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IMPACT ASSESSMENT REPORT

Combatting microplastic pollution in the European Union

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on preventing plastic pellet losses to reduce microplastic pollution

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{SWD(2023) 333 final}

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Glossary

Term or acronym	Meaning or definition
Microplastics	Microplastics are small pieces of plastic, usually smaller than 5mm
Pellets	Plastic pellets, also referred to as nurdles, nibs, preproduction pellets, and resin pellets, are the starting material used for all plastic production worldwide. Pellets are defined within ISO 472:2013 as “a small mass of preformed moulding material, having relatively uniform dimensions in a given lot, used as feedstock in moulding and extrusion operations”.
Pellet spill	One-off escape of pellets from primary containment not necessarily resulting in loss to the environment (if contained inside the operating boundary).
Pellet loss	One-off or prolonged escape of pellets to the environment. The escape would therefore result in loss outside the operating boundary into the environment (e.g. water, soil).
Textiles	In the context of this assessment, textiles refer to synthetic clothes made out of chemically produced fibers that can be based on polymers produced by oil distillation, such as polyester, acrylic, polyamide (nylon), acetate, and PPT (polyparaphenylene terephthalamide i.e. Kevlar™).
Paints	Paint means a pigmented or clear coating material, supplied in a liquid paste or powder form, which, when applied to a substrate, forms an opaque film having protective, decorative or specific technical properties and after application dries to a solid, adherent and protective coating. It is a mixture of pigment (absent in the case of vanishes), additives and binder (resin) in a solvent (organic solvent and/or water). Most binders are synthetic polymers such as acrylic, alkyd, polyurethane, epoxy or chlorinated rubber.
Detergent capsules	These are small pouches containing highly concentrated detergent used in washing machines and dishwashers. They are mostly made of dissolvable plastics such as polyvinyl alcohol.
Geotextiles	Geotextiles are a type of geosynthetics used for a variety of civil engineering applications such as building roads, coastal protection, diking, flooding protection, etc. They are primarily made of polymers such as polypropylene or polyester and are mostly manufactured in two different forms woven and nonwoven.
CPR	Construction Product Regulation
DDT	Dichlorodiphenyltrichloroethane
EDC	Endocrine disrupting compounds
EPR	Extended Producer Responsibility
EQSD	EU Directive 2008/105/EC on Environmental Quality Standards
EQS	Environmental Quality Standards
ESPR	Ecodesign for Sustainable Products Regulation
EURO7	European vehicle emissions standards – Euro 7 for cars, vans, lorries and buses
GHG	Greenhouse gases

Term or acronym	*Meaning or definition*
GWD	EU Groundwater Directive 2006/118/EC
GPP	Green Public Procurement
IA	Impact Assessment
IED	Industrial Emissions Directive
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
LCA	Life-cycle Assessment
MARPOL	International Convention for the Prevention of Pollution from Ships
MSFD	EU Marine Strategy Framework Directive
OCS	Operation Clean Sweep
OCS CS	Operation Clean Sweep Certification Scheme
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PET	Polyethylene terephthalate
PM	Particulate Matter
PVOH/PVA	Polyvinyl alcohol
PVC	Polyvinylchloride
PVOH based products	Different Polyvinyl alcohol-based compositions used as protective films in detergent capsules for laundry & dishwashers
REACH	Regulation (EC) No 1907/2006 on the registration, evaluation, authorisation and restriction of chemicals
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises. They are defined in the Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. SMEs are enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million. In particular, within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million; a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million. Large-sized enterprise means an enterprise that is not a micro, small or medium-sized enterprise.

Term or acronym	*Meaning or definition*
SQAS	Safety & Quality Assessment for Sustainability system
SSD	Sewage Sludge Directive
SUP	Single-use plastics
SWO	Storm water overflows
TPMS	Tyre Pressure Management System
TRWP & TWP	Due to tyre’s friction with the road surface, the tyre wear particles (TWP) get contaminated and encrusted as a mixture of road wear, tyre particles and other road dust substances, called Tyre and Road Wear Particle (TRWP)
UWWTD	Urban Wastewater Treatment Directive
Water FD	Water Framework Directive
WEEE	Waste from electrical and electronic equipment
WFD	Waste Framework Directive
WWTP	Wastewater treatment plants

1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT

Microplastics are ubiquitous, persistent, very mobile and virtually impossible to capture once released into the environment. In 2018, the EU Strategy for Plastics in a Circular Economy acknowledged the risks posed by microplastics and advocated innovative solutions targeting different sources. In 2019, the European Commission's group of Chief Scientific Advisers recognised the potential risks posed by these microplastics and encouraged action to reduce and prevent further pollution.[1] In 2020, as a follow-up action of the European Green Deal, the Circular Economy Action Plan 2.0 committed the Commission to tackling the presence of microplastics in the environment by:

- restricting **intentionally added microplastics** in products (e.g. cosmetics, detergents, fertilisers, artificial infill)[2];
- addressing **unintentional releases of microplastics** by developing labelling, standardisation, certification and regulatory measures; harmonising methods for measuring unintentional releases of microplastics; closing the gaps in scientific knowledge related to the risks and occurrence of microplastics in the environment, drinking water and foods.

In 2021, in its Action plan: 'Towards Zero Pollution for Air, Water and Soil', the Commission proposed that, by 2030, the EU should reduce both (intentional and unintentional) microplastic releases into the environment by 30%. This target does not include the contribution of the degradation and fragmentation of macroplastics abandoned, discarded or improperly disposed of into the environment.[3]

Microplastic pollution observed in the environment originates from:

(i) the degradation and fragmentation of larger 'macroplastic' pieces abandoned, discarded or improperly disposed of in the environment;
(ii) microplastics that are added intentionally to certain products, such as cosmetics, and ultimately find their way into the environment; and
(iii) microplastics that are released unintentionally, mainly due to abrasion during use or poor handling.

Although "macroplastics" are likely a large source of microplastics, their degradation and fragmentation are not addressed in this Impact Assessment as these processes can take between a couple of years and up to several centuries so no reliable information is available on the amount of microplastics generated from macroplastics yearly. In addition, the most effective way of tackling the degradation of macroplastics as a source of microplastics is by reducing the improper disposal of macroplastics into the environment. The EU has already introduced an extensive strategy[4] and legislative framework to tackle macroplastic pollution, including the Single Use Plastics Directive

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[1] Scientific opinion on the environmental and health risks of microplastic pollution, April 2019.
[2] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.
[3] Instead, the Zero Pollution Action Plan sets a 50% reduction target for plastic marine litter which will help contribute to a reduction in the releases of microplastics from this source (see also Annex 2 of the Zero pollution action plan).
[4] A European Strategy for Plastics in a Circular Economy, 2018.

(SUPD)[5], the Waste Framework Directive (WFD)[6], the Packaging and Packaging Waste Directive (PPWD)[7] and the Marine Strategy Framework Directive (MSFD).[8]

Similarly, **intentionally added microplastics** are not addressed in this IA because the Commission has proposed a draft REACH restriction. This restriction was adopted on 25 September 2023.[9]

On **microplastics unintentionally released**, while several main sources were initially being examined (see Table 1)[10], **this Impact Assessment focuses on plastic pellets**. They also referred to as nurdles, nibs, preproduction pellets, and resin pellets, are the starting material used for all plastic production worldwide[11]. Due to their nature and size, they are regarded as being microplastics. The focus on pellets is due to the conditions being in place for the application of the precautionary principle[12] and for immediate regulatory action tackling this source:

- Contrary to other sources of microplastics unintentionally released, for which an EU legal framework exists or is being negotiated with the European Parliament and the Council, there is no existing or forthcoming EU legislation specifically preventing and reducing pellet losses as a form of pollution occurring along the entire supply chain in the EU. The proposal would remedy a loophole in the current EU legislative framework.
- Sufficient evidence is available documenting the problem and the impacts related to pellet losses, justifying intervention and allowing the design of specific policy measures, while this is not yet the case for most other sources of unintentionally released microplastics.
- Contrary to other sources of microplastics unintentionally released, pellet losses are due to poor handling and therefore largely preventable today in a cost-effective manner. No changes to product or consumer behaviour are required to prevent and reduce pellet losses.
- Techniques to prevent pellet losses are already available to economic operators at an acceptable cost.
- They are the third source of releases and account for 7-10% of microplastics unintentionally released in the EU.
- Preventing and reducing pellet losses now does not impede any future action on other sources later, as there is no interference between the different sources of microplastics.

In contrast, the other sources identified (paints, tyres, synthetic textiles, geotextiles and detergent capsules) were not pursued in this Impact Assessment for several reasons. Measures tackling microplastic releases from tyres had already been included in the EURO 7 Regulation proposal. While the preliminary analysis showed that there is potential to reduce releases from paints, synthetic textiles, geotextiles and, to a lesser extent, detergent capsules, it also highlighted uncertainties and

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5 Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment.

6 Directive 2008/98/EC on waste and repealing certain Directives.

7 Directive 94/62/EC on packaging and packaging waste.

8 Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy.

