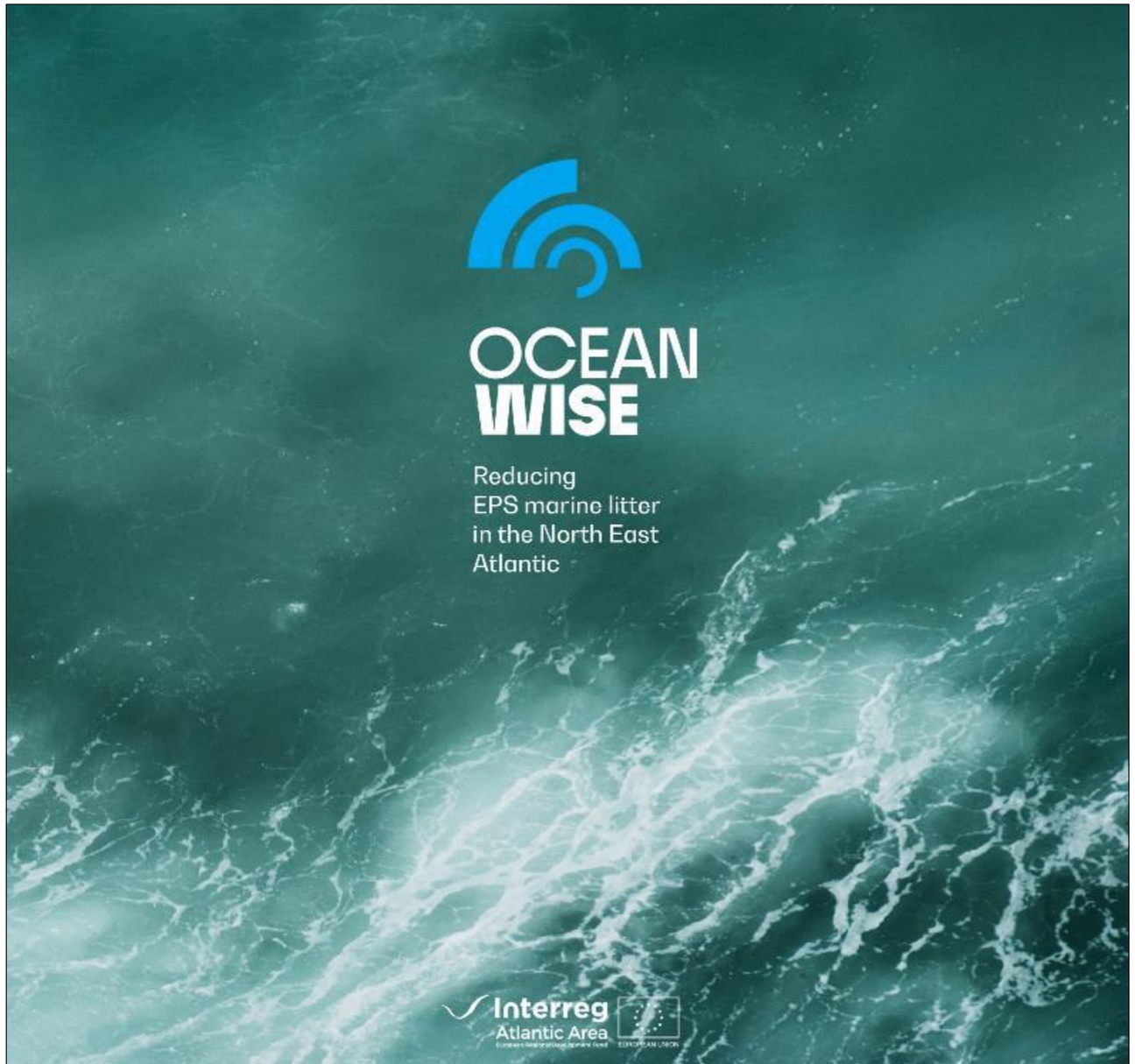
								4. A comprehensive knowledge base on chemicals
Objectives for SUP revision	Problem identified by OceanWise	Solution proposed by OceanWise	Proposed legal documents to be updated or revised	Impacts on SDGs (17 goals)	Impacts on Green Deal (8 thematic areas)	Impacts on Zero Pollution Action Plan (9 Flagships)	Impacts on Circular Economy Action Plan (7 key actions)	Chemical Strategy for Sustainability
5	Absence of a material to replace foamed plastics in a specific product	Funding mechanisms for research and development must be created to quickly find an alternative in the cases of single use B2C and in other single use.	Funding programs including Horizon Europe, Interreg, Life+, ERAMUS+ and EIT.	12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	
5	Too few initiatives to impulse the consumption of foamed plastics post-consumption	Promoting markets for foamed plastics recycled or refurbished products (or other circularity solution for used foamed plastics). Public procurement for products containing or made of post-consumption foamed plastics.		12. Responsible consumption and production	Area 3: Industry for a clean and circular economy	3. Promoting zero pollution across regions	2. Key product value chains 3. Less waste, more value	
Note: Concerning legislation, most changes are expected to be made in SUP Directive. In this case, the sentence in article 2 of SUP Directive should change to: Where this Directive conflicts with other directives, this Directive shall prevail.								

Table 2. Rules on the use of foamed plastics depending on the economic flow

Type of application	Single use application, not attached, untied application (*e.g.,* packaging, beads and peanuts for packaging, box)	Short-life single use or reusable (*e.g.*, children car seat)	Long-life single use (*e.g.,* insulation material for construction)	Short-life single use or reusable (*e.g.,* surfboard)	Long life single use (*e.g.*, pontoons)
Degradation in the environment during use	Not applicable	Foamed plastics **does not** degrades in the environment (it is immobilized, a component of a product where the foamed plastics is protected, and encapsulated)		Foamed plastics **degrades** in the environment (it is immobilized but not protected either tight or encapsulated; untied. There is a risk to degrade due to climate conditions)	
Business to consumer flow (B2C)	Forbidden	Allowed, with EPR scheme	Allowed, with EPR scheme	Forbidden	Forbidden
Business to business flow (B2B)	Allowed, with EPR scheme	Allowed, with EPR scheme	Allowed, with EPR scheme	Forbidden	Forbidden

Notes:

- EPR scheme may include deposit refund, reverse logistics, separate collection. A possible collection scheme implemented through EPR is: The producer and distribution sectors should provide the separate collection, densification, when possible, and recycling for foamed plastics (a recycling scheme) at sales areas. This should be a reality on fish market at big markets, and sales from restaurants and retail stores. At sales areas with 400 m^2 at least, the existence of densification service should be mandatory.
- short-life (includes reusable; time frame 1 to 10 years) and long-life (equal and more than 10 years).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