OCEAN WISE
Reducing EPS marine litter in the North East Atlantic

State of the Art Working Catalogue/Database of Current Available Alternatives to EPS & XPS

Report | Summary

Executive Summary

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

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

Alternatives to expanded and extruded polystyrene are available on the market and new ones are also being tested. There are an array of different materials that can be used to cover the entire range of applications. Alternative materials can be oil- or bio-based. Consumers have a variety of choices already available on the market when choosing alternatives.

The decision to adopt an alternative to EPS/XPS depends on many factors, but the fate of end-of-life products is important to consider. Biodegradability, compostability, or at least widespread recyclability, are desirable characteristics and their certification is necessary to ensure that impact on the environment is reduced.

Find the full report and database:

www.oceanwise-project.eu

Figure 1: Map of countries participating in the OceanWise project

The OceanWise project covers the Atlantic area which is shown in blue above, but it is important to consider the movement of EPS and XPS for this action so other EU countries were included .

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION

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Introduction to EPS/XPS

Expanded polystyrene (EPS) and extruded polystyrene (XPS) are two foams of the polymer polystyrene (PS), a hard, stiff, transparent synthetic resin (thermoplastics) which was discovered in Germany in 1839. The monomer of PS is the styrene, which is produced from the resin of the American sweetgum tree (*Liquidambar styraciflua*). PS commercial production started in the 1930s thanks to the German company BASF, while polystyrene foams were invented by the Dow Chemical Company in 1954.

EPS and XPS are mostly (95-98 %) composed of air, which makes them lightweight and provides high thermal insulation qualities. Both foams are waterproof, strong, durable, 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 additional properties to the PS.

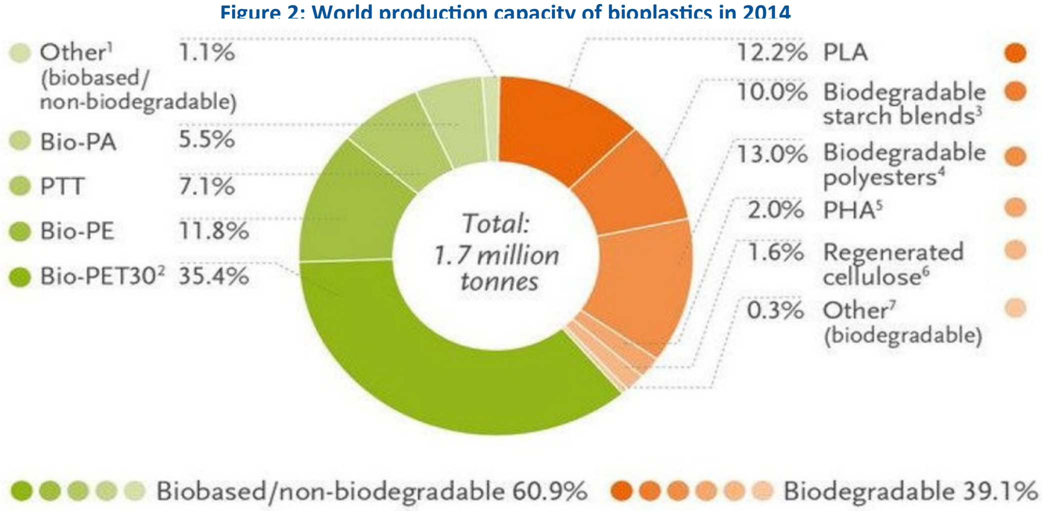
PS and its foams are presented by the plastic industry as a 'sustainable' plastic because the material is stable and durable, its lightweight is advantageous during transportation because does not increase carbon emission, and the material is theoretically fully recyclable. Despite being fully recyclable, PS is not widely recycled.

Mismanagement and fragmentation of EPS and XPS products make them a contributor to marine litter and microplastics, which are accumulating in the world oceans with obvious impacts on marine life, human economy and health.

Alternatives to EPS/XPS

Alternatives include other thermoplastics and natural or synthetic biopolymers. Some oil-derived thermoplastics are considered greener alternatives because they are easier to sort, collect and recycle. The other class of materials considered as an alternative to EPS and XPS is the one of biopolymers. These materials are defined by the fact that the majority of their constituents come from living organisms. Biopolymers are eligible for a wide range of applications, but currently cost 2-4 times that oil-based polymers to produce.