9 Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

10 Different approaches were used to estimate the releases from these sources because of the heterogeneity of the available data or data unavailability. For pellets, textiles, detergent capsules and geotextiles, researchers have estimated varying emission levels, as well as a range of possible emissions scenarios. For tyres, a modelling approach was used to estimate the potential microplastic releases. For paints, a confidence interval was used in the estimations.

11 Pellets are defined within ISO 472:2013 as “a small mass of preformed moulding material, having relatively uniform dimensions in a given lot, used as feedstock in moulding and extrusion operations”.

12 Communication from the Commission on the precautionary principle, 2000.

data gaps and concluded that other policy instruments may be better suited to tackle them. More information and additional analysis is needed to better understand their patterns and frame the most appropriate interventions. Where appropriate and necessary, separate impact assessments will be prepared, to support possible measures to tackle microplastics releases. Box 1, below, provides an overview of the conclusions for each source not pursued in this impact assessment. Annex 15 contains the preliminary analysis undertaken for each of these sources.

Table 1: Estimated releases from six main sources of unintentional microplastic releases to the EU environment

Source	Quantity (tonnes/year), 2019*
Paints	231 000 – 863 000
Tyres	360 000 – 540 000
Pellets	52 140 – 184 290
Textiles	1 649 – 61 078
Geotextiles	6 000 – 19 750
Detergent capsules	4 140 – 5 980
TOTAL of the selected six sources	654 929 – 1 674 098 (90-93% of total emissions)
TOTAL of all sources	729 087 – 1 808 198

(*) Estimations based on the supporting study for this Impact Assessment

Box 1: Preliminary assessment of the other main sources of microplastic pollution not pursued in this impact assessment[13]

Paints – Paints are widely used and on average 37% plastic polymer-based, making them a significant source of microplastic releases. While shifting towards mineral paints would help reduce microplastic releases, it is not clear yet if this would lead to an increase of other environmental impacts. The full environmental profile andlife-cycle assessments of polymer and mineral paints are not available yet. Once this information is obtained, requirements on microplastics in paints could be introduced via the Ecodesign for Sustainable Products Regulation (ESPR)[14], where paints is one of the twelve priority products.

Tyres – Tyre abrasion leads to the release of microplastics. These releases are already being targeted in the EURO 7 Regulation proposal[15] and may be addressed by a delegated act under the Tyre Labelling Regulation.[16]

Synthetic textiles – Most apparel is now made out of plastic fibres and releases microplastics. Some key challenges encountered in the course of the assessment are that microplastic releases from synthetic fibres occur throughout the value chain, that most of their production takes place outside of the EU, and that there

[13] More details in Annex 15.
[14] Proposal for a regulation of the European Parliament and of the Council COM/2022/142 final establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC.
[15] Proposal for a regulation of the European Parliament and of the Council COM/2022/586 final on type-approval of motor vehicles and engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7) and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009.
[16] Regulation (EU) 2020/740 on the labelling of tyres with respect to fuel efficiency and other parameters, amending Regulation (EU) 2017/1369 and repealing Regulation (EC) No 1222/2009.

is not sufficient data regarding the profiles of different synthetic fibres and fibre combinations in terms of microplastic releases. Subject to a better understanding of releases from synthetic textiles thanks to a standardised measurement methodology, along with more life-cycle data of alternatives' impacts, relevant measures could be introduced in the framework of the Ecodesign for Sustainable Products Regulation, as announced in the EU Strategy for Sustainable and Circular Textiles. Such an approach will ensure the environmental sustainability challenges of textiles are addressed in a coherent and integrated way.

Detergent capsules – Laundry and dishwasher detergent capsules often rely on a dissolvable plastic film to dispense their product during the wash. However, the complete biodegradation of this film is not guaranteed and may cause microplastic pollution. Subject to scientific evidence pointing towards a need for biodegradability criteria, future action could be taken under the Detergents Regulation.

Geotextiles – Geotextiles are a source of microplastic releases as they are mostly synthetic, used in harsh conditions and not removed at the end of their service life. However, data on their uses and profile in terms of degradation and microplastic releases is scarce. Once more data is available future action could be taken in the framework of the Construction Products Regulation.[17]

In May 2023, five EU Member States and Norway called on the Commission to introduce the necessary measures tackling unintentional microplastic releases, to reach the 30% reduction target in microplastic releases by 2030. According to these countries, tackling microplastics pollution is a cross-border challenge, and therefore national and voluntary measures alone are not sufficient. Measures at EU level are needed.[18]

In March 2022, the United Nations Environmental Assembly launched international negotiations on a Global Treaty on Plastic Pollution , which is expected to target inter alia microplastics. Other international conventions and agreements are looking at the microplastics issue, such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) which issued a non-binding recommendation.

In the EU submission to UNEP in view of the second session of the Intergovernmental Negotiating Committee on an international legally binding instrument on plastic pollution (INC-2)[19], the EU and its Member States "stress the need for the future instrument to include measures to reduce unintended release of microplastics. This could include, for example, measures to minimise the risk of leakages of plastic pellets from production, handling and transport".

The EU has committed to implementing the UN 2030 Agenda for Sustainable Development guided by the 17 Sustainable Development Goals (SDG). This initiative would contribute to goal 12 on sustainable consumption and production, goal 14 on the conservation and sustainable use of the oceans, seas and marine resources for sustainable development and goal 15 on life on lands, together with goals 3 (Good health), 9 (Industry, innovation and infrastructure), 13 (Climate).

2 PROBLEM DEFINITION

2.1 What are the problems related to microplastics in general?

Microplastics are ubiquitous, persistent and transboundary. They are detrimental to the

[17] Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.
[18] Non-paper: Call for ambitious EU measures to reduce and prevent microplastic pollution, May 2023.
[19] UNEP, The EU's Pre-session Submission ahead of Second Session of Intergovernmental Negotiating Committee to develop an international legally binding instrument on plastic pollution, 2023.

environment and potentially harmful to human health, and their mobility is an aggravating factor (see an extensive analysis in Annex 7). Microplastics are easily transported through the air and by surface and marine waters. They are found in soils (including agricultural lands), lakes, rivers, estuaries, beaches, lagoons, seas and oceans. They travel across entire continents and are found in the most remote, once pristine regions such as the Antarctic and Mount Everest, or in vulnerable ecosystems like coral reefs and deep seas. Adverse impacts of pellets are described in detail in Section 2.3.

Risks of microplastic pollution were highlighted in a publication revealing that the 5th planetary boundary of novel entities was exceeded.[20] Chemicals at large, including plastics, have been identified as fulfilling the characteristics of a novel entity. The concept of planetary boundaries was defined as the nine "boundaries within which we expect that humanity can operate safely"[21], demonstrating the threat microplastics pose to the environment and potentially to humans.

Microplastic releases to the environment will continue to increase unless action is taken. All global scenarios point to an increase. A 2019 global scenario[22] suggests an exponential increase in microplastic releases to the oceans unless their release is stopped urgently. In Figure 1, the global accumulation of microplastics in the surface ocean is shown under three plastic emission scenarios.

A recent OECD scenarios for 2060[23] also highlight the importance of closing leakage pathways. This scenario estimates that 298 610 tonnes of microplastics leak annually into the environment in the EU-27 (intentional and unintentional).[24] This IA has found a much higher figure for the annual (2019) releases of (only) unintentional microplastics into the European environment: between 0.7 and 1.8 million tonnes. This estimate is considered an update, as it considers all recent relevant research on the sources. It considers in particular the quite recent estimate on paints, which was neglected by many studies before, but is now considered as probably the largest source of unintentional microplastic releases.[25] Annex 14 gives an overview of all sources of unintentional microplastics identified. Annex 15 includes the calculations for the five other sources analysed in the preliminary phase of this impact assessment.

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[20] Persson, L., Carney Almroth, B., Collins, C. et al., 'Outside the Safe Space of the Planetary Boundary for Novel Entities', *Environmental Science and Technology,* Vol. 56, No 3, 2022, pp. 1510–1521, American Chemical Society.

[21] Rockström, J., Steffen, W., Noone, K. et al., 'Planetary boundaries: exploring the safe operating space for humanity', *Ecology and Society*, Vol. 14, No 2, Article 32. The planetary boundaries framework was updated in 2023 suggesting the novel entities boundary is transgressed see 'Earth beyond six of nine planetary boundaries', Science Advances, Vol. 9, Issue 37, Sep 2023.

[22] Ourworldindata.org, "Microplastics in the surface ocean, 1950 to 2050" (https://ourworldindata.org/grapher/microplastics-in-ocean).

[23] OECD (2022), Global Plastics Outlook: Policy Scenarios to 2060, OECD Publishing, Paris, https://doi.org/10.1787/aa1edf33-en.

[24] The European Chemicals Agency ECHA (2020) estimated 176 000 tonnes of microplastics annually due to abrasion and weathering of plastic products and an additional 42 000 tonnes of microplastics deliberately added to products that are subsequently discharged. Opinion of the Committee for Risk Assessment and Opinion of the Committee for Socio-Economic Analysis on an Annex XV dossier proposing restrictions on intentionally-added microplastics.

[25] Paruta et al. (2022) Plastic Paints the Environment, EAEnvironmental Action 2022, ISBN 978-2-8399-3494-7.

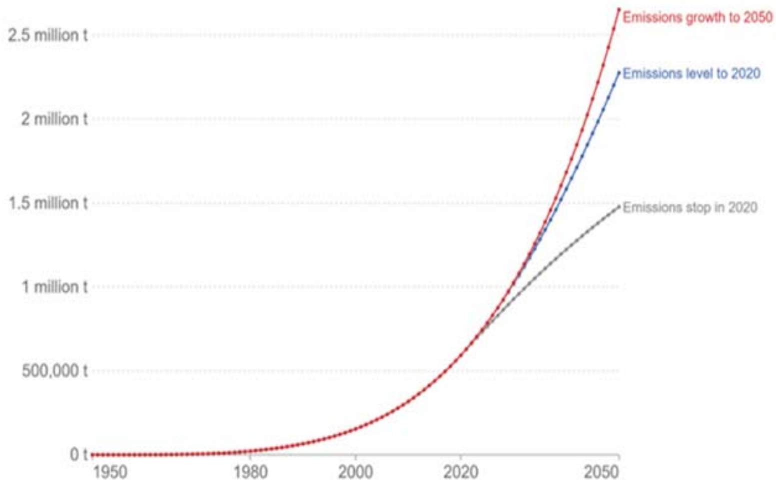

***Figure 1*: Microplastics on the surface ocean 1950 to 2050**[26]

In 2019, the Commission's Group of Chief Scientific Advisors considered that 'although the currently available evidence suggests that microplastic pollution at present does not pose a widespread risk to humans or the environment, there are significant ground for concern and for precautionary measures to be taken'[27] (see Box 2).

Box 2: Recommendations by the European Commission's Group of Chief Scientific Advisors

- Broaden existing policy to prevent and reduce microplastic pollution in both marine and freshwater environments, and in air and soil, and prioritise substance- and context-specific measures for high-volume, high-emission sources;
- Ensure that any new measures are of benefit to society by undertaking cost/benefit and similar analyses;
- Develop a coordinated international response consisting of research collaboration (including filling knowledge gaps on nanoplastic pollution), data sharing and standards development for measurement, monitoring and risk assessment.

Since then, microplastic pollution has been extensively researched, and new evidence has emerged confirming the need for precautionary measures to be taken.

Stakeholder views (see Annex 2) largely refer to the hazardous nature of microplastic pollution in the EU and its negative impact on the environment (79% of all respondents completely or somewhat agreed) and on human health (81% of all respondents completely or somewhat agreed). Regarding the harmful economic effects of microplastics, 58% of EU citizens completely or somewhat agreed with the statement, including half of the business organisations and two-thirds of the NGOs. All stakeholders agreed action to reduce microplastics should be undertaken by all levels of public authorities (EU, national, regional and local levels). Regarding pellets, stakeholders mostly agreed that there is improper handling in current pellet-related activities. As to the type of action, 95% of all respondents supported international action, 87% of them called on the EU to set up a comprehensive legislative system for pellet-handling companies, and 71% of them supported voluntary measures.

[26] Microplastics in the surface ocean, 1950 to 2050, Our World In Data.
[27] Scientific opinion on the environmental and health risks of microplastic pollution, April 2019.

2.2 What are the problems related to plastic pellets?

Current practices for handling pellets lead to losses at each stage in the supply chain, causing adverse environmental and potential human health impacts.

The problem of pellet losses has been known about since the 1980s with the US Environmental Protection Agency (EPA) and the Center for Marine Conservation (now known as the Ocean Conservancy) "detecting plastic pellets in US waterways from the Atlantic to the Pacific".[28]

Plastic industrial raw materials come in different forms, including pellets, flakes, powders and in liquid forms, all referred to collectively as "pre-production plastic pellets".[29] The umbrella term of "pellets" will be used in this IA. In Europe, approximately 80 % of all plastic industrial raw materials produced are in the form of round to oval granules of approximately 2 mm to 5 mm in diameter.[30] A relevant part of the remaining 20% is even smaller than 2 mm, such as powders, and a minor part can be slightly bigger.

The pellet supply chain

Pellets can reach the environment through losses occurring at every stage in the supply chain: production (virgin or recycled), processing (compounding, masterbatch making, converting, etc.), distribution, other logistic operations (storage and tank cleaning), waste management, etc. Therefore, tackling pellet losses clearly requires a supply chain approach.

The pellet supply chain is complex, involving several operators as outlined in Box 3. Virgin pellets are manufactured at large installations and then stored in silos. They are mostly filled directly into tankers, or packed for transport to conversion sites, where final plastic products are made. Transport occurs by road, rail, air and cargo ship. Distribution methods vary from small bags (20-25 kg) to silo trucks (up to 35 t) and large maritime containers. Not all bags are sealed, airtight and puncture-resistant to prevent damage and tears. Losses can also occur at recycling facilities, where plastic waste is recycled back into pellets in order to be reintroduced into the plastic manufacturing cycle.[31]

Box 3: Companies handling pellets

- Producers who create virgin plastic pellets from oil, gas and other raw materials;
- Recyclers who collect, sort, clean and process plastic waste into recycled plastic flake or pellets;
- Traders/brokers who purchase the plastic material and store it or otherwise handle it before selling it to converters or exporting;
- Intermediary facilities that handle the plastic material between the producer and the processor, such as storage and repacking facilities;

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[28] Document Display | NEPIS | US EPA; Plastics Industry Association (2016) Operation Clean Sweep Celebrates 25 Years

[29] The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission, OSPAR Background document on pre-production plastic pellets, 2018. Technically, according to ISO 472:2013, a pellet is a "small mass of preformed moulding material, having relatively uniform dimensions in a given lot, used as feedstock in moulding and extrusion operations".

[30] Plastics Europe, 'Operation Clean Sweep® Progress Report 2017', 2018 (https://www.opcleansweep.eu/application/files/8316/3456/6233/PlasticsEurope_OCS_progress_report-2017.pdf).

[31] Hann, S., Sherrington, C., Jamieson, O., Hickmann, M., Kershaw, P., Bapasola, A., Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products, Eunomia.

- Processors who transform the plastic pellets by either mixing them with other materials to alter their physical properties or by transforming them directly into manufactured goods (the former are called compounders and the latter converters). In this IA, we refer to all of them as “converters”;
- Distributors who sell (a small portion of) the plastic pellets to sectors such as construction;
- Logistic companies (including importers, transport and cleaning stations); and
- Waste management companies.

Producers: in Europe, there are close to 100 large polymer-producing companies that are members of the trade association “Plastics Europe”.[32] These companies produce some 54.8 million tonnes of virgin pellets per year and represent 90% of the total EU production. In 2021, circa 138 000 people worked for plastic manufacturers in the EU27. The number of individual enterprises was around 2 300. In 2021, plastic manufacturers created a turnover of EUR 117 billion.

Processors / converters: their situation is significantly different as Figure 2 shows: the trade association “European Plastic Converters” (EuPC) totals about 51 national and European industry associations, representing 90% of the total EU processing, equivalent to ca 48 000 individual companies, out of which 66% are micro-companies (some 31 400 micro-enterprises handling an average tonnage below 100 tonnes and representing an average turnover of EUR 300 000 annually, equivalent to 4% of the total turnover of the industry).[33] Converters employ 1.3 million people and have an annual turnover of EUR 269 billion.[34]

Recyclers: in 2021, there were some 730 plastic recycling companies in the EU. They have more than 20 000 employees and create a turnover of EUR 8.5 billion annually. In 2021, they produced 7.6 million tonnes of recycled pellets, while the installed capacity is roughly 11 million tonnes. About 165 organisations are members of the trade association “Plastics Recyclers Europe” (PRE) regrouping both national industry associations and individual, mostly large, companies.[35] These companies represent 80% of the EU market installed capacity.

Transporters: the “European Chemical Transport Association” (ECTA) represents approximately 100 transport companies active in the transport of chemical products, with about half handling also pellets.[36] Most of these ECTA members are not SMEs. They cover about 30% of the total pellet transport in Europe. Beyond ECTA members, ca. 13 000 transporter providers are mainly micro and small enterprises.

Other logistic operators: the “European Federation of Tank Cleaning Organizations” (EFTCO) declares that around 440 tank cleaning stations in Europe deal with tanks containing pellets. Also, there would be at least 850 storage or warehouse providers in Europe storing pellets. These companies are mainly micro and small enterprises.