Figure 2: World production capacity of bioplastics in 2014



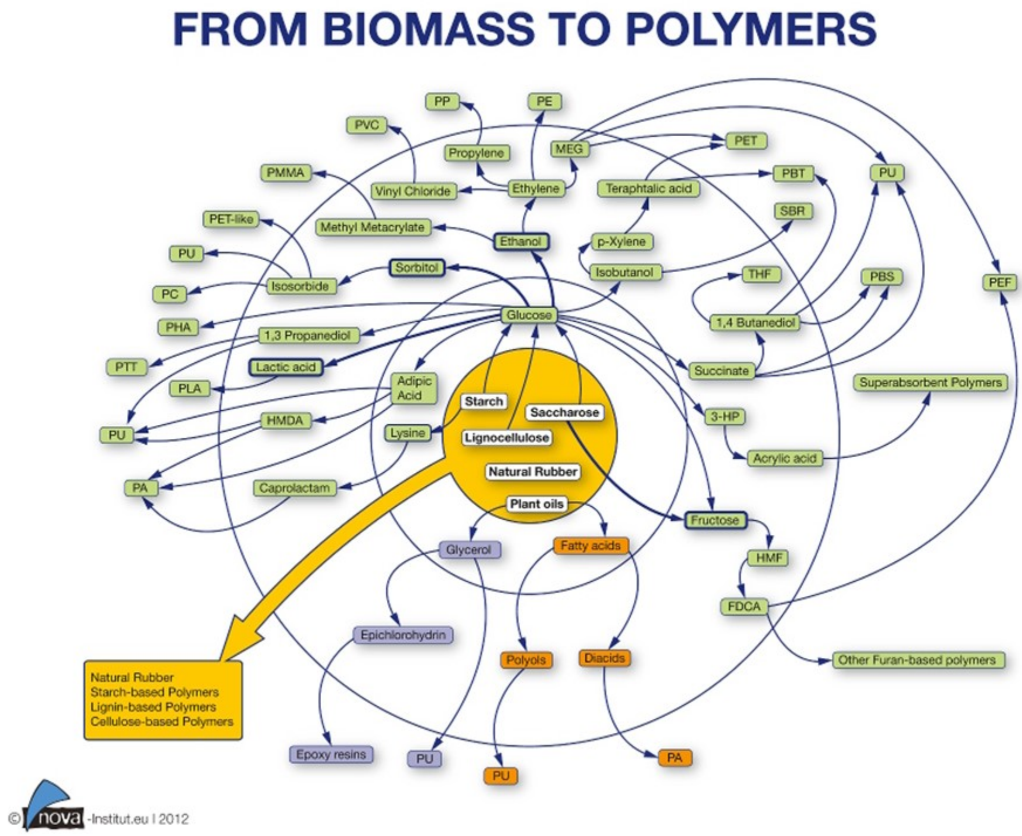


Figure 3 : Polymer based by biomass extraction (source Nova-institute)

End of Life

One of the factors that should play a pivotal role in deciding whether to adopt an alternative material, instead of EPS and XPS, is the capability to divert these materials from landfill, incineration, and dispersion in the environment once they become post-consumer waste. The circularity of thermoplastics is currently related to their ability to be reused and recycled, natural and synthetic biopolymers present more options since some of them are biodegradable or compostable in home/industrial environments.

In order to provide a clear framework allowing producers and consumers to decide on the use of biodegradable plastics, in December 2020 the European Commission gathered scientific advice about biodegradability of plastics in open environment. Following this consultation, the European Commission recommend to:

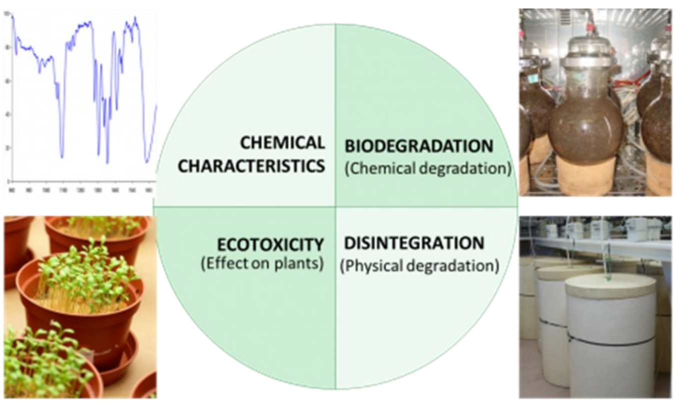
⇒ Limit the use of biodegradable plastics in the open environment to specific applications for which no reduction or reuse or recycling is feasible.

⇒ Support the development of consistent testing and certification standards for the biodegradation of plastics in the open environment.

⇒ Clarity needed over 'biodegradability', 'home compostability' and 'industrial compostability'.