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32 Plastics Europe, ‘Membership’ (https://plasticseurope.org/about-us/membership/).
33 European Plastic Converters (EuPC), ‘Organisation’ (https://www.plasticsconverters.eu/).
34 Eurostat (2021 figures) for EU-27 (Statistics | Eurostat (europa.eu))
35 Plastics Recyclers Europe, ‘Plastics Recycling Industry in Europe: Mapping of Installed Plastics Recycling Capacities 2021 Data’, 2023 (https://www.residuosprofesional.com/wp-content/uploads/2023/03/Plastics-Recycling-Industry-in-Europe-2023.pdf).
36 European Chemical Transport Association, ‘List of ECTA and ECTA RC* Members 2023’ (https://www.ecta.com/organization/list-of-members/).

More information on the share of SMEs[37] in the pellet supply chain is presented in Annex 12.

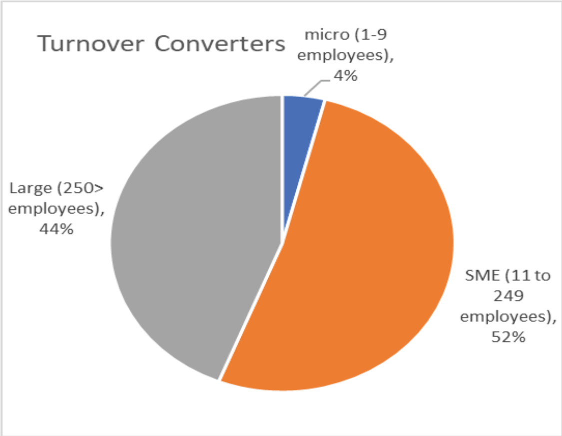

Figure 2: Breakdown of plastic processors

Pellet losses

Pellet losses can be the result of:

1) chronic, ongoing pellet incidents during routine operations. These losses usually occur as a result of lack of awareness and improper training, poor handling and housekeeping practices and due to the absence of pellet loss preventive and mitigating measures. They typically happen during both bulk and packed loading and unloading operations at special installations and during transport and logistic operations. The industry corroborates this presumption by adding process and mixing points as other pellet loss hotspots.[38]
2) acute, one-off, pellet incidents. These usually occur as a result of accidents during transport or major equipment failures in the absence of pellet loss preventive and mitigating measures.

[37] SMEs are defined in the Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. In particular, within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million; a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

[38] Plastics Europe, 'Operation Clean Sweep® Progress Report 2019', 2020 (https://plasticseurope.org/knowledge-hub/operation-clean-sweep-progress-report-2019/).

Figure 3: pellets lost in the environment & pellets ingested by fishes

(Credits last picture: Sri Lanka Marine Environment Protection Authority)

Chronic pellet incidents have been reported at production sites in the Netherlands[39], Belgium[40], Spain[41], Denmark[42] and Sweden.[43] Logistics platforms like ports are hotspots for pellet losses: the ports of Rotterdam, Antwerp and Tarragona have been reported to be heavily polluted locations by several organisations active in the monitoring of pellet losses.[44] An important part of chronic pellet incidents also happens during the transport of pellets across land (e.g. road and rail), such as in Belgium[45], or during maritime transport.[46]

Acute pellet incidents have happened in industrial facilities in Italy[47] and during the transport of pellets across land, e.g. in France[48] and during maritime transport, e.g. in the Netherlands[49] or in Denmark.[50] Acute pellet incidents where entire containers are lost at sea result in large quantities of pellets being released directly into the marine environment.[51] Some big incidents with unknown origin have also to be mentioned, such as in the Loire-Atlantique coastline of France[52], among several others in Europe and worldwide.[53] Chronic and acute pellet incidents are presented in Annex 8.

Existing monitoring programs in Europe show the presence of plastic pellets in the marine environment. In addition to those implemented in the context of the Marine Strategy Framework Directive, which requires all Member States[54] to monitor and assess microlitter on beaches[55], there are programs like the Port of Antwerp's collaboration with PlasticsEurope.[56] However, plastic pellets have been observed, since the 1970s, all over the world, in marine environments that are not close to petrochemical or polymer industries. NGOs such as SOS Mal de Seine and Fidra have documented this using different observation protocols. This demonstrates that while pellet losses can be

39 Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf (plasticsoupfoundation.org)
40 Ecaussinnes (Belgium): Surfrider Foundation tackles industial plastic granules
41 New report out exposes alarming impacts of plastic pellets across Europe - Good Karma Projects
42 Tackling sources of Marine Plastic Pollution through effective corporate engagement: a Danish Case Study
43 The unaccountability case of plastic pellet pollution - ScienceDirect
44 Plastic Giants polluting through the backdoor. New report out exposes alarming impacts of plastic pellets across Europe - Good Karma Projects
45 Ecaussinnes (Belgium): Surfrider Foundation tackles industial plastic granules
46 Sources, fate and effects of Microplastics in the marine environment: a global assessement
47 Nurdle pollution hotspot identified in Italy (nurdlehunt.org.uk)
48 Morbihan. A truck loses its cargo, 28 tons of plastic pellets on the road (ouest-france.fr)
49 24 million plastic pellets from MSC Zoe on northern Dutch coastline – The Northern Times
50 Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines – KIMO (kimointernational.org)
51 In 2021, the container ship MV X-Press Pearl caught fire and sank losing approximately 1680 tonnes of plastic pellets in a single event (some 84 billion pellets). In Europe, in 2020, the MV Trans Carrier lost more than 10 tonnes of plastic pellets in the German Bight. Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines – KIMO (kimointernational.org) 24 million plastic pellets from MSC Zoe on northern Dutch coastline – The Northern Times
52 Les plages de la côte Atlantique polluées par une marée de granulés plastiques, l'Etat porte plainte (lemonde.fr). In less than an hour, volunteers collected more than 80,000 pellets from the Tréguennec in Finistère beach.
53 Nurdle Map (nurdlehunt.org.uk)
54 Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU
55 In 2016, pain started the MSFD subprogram on microplastics on beaches, and pellets were detected with an average concentration of 47.8 pellets/kg or 419.2 pellets/m2. Currently, the MSFD Technical Group on Litter is developing a protocol for monitoring pellets on beaches.
56 Plastics Europe, 'Port of Antwerp Activity report 2021', 2021 (https://plasticseurope.org/knowledge-hub/port-of-antwerp-activity-report-2021/).

concentrated in one geographical area, they are also extremely mobile and can be dispersed by surface water and sea currents, as well as through the air.

Pellet pathways

Spilled pellets can reach the environment and become losses through several pathways (Figure 4).

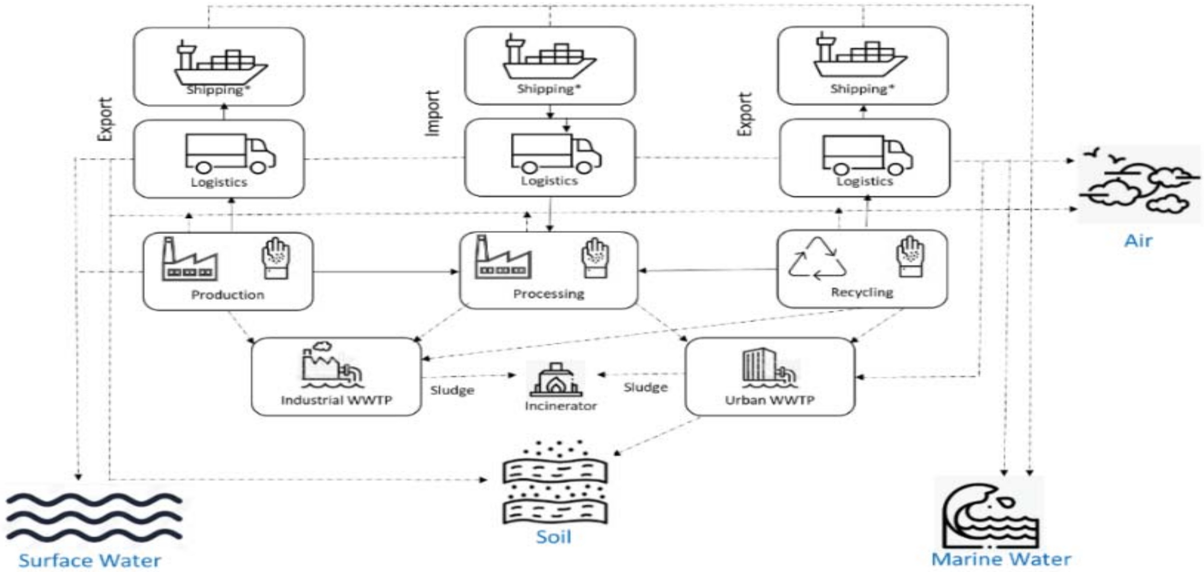

Figure 4: Pellet pathways (solid lines are pellet movements; dotted lines are loss pathways)

From **production, processing and recycling installations**, spilled pellets can either reach industrial or urban wastewater treatment facilities (via wet cleaning pushing pellets to drains[57]) or can enter the environment directly (air, soil, surface and marine waters, but also via overflows making pellets bypass the wastewater treatment facilities). In industrial wastewater treatment facilities, pellets are captured in sludge and incinerated. However, the effluent may still contain some pellets (particularly, flakes and powders). In urban wastewater treatment facilities, pellets are captured in sludge (between 95-99%, depending on the treatment efficiency). On average, half of sludge, which has captured pellets, in the EU is spread on agricultural lands as fertiliser.

Pellets lost during **logistic and shipping operations** often reach the environment directly. Therefore, the main pellet loss pathways are water-related, i.e. urban, rain and storm water for losses occurring in terrestrial areas and marine water for losses at installations close to ports or occurring in the sea.

Scale of the problem

While observable, these losses are not routinely measured, or indeed readily measurable at any specific step. There is no harmonized methodology for measuring pellet losses and not many measurements have been made at different steps of the supply chain, nor are any systemic monitoring and reporting data available within the Member States or the industry to calculate pellet losses. Hence, it is impossible to establish exact figures on pellet losses at each step because it depends on the installation size, actors involved, handling practices, etc., and all these aspects are very heterogeneous in the EU. Nevertheless, efforts to quantify the amount of pellets entering the

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[57] In case of dry cleaning, pellets go to waste management (mostly for incineration) except for recyclers who collect and put them back in the recycling process.

environment typically apply a 'loss rate' as well as a number of handling steps to the total pellet volume handled. Robust empirical evidence to inform a 'loss rate' or a number of handling steps is scarce. However, the greater the number of steps at which pellets are handled, the greater the opportunities for loss. The major handling steps occur at production plants (of both virgin and recycled pellets), processing installations and during logistic operations, i.e. all loading and unloading operations to transport pellets from one installation to another, including warehouse installations, where pellets are stored and/or re-packed, and cleaning installations.

Several studies use the figures for pellet losses of 0.01%-0.04%.[58] However, all these studies refer to the same estimate from just one processor and is based on measurement in the effluent, so it does not measure losses at other steps of the supply chain or emissions happening otherwise, i.e. direct emissions to air, water and soil. Given the high uncertainty and potential double counting, rates in the range of 0.001% and 0.1% have been suggested by some studies.[59] The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)[60] found an even bigger range in various publications; loss estimates show a variation from 0.0003% to 1% of total plastic demand, making it difficult to estimate the exact magnitude of the problem. The reason for such a large variation is that the actors involved in the supply chain range from micro-enterprises to large companies and the level of awareness and measures in place to prevent pellet losses vary considerably. Similarly, the number of handling steps in a typical supply chain is influenced by the size of the operation.

To take into account these uncertainties, a range of loss rates has been used to calculate the losses occurring at four major steps: production, processing, recycling and logistics (including distribution), starting from the most often cited loss rates. It is estimated that losses happen at a higher rate at processing and recycling installations because of relatively small installations and a large number of handling steps (0.02%-0.06% of the total volume processed or recycled) than at production ones (0.01%-0.03% of the total volume produced), and at an even higher rate during transport and logistic operations because pellets more often reach the environment directly at these steps, but with a higher uncertainty (0.03%-0.12%). These rates count for the major handling steps in the production, processing, recycling and transport/logistic phases. These figures can be improved once the reporting obligation under REACH (possibly complemented with a harmonised methodology under this initiative) is in place.

Chronic losses in reference year

High volumes of pellets are produced and handled every year, both globally and in the EU. In 2019, about 65.3 million tons of pellets (57.9 million tonnes of virgin, 6.5 million tonnes of recycled, and 0.9 million tonnes of bio-based) were produced in the EU.[61] In the same year, 12.7 million tonnes of pellets were imported to the EU to be converted into final plastic products at a converting site in the EU, while 14.9 million tonnes of pellets were exported.

This IA has found that the amount of pellets lost to the environment in the EU in 2019 can be estimated to be between 52 140 tonnes and 184 290 tonnes (logistics 27 870 – 111 480 tonnes, converters 15 600 – 46 800 tonnes, producers 7222 – 21 665 tonnes and recyclers 1448 – 4345

[58] Sea-based sources of microplastics to the Norwegian marine environment. Norwegian Environment Agency (Miljødirektoratet) (2021). (according to Sundt et al. (2014)

[59] Peano et al., 'Plastic Leak Project', 2020 (https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/plastic-leak-project/).

[60] OSPAR, 'Assessment document of land-based inputs of microplastics in the marine environment', 2017 (https://www.ospar.org/documents?v=38018 Page 22).

[61] Based on data from Eurostat and industry.

tonnes), equivalent to 0.08% to 0.28% of total pellet volumes in the EU. The methodology used to calculate these losses is presented in detail in Annex 8.

2.3 The impacts of pellet losses

Four types of adverse impacts can be observed from pellets finding their way into the environment: on the environment; on climate; on human health; and on the economy.

These impacts are summarised below and explained in more detail in Annex 7. Most of these impacts are related to microplastics in general, due to a lack of research specifically assessing the impact of pellets. However, as a subset of microplastics, it is assumed that most of the impacts of pellets are comparable to those of microplastics. Indeed, approximately 80 % of all plastic raw materials produced are approximately 2 mm to 5 mm in diameter, therefore well within the usual size of microplastics (up to 5mm). Of the remaining 20%, a significant portion is smaller than 2 mm, such as powders, and a minor part can be slightly bigger. In particular the portion with the smallest size can have an impact on health. The disintegration of pellets into smaller particles also increases their number and impacts. The sections below clearly state when the discussed impacts pertain to pellets or microplastics more generally.

While certain categories of impacts (environment, climate and economy) are well documented and relatively well known, the impacts on human health are still poorly understood, despite their extensive presence in the human body. Nevertheless, as concluded by the General Scientific Advisers of the Commission and the European Chemicals Agency, this gap in understanding should not prevent action from being taken as it is likely that they pose a risk to human health. The precautionary principle should therefore be applied. Research efforts are ongoing, in part thanks to EU support under LIFE and Horizon2020, to further elucidate these risks and impacts. Global trends suggest that microplastic emissions will continue to increase. We would generally expect that the adverse impacts of pellets will be proportional to their part in the total microplastic emissions (see Annex 7).

Impacts on the environment

International Pellet Watch, initiated in 2005 by Hideshige Takada[62] and The Great Nurdle Hunt[63], organised by UK charity FIDRA, both relied on pellet samples collected by citizens to demonstrate that pellet pollution is a global issue. Indeed, they are highly mobile and have been found thousands of kilometres from the nearest pellet production or conversion facility[64] in areas including important Natura 2000 areas[65]. Once in the environment, pellets are known to be eaten by a range of organisms and animals and to cause harm to biodiversity and habitats[66,67]. As pellets are mainly composed of either polyethylene or polypropylene, once in the aquatic environment[68], they normally float. If a

62 edge://newtab (pelletwatch.org)
63 The Great Nurdle Hunt, Reducing plastic pellet pollution at sea.
64 Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, Science of the Total Environment, 747:141227, 2020.
65 The unaccountability case of plastic pellet pollution - ScienceDirect
66 Cole, M., Lindeque, P., Halsband, C. and Galloway, T. S., 'Microplastics as contaminants in the marine environment: A review', Marine Pollution Bulletin, Vol. 62, 2011, pp. 2588-2597.
67 Koelmans, A. A. et al., Risk assessment of microplastic particles, Nature Reviews Materials, 7:138–152, 2022.
68 The persistence of a pellet in the aquatic environment may be measured over decades or more, depending on the resin type, the types and amounts of additives, and the reactions of the resins and additives to environmental processes (e.g. weathering, sunlight, wave action). P. L. Corcoran, Degradation of Microplastics in the Environment, Handbook of Microplastics in the Environment, 2022, 531–542. N. Kalogerakis et al., Microplastics Generation: Onset of Fragmentation of Polyethylene Films in Marine Environment Mesocosms, 2017, doi.org/10.3389/fmars.2017.00084

biofilm starts to form on the pellets, which may change the buoyancy of the particle. Harm is caused by pellets when they float or are in the water column, where they can be eaten by organisms and marine animals either intentionally because they are mistaken for food or unintentionally when filter feeding animals take in seawater.[69] Several documented accounts describe pellet and other plastic ingestion by wildlife, most notably seabirds and sea turtles.[70,71,72] Seabirds, like fulmars, ingest pellets more frequently than any other animal, as they capture prey from the sea surface, and approximately one-quarter of all seabird species are known to ingest pellets.[73] The ingestion of pellets, as with any microplastic, can cause physical harm such as internal injuries and impair the ability to breathe, swallow, digest food properly, or lead to death.[74] In certain cases, microparticles cannot pass through the digestive system, leading to malnutrition or starvation by creating a false feeling of fullness.[75]

Pellets' and microplastics' potential to act as a carrier for pathogenic microorganisms and their potential toxicity are other integral parts of the problem. There is an emerging concern that microplastics can act as a carrier for pathogenic microorganisms, including species of bacteria, resulting in an increase in the occurrence of non-indigenous species.[76,77,78] Although microplastics do not pose acute fatal effects on living organisms, they can cause chronic toxicity over the longer term. Due to their physical and chemical properties, microplastics can absorb and transport numerous organic contaminants. Microplastics can also contain a complex mixture of chemicals, which may subsequently be released into the environment and constitute new routes of exposure for organisms.