Compostability

In order to be considered compostable, products have to be tested for four parameters;



In order to be certified as industrially compostable, the four essential requirements need to be met. However, biodegradation and disintegration need to be performed at elevated temperatures.

In case the product's intended disposal route does not include industrial or home composting, its end-of-life fate might involve the disposal in other environments (e.g. soil, fresh water, marine water, anaerobic digestion or landfill), in which the product will need to degrade after being disposed of.

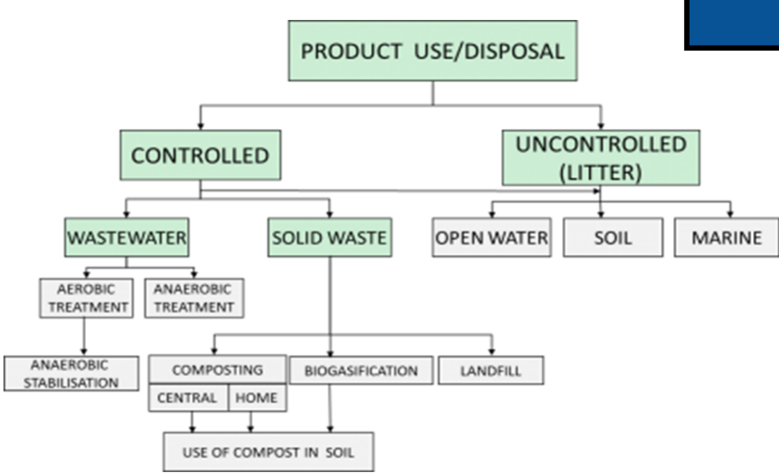


Figure 4: End of life environment flow chart

- **Biodegradable:** a material that is mineralised in the environment without the need for specific condition.
- **Home compostable:** a material that is mineralised in compost bins/heaps in citizen's garden or households.
- **Industrially compostable:** a material that is mineralised in stringent environmental conditions that are maintained in dedicated industrial facilities.

Aggressivity of Biodegradation

The biodegradation of a product varies from one environment to another. In most cases it is the temperature and the microbial activity which determines the rate and level of (bio)degradation. Compost is considered as the most aggressive environment, while landfill is considered as the least aggressive environment.

Oklin New Composting System:

Self-contained machines that use patented Acid-ulo™ microbial technology to speed up the organic waste composting process and reduce their volume by up to 90 % in 24 hours. The output is immature compost which can then be matured and used as a soil amendment.

Aeschelmann, F., Carus, M., Baltus, W., Carrez, D., de Guzman, D., Käb, H. and Ravenstijn, J., 2016. Bio-based building blocks and polymers. Global Capacities and Trends, 2021.

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Alternatives to EPS/XPS

(Food, packaging, transport, and leisure)

Being thermic insulators, EPS and XPS are used to transport and preserve hot and warm food. Examples are the clamshells used for takeaway food, or the fish boxes used to move fresh and frozen seafood. The list below includes several options already available on the market to provide alternatives to EPS/XPS. More detail is provided on each of these materials in the full report. Details include a description of the material, production method, benefits, and applications.

Alternatives materials include:

⇒ Polyethylene, Polypropylene and their forms

⇒ Polyurethanes

⇒ Polylactic acid (PLA)

⇒ Kaneka Biodegradable Polymer Green Planet PHBH™

⇒ Bagasse

⇒ Palm leaves

⇒ Pelaspan-Bio (Storopack) - starch

⇒ Paper/cardboard

⇒ Mushroom biomass

⇒ Wool

⇒ Denim

⇒ Foamed nanocellulose

⇒ MOTALI—Mousse TAnins LIgnine

⇒ Wood-based foams—Aalto University

Alternatives to EPS/XPS

(Insulation)

Thanks to their thermic properties, EPS and XPS boards are used to insulate buildings. When used for this purpose, the material remains in the buildings for long time and, therefore, do not create waste until the demolition or renovation of the building itself.

Alternative materials include:

⇒ Straw bale

⇒ Mineral and glass wool

⇒ Cork

Conclusions

There are many materials that can be used as an alternative to EPS. Many of these products are available on the market already, and new materials are in the development stage. While there is not a unique material that can substitute EPS and XPS in all their uses, there are available alternatives that can work towards a substantial reduction in the use of PS foams. Many of the alternatives have a lower carbon footprint than EPS/XPS. The production of thermoplastics like polyethylene and polypropylene, which are oil-based like EPS/XPS, are not more environmentally friendly than PS foams unless recycled material is used. Alternatives to EPS/XPS products are generally easier to fit into a circular economy model. However, there is lack of clarity about how to correctly dispose of some of these products.

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