Impacts on climate

Microplastics represent a non-climatic pressure on ecosystems as carbon and nutrient cycling processes in soil can be greatly affected by the presence of microplastics and their further decomposition[79] (and might therefore lead to a decreased capacity for GHG absorption). In addition, plastics and microplastics are a source of GHG emissions, putting additional pressure on the climate. GHGs are emitted throughout the plastic life cycle, because all related activities (extraction, refining, manufacturing and end of life management) are carbon intensive. Conventional plastics (based on fossil fuels) produced in 2015 accounted for 3.8% of total global CO_2 emissions, and their share could

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69 Werner S; Budziak A; Van Franeker J; Galgani F; Hanke G; Maes T; Matiddi M; Nilsson P; Oosterbaan L; Priestland E; Thompson R; Veiga J; Vlachogianni T. Harm caused by Marine Litter. EUR 28317 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC104308

70 Lacroix C. et Huvet A., https://enviroplast2019.sciencesconf.org/data/TR1_1_PPT_journe_es_plastiques_et_environnement_Lacroix_Huvet.pdf [Roundtable n°1 : Outlook and management in ports and coastal environments – scientific introduction : the characterisation of pollution and associated risks], June 2019.

71 Ryan, P. G., 'Seabirds indicate changes in the composition of plastic litter in the Atlantic and south-western Indian Oceans', *Marine Pollution Bulletin*, Vol. 56, no. 8, 2008, pp. 1406-1409.

72 Sheavly, S.B. and Register, K.M., 'Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions', *Journal of Polymers and the Environment*, Vol. 15, 2007, pp. 301-305.

73 Plastic particles in fulmars | OSPAR Commission

74 Group of Chief Scientific Advisors, 'Scientific opinion on the Environmental and Health risks of microplastics pollution', Aprile 2019.

75 The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission, OSPAR Background document on pre-production plastic pellets, 2018.

76 Sources, fate and effects of Microplastics in the marine environment: a global assessement

77 Cole, M., Lindeque, P., Halsband, C. and Galloway, T. S., 'Microplastics as contaminants in the marine environment: A review', *Marine Pollution Bulletin*, Vol. 62, 2011, pp. 2588-2597.

78 Khalid, N. et al., Linking effects of microplastics to ecological impacts in marine environments, Chemosphere, 264: 128541, 2021.

79 Rilling M. C. et al., Microplastic effects on carbon cycling processes in soils, Plos Biology, 2021, https://doi.org/10.1371/journal.pbio.3001130

reach 15% by 2050[80]. A more recent study estimates even higher CO_2 emissions from plastic production (1.96 Gt of CO_2e)[81].

Microplastics are widely found in aquatic environments.[82] Their presence may cause more greenhouse gas emissions as they can negatively affect multiple factors, such as phytoplankton photosynthesis, which contribute to carbon sequestration.[83]

Impacts on human health

Humans are exposed to microplastics via food consumption[84] and inhalation. The annual intake of microplastics by humans has been estimated to range from 70 000 to over 120 000 particles a year, depending on age, gender, region, and consumption, including ~70 000 particles inhaled in air and ~50 000 particles ingested in food and drink. Seafood is one of the main concerns for humans[85]; however, microplastics can also enter the food chain through plants.[86] Microplastics have been found in human stool,[87] and some studies suggest that they may be present in pregnant women's placenta,[88] and more recently, in human blood.[89]

Although there is still no scientific consensus on their impacts, microplastics may be of concern to human health mainly due to their small size, mobility and extensive presence in different environments, increasing chances of exposure.[90] High levels of exposure to microplastics are believed to induce inflammatory reactions and toxicity, possibly due to the additives used to produce the plastic.[91] In addition to being toxic, there is evidence to suggest that additives such as dyes or plasticisers could be carcinogenic and mutagenic.[92,93] Pellets are likely to carry toxic chemicals as well since persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs), dichloro-diphenyltrichloroethane (DDT), hexachlorocyclohexanes (HCHs), and polycyclic aromatic hydrocarbons (PAHs) can be easily adsorbed to their surface and then released over time.[94] The health

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80 IPCC Working Group III Report: Mitigation of Climate Change (2022) https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/

81 Cabernard, L., Pfister, S., Oberschelp, C. et al. Growing environmental footprint of plastics driven by coal combustion. Nat Sustain 5, 139–148 (2022).

82 Phytoplankton response to polystyrene microplastics: Perspective from an entire growth period - ScienceDirect

83 Can microplastics pose a threat to ocean carbon sequestration? - ScienceDirect

84 Sciencealert.com, Study shows how microplastics can easily climb the food chain. Should we be worried?, 2022.

85 Cox, K. D. et al., 'Human consumption of microplastics', *Environmental Science and Technology*, Vol. 53, No 12, 2019, pp. 7068–7074.

86 Sciencealert.com, 'Study shows how microplastics can easily clim the food chain. Should we be worried?', 2022 (https://www.sciencealert.com/study-shows-how-microplastics-can-easily-climb-the-food-chain-should-we-be-worried).

87 Schwabl, P. et al., 'Detection of various microplastics in human stool', *Annals of Internal Medicine*, Vol. 171, No 7, 2019, pp. 453–457, American College of Physicians.

88 Ragusa, A. et al., 'Plasticenta: First evidence of microplastics in human placenta', *Environment International*, Vol. 146, 2021, Elsevier BV.

89 Leslie, H. A. et al., 'Discovery and quantification of plastic particle pollution in human blood', *Environment International*, Vol. 163, 2022, Elsevier BV.

90 Marine microplastic debris: An emerging issue for food security, food safety and human health - ScienceDirect

91 Potential Health Impact of Environmentally Released Micro- and Nanoplastics in the Human Food Production Chain: Experiences from Nanotoxicology | Environmental Science & Technology (acs.org)

92 Gasperi, J., et al., Microplastics in Air: Are We Breathing It In?, Current Opinion in Environmental Science & Health, 1–5. 2018. https://doi.org/10.1016/J.COESH.2017.10.002

93 Blackburn, K., Green, D., The potential effects of microplastics on human health: What is known and what is unknown, Springer, Ambio, 51:518–530, 2021.

94 Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, *Science of the Total Environment*, 747:141227, 2020.

impacts of POPs are not immediate but result rather from chronic, cumulative and long-term exposure.[95] In addition, microplastics could potentially act as vectors for pathogens and microbes.[96]

Impacts on the economy

Generally, the growing evidence on microplastics' presence in seafood, salt, honey, fruits, vegetables and drinking water could undermine consumer confidence and bear economic consequences.

There are potential negative economic impacts on activities such as commercial fishing and agriculture (e.g. reduced fishing due to impacts of microplastics on marine eco-systems and fauna, which eats it) as well as tourism and recreation (e.g. reduced attractiveness due to impacts of microplastics on beaches and vulnerable areas like national parks, rivers and lakes[97]). Clean-up operations are challenging and, according to OSPAR, often costly, as clean-up off-site and in the environment requires time and specialist equipment. Operations are usually the responsibility of local communities with a negative impact on their budgets. Clean-up costs are often unknown. However, beach clean-ups are estimated to cost the city of Marseille (France) EUR 1 000 000 per year.[98] KIMO Netherlands reported that the clean-up costs of the 2019 pellet spill of the MSC Zoe in the Wadden Sea would be approximately EUR 100 000 annually.[99] Monitoring costs of pellet ingestion by species are also often unknown. However, la Rochelle Aquarium's monitoring of microplastic ingestion by loggerhead sea turtles cost a total of EUR 50 000 over four years. Another relevant example is the monitoring of microplastic ingestion by fulmars provided by ornithological groups, which costs EUR 33 300 for one winter season.

The cost of pellets lost to the environment is equivalent to an economic loss for the businesses owing them of EUR 52 – 184 million, coming from about 52 140 – 184 290 tonnes of lost pellets (with around 1000 EUR/t).

2.4 What are the problem drivers?

There are several market and regulatory failures, which are summarised below and explained in more detail in Annex 8.

2.4.1 Market failures

Prices do not reflect negative externalities: The activities of economic operators do not integrate the negative externalities caused by pellets finding their way into the environment, leading to a suboptimal market outcome. On one side, due to their small size, pellets are easy to spill; on the other side, it is relatively costly to prevent spills or to clean up after spills as good handling practices require measures to be taken, such as training of staff. The cost of lost pellets, incurred by economic operators

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95 Nadal, M. et al., Climate change and environmental concentrations of POPs: A review, *Environmental Research*, 143: 177-185, 2015.

96 Microplastics from textiles: towards a circular economy for textiles in Europe — European Environment Agency (europa.eu)

97 Plastic Giants polluting through the backdoor; Silent Pollution – Who is contaminating Puglia's coastline with plastic pellets?; Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines; Microplastic pollution in the surface waters of Italian Subalpine Lakes; Granulés plastiques industriels sur le littoral français

98 OSPAR Background document on pre-production Plastic Pellets 2018. SOS Mal de Seine Association highlighted the lack of capacity of public authorities to deal with large-scale pollution of pellets on beaches (e.g. caused by lost containers). As a matter of fact, clean-up operations are complex to undertake because these particles are difficult to see due to their size or vegetation which may hide them, and they should be carried out within an hour of an incident to prevent widespread pollution by wind, rain, and/or tides.

99 Fishing for Litter fleet cleans up after MSC Zoe but who pays the costs? – KIMO (kimointernational.org)

involved in the production, use and transport of pellets, is not sufficiently high to motivate a change in behaviour. In addition, once spilled, pellets are considered contaminated and therefore become waste.[100] There are no other incentives for economic operators to integrate the negative externalities caused by pellets finding their way into the environment.

Imperfect information: Economic operators do not have sufficient information to be fully aware of the pellets that are unintentionally lost from their operations (and of consequential impacts). As no systematic reporting is in place, they are not aware of quantities released, and because there is no or insufficient awareness raising about the impacts, they are not aware of the negative externalities. Furthermore, as information on available preventive and mitigating measures by responsible companies is not sufficiently promoted throughout the supply chain, they are not aware of possible actions to be taken. Under these circumstances, it is difficult for economic operators to make sustainable choices when investing in the equipment, determining their internal procedure or choosing partners along the supply chain.

As such, no sufficient information about quantities, impacts, actions etc., is routinely sought or promoted throughout the supply chain and economic operators do not sufficiently integrate concerns about pellet losses in their operations. This problem of insufficient information is particularly acute among the smaller companies, mostly on the conversion and logistic side.

Lack of specific support and attention for the smaller companies present in the pellet supply chain, to which the measures to implement would be costly, also explains a suboptimal market outcome.

2.4.2 Regulatory failures

Existing EU legislation does not address pellets sufficiently: The absence of specific requirements to implement best handling practices is arguably the most significant of the problem drivers. While existing EU regulatory frameworks could be relevant (governing chemicals, marine litter, water, industrial emissions, waste, packaging and transport activities), they do not specifically address the issue of pellet losses and their responsible handling to prevent and reduce losses to the environment. In particular, pellets are only very partially covered by the REACH restriction on microplastics intentionally added to products[101] as: 1) the requirements i.e. instructions for use and disposal and reporting on estimates on quantities released on an annual basis, are generally defined and 2) they do not help as such to effectively reduce pellet losses or prevent them (e.g. they are not a requirement on their handling). No methodology is foreseen to measure pellet losses (it was left to the industry to develop a methodology).

At the national level, France is the only Member State who has adopted legislation specifically to prevent pellet losses. This is described in detail in Section 5.1.2. Generally, the very large majority of facilities involved in the pellet conversion or the pellet logistic are too small to attract any public attention and routine visits from the environmental regulators.

The absence of specific requirements in EU legislation to implement best handling practices is explained in detail in Annex 8.

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[100] Hann, S., Sherrington, C., Jamieson, O., Hickmann, M., Kershaw, P., Bapasola, A., Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products, Eunomia.

[101] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

2.5 How likely is the problem to persist?

It is likely that without EU action, the problems related to plastic pellets would worsen.

Table 2: Assumptions on whether / how the identified problems will persists

Problem	Assumptions on whether / how this problem persists
(I) Market failure - economic operators do not integrate negative externalities of pellet pollution	• In the absence of external factors (economic crisis, pandemic etc.), the demand and consumption of plastic products is expected to increase. Pellets losses are also expected to continue in the coming years, as without EU action, there are no incentives for economic operators to act, particularly for some actors in the supply chain (e.g. actors with a low public profile). • Recently adopted voluntary initiatives and regulatory actions at Member State level (i.e. France; other MS are mostly relying on industry efforts or waiting for EU action) are expected to lead to some reduction in pellet losses. However, the effectiveness of these initiatives and actions is also likely to remain limited considering current enforcement issues and the lack of enforcement mechanisms in the new initiatives and actions, particularly for some actors in the supply chain (e.g. actors with a low public profile).
(II) Market failure – economic operators do not have sufficient information and awareness as to pellet losses (and consequential impacts)	• As scientific understanding of environmental and human health impacts of pellet pollution is further updated, new risks may be identified and pressure to take action may increase. • Recently adopted voluntary initiatives and regulatory actions are also expected to increase the availability of information. • However, the level and quality of information are likely to remain limited. In particular, competencies, training and awareness of staff for all actors in the supply chain may not improve substantially in the absence of proper and mandatory training requirements. Similarly, accessibility of information may not improve substantially in the absence of proper and mandatory transparency mechanisms.
(III) Regulatory failure, even if some aspects of this can be addressed by ongoing initiatives (REACH reporting obligation)	• The REACH reporting obligation may increase information on pellet losses and improve the quality of the information collected to assess future risks. • However, the obligation is not specific to pellets but generic to all ‘derogated uses’, and it does not reduce pellet losses or prevent them (e.g. it is not a requirement on their handling). Moreover, in the absence of a harmonised methodology for measuring pellet losses, there will be inconsistencies in estimates reported, and comparing data will be difficult.

3 WHY SHOULD THE EU ACT?

3.1 Legal basis

This initiative is based on Article 192(1) of the Treaty on the Functioning of the European Union (TFEU).

3.2 Subsidiarity: Necessity of EU action

Transboundary nature of the problem

This is the most important aggravating factor and reason to act. Microplastic pollution is readily transported from one geographical place to another by atmosphere and surface waters and seas, and can be found in the most remote places on the planet. National action alone cannot address the problem of transboundary pellet pollution. As an example of this, 60% of European river basin districts are international (either shared between EU Member States or between an EU Member State and a third country), and the Water Framework Directive made cooperation between countries sharing a basin within the EU mandatory. As an answer to this transboundary pollution, the Regional Seas Conventions for the protection of the marine and coastal environment around Europe (for the Mediterranean, Baltic, Northeast Atlantic and the Black Sea) have regional plans against marine litter, including microplastics, and recommend actions to reduce them. In particular, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) has adopted a non-binding Recommendation[102] containing guidelines to reduce the loss of plastic pellets into the marine environment.

3.3 Subsidiarity: Added value of EU action

There is a clear benefit in taking action at the EU level on pellet losses, as this can efficiently ensure a high level of environmental protection throughout the EU territory, and a harmonised and well-functioning internal market across all Member States (same requirements for pellet pollution prevention and reduction, reduced costs of harmonised approaches). Fragmented approaches, such as national actions on one aspect only of pellet pollution (e.g. measuring), actions not covering the entire pellet supply chain (e.g. producers and converters but not transporters) or actions limited to one or a few Member States, would not bring efficiency gains as they are less effective in reducing transboundary pellet pollution and overall more costly in achieving wider policy goals on reducing releases of microplastics.

Furthermore, the size of the internal market provides a critical mass enabling the EU to promote handling practices that release fewer pellets that could influence the pellet supply chain worldwide. It will also guide EU actions at the global level in the context of the negotiations on a Global Plastic Agreement and at the level of Regional Seas Conventions.

The principle of proportionality requires EU action to be limited in its content and form to what is necessary to achieve the objectives of the Treaties it intends to implement. The application of this principle is linked to the principle of subsidiarity and the need to match the nature and intensity of a given measure to the identified problem. The principle of proportionality is considered throughout the impact assessment and, in particular, in Annex 11 where the costs of the regulatory option for SMEs are assessed.

4 OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1 General objectives

The general objective of this initiative is to contribute to the reduction of microplastic-related pollution by preventing and reducing pellet losses to the environment that are due to current handling

[102] OSPAR Recommendation 2021/06 on the reduction of plastic pellet loss into the marine environment.

pellet practices at all stages of the supply chain within the EU, thus reducing the adverse environmental, economic and potential human health consequences of pellet pollution.

4.2 Specific objectives

Accordingly, the above general objective translates into three specific objectives:

- To reduce and prevent pellet losses in an economically proportionate manner to a level consistent with the Commission's 2030 target of a 30% reduction in both intentional and unintentional microplastic releases (compared to 2016 levels);

- To improve information on the magnitude of pellet losses throughout the pellet supply chain, in particular the accuracy of loss estimates, and to raise awareness among relevant actors; and

- To ensure the appropriate mitigation of impacts on SMEs involved in the pellet supply chain.

5 WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1 What is the baseline from which options are assessed?

The baseline has been developed using 2019 as the base year and the following data sources and assumptions.

- 2019 is taken as the base year, as 2020 is an outlier because of COVID, and we are seeing positive growth trends again from 2021.
- For virgin pellets, the projections are made from 2019 figures[103]; a growth rate of 0.9% per year is assumed till 2030.[104]
- Source for recycled pellets production data (2019-2021) is Plastic Recyclers Europe; a growth rate of 5.6% per year is assumed.[105]
- Source for bio-based pellets production data (2019-2021) is Plastics Europe; for growth rate a CAGR of 14% for 2022-2027[106], and the same trend is assumed to continue till 2030.
- Pellets imports and exports figures for virgin pellets are from Eurostat, a growth rate of 0.9% is assumed till 2030.

Using these assumptions, the total EU pellet production is expected to reach about 80 million tonnes in 2030. If we take into account imports and exports, the net volume of pellets used in the EU would be around 76 million tonnes in 2030. The total figures estimated here are within a 1% range of to the estimates from the recent OECD scenario[107] that used a modelling approach.

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[103] Plastics Europe changed the calculation method in 2021, excluding adhesives, paints and coatings, thus not used to be coherent with previous year estimates and also with import/export figures

[104] Plastics Europe and SystemIQ

[105] K 2022 - Trend Report Europe https://www.k-online.com/en/Media_News/Press/Technical_article/K_2022_-_Trend_Report_Europe

[106] Nova Institute (2023) Bio-based Building Blocks and Polymers Global Capacities, Production and Trends 2022–2027 https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2022-2027-short-version-pdf/

[107] OECD (2022) Global Plastics Outlook: Policy Scenarios to 2060. https://www.oecd.org/publications/global-plastics-outlook-aa1edf33-en.htm

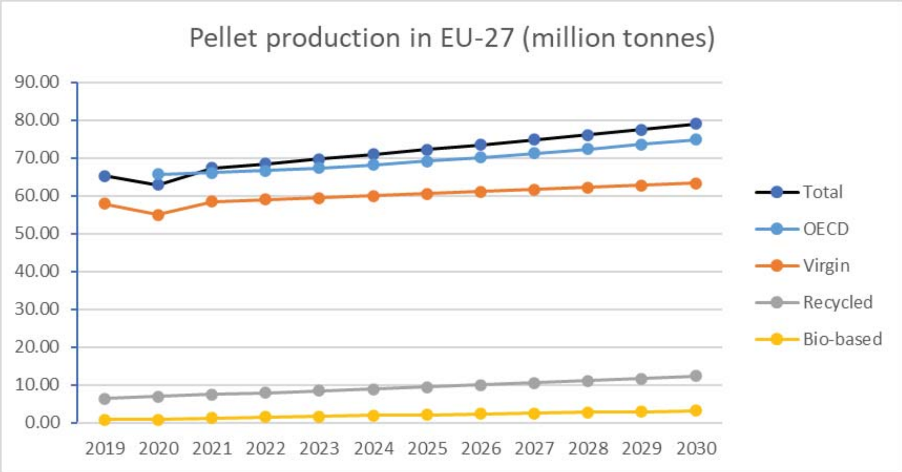

***Figure 5*: Pellet production volumes in EU-27 and projections until 2030**

To define the projected development of total pellet losses by 2030, consideration was given to the following: Existing and forthcoming EU legislation; National and international initiatives; Industry initiatives. These legislation and initiatives are presented below.

5.1.1 Existing and forthcoming EU legislation

The requirement to report estimates of pellet losses under the REACH restriction on microplastics intentionally added to products[108] aims to increase information on pellet losses and improve the quality of the information collected to assess the risks deriving from these microplastics in the future. The reported information aims to allow uses with high releases to be identified and prioritised for further regulatory risk management. However, the requirement does not help as such to effectively reduce pellet losses or prevent them (e.g. it is not a requirement on their handling), and is lacking a methodology to measure pellet losses (it was left to the industry to develop a methodology).

The Marine Strategy Framework Directive (MSFD) addresses the monitoring and assessment of the impacts of microlitter, including microplastics, in coastal and marine environments in a way that they can be linked to point-sources.[109] An update of the first MSFD guidance[110] on monitoring marine litter guidance document is under development in view of harmonised methodologies, including the monitoring of the presence and distribution of plastic pellets along the coastline. However, this does not include specific requirements concerning the prevention or reduction of pellet losses at the source.

The revised Urban Wastewater Treatment Directive (UWWTD)[111] and the evaluation of the Sewage Sludge Directive (SSD)[112] are not explicitly considered in the baseline as (1) the analysis was done at the same time, and (2) more importantly, the measures under consideration for the UWWTD are

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[108] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

[109] Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy: "…micro-litter shall be monitored in the surface layer of the water column and in the seabed sediment and may additionally be monitored on the coastline. Micro-litter shall be monitored in a manner that can be related to point-sources for inputs (such as harbours, marinas, waste-water treatment plants, storm-water effluents), where feasible."

[110] Guidance on Monitoring of Marine Litter in European Seas (europa.eu)

[111] COM/2022/541 final, 2022.

[112] Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.

limited in scope and impact (mainly monitoring and in larger plants, additional treatment to remove microplastics, which would go to sludge). As for the SSD, which is currently being evaluated, it is not clear yet which measures would be proposed in a potential future revision. More information on the links between water legislation and pellet losses is presented in Annex 6.

The Industrial Emissions Directive (IED)[113] regulating the prevention and management of pollution arising from industrial activities in large industrial installations, is only partially suited to address pellet losses as a form of pollution occurring along the entire supply chain. While activities like the production of polymeric materials on an industrial scale fall under the scope of the IED, other activities like the conversion, storage or transport of pellets, usually operated by small and medium enterprises, are not covered. Moreover, the BAT (Best Available Technique) Reference Document (BREF) for the production of polymers was adopted in 2007 and does not address the specific issue of pellet losses.[114]

Waste legislation such as the Waste Framework Directive (WFD)[115] and Packaging and Packaging Waste Directive[116] does not specifically address the pellet loss issue as they do not regulate emissions during the production of products or packaging. The WFD imposes Member States a generic obligation to take waste preventive measures addressing the industrial generation of waste as pellets can be.

Therefore, there is no comprehensive EU legislation addressing pellets to reduce their losses and their environmental and potential health impacts, with a full supply chain approach.

5.1.2 National and international initiatives

A few Member States have already started to introduce measures to tackle pellet losses. These measures are summarised in Table 3 and presented in detail in Annex 6.

Table 3: Member State actions targeting pellet losses

Country	Actions
Austria	• Law adopted addressing "filterable substances" to which pellets belong
Belgium (Flanders)	• Introducing environmental permit system / Best Available Techniques • Examining an environmental management system with possible certification
Denmark	• Monitoring • Waiting for OCS certification scheme implementation and Commission's proposal
France	• Law adopted providing minimum obligations to prevent pellet losses for all actors in the supply chain along with mandatory external auditing
The Netherlands	• Monitoring • Waiting for OCS certification scheme implementation
Spain	• Promoting OCS certification scheme implementation
Sweden	• Revising current guidelines to make them more comprehensive and include more actors across the supply chain

113 Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (recast)
114 https://eippcb.jrc.ec.europa.eu/reference/production-polymers
115 Directive 2008/98/EC on waste and repealing certain Directives.
116 Directive 94/62/EC on packaging and packaging waste.

France is the only Member State who has adopted legislation specifically to prevent pellet losses. This legislation covers businesses making and handling pellets in quantities higher than 5 tonnes including logistic platforms but not transporters. The threshold has been reduced from what initially proposed, i.e. 10 tonnes following public consultation. Businesses are subject to equipment and procedural obligations to prevent the loss and leakage of pellets, and are required to be regularly audited by independent and accredited certification bodies.[117] Obligations remain of a relatively generic nature. For instance, a business must identify areas where pellets are more likely to spill, check that the packaging used is designed to minimise the risk of spills and train and raise awareness among staff. As a unique transparency measure, the company must make the summary of the auditing report available on its website. The Decree entered into force on January 1, 2022 for new sites, while for existing sites, it will enter into force in 2023, at the same time as equipment obligations.

In 2021, the British Standards Institution published the Publicly Available Specification PAS 510:2021.[118] This PAS is for use by any organization of any size in any part of the supply chain that handles pellets. It builds on the industry-led Operation Clean Sweep® (OCS) programme by creating a standardized and consistent approach to risk management and containment of pellets.[119] The PAS can be considered for further development as a British standard or constitute part of the UK input into the development of a European or International standard on pellets.

In 2021, the parties to the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) adopted the non-binding Recommendation 2021/06[120] to reduce the loss of plastic pellets in the marine environment by promoting the timely development and implementation of effective and consistent pellet loss prevention standards and certification schemes for the entire plastic supply chain. The Recommendation was accompanied by supporting guidelines which set out essential requirements for standards and certification schemes. The first full implementation report is due in January 2025. However, an interim report on the progress made will be published in 2024. A preliminary interim report was informally shared by OSPAR in February and the actions reported by the Member States that are parties to the OSPAR Convention are presented in the above Table 3.

In the International Maritime Organization (IMO), a Correspondence Group on Marine Plastic Litter from Ships looked at measures that could be relevant in reducing the environmental risk associated with the maritime transport of plastic pellets. While three primary measures including packaging were identified as particularly relevant to reduce the environmental risks associated with the maritime transport of plastic pellets (and a voluntary circular to this effect was drafted), the Group was not in

[117] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official "Lois et Décrets" no. 0092 du 18 avril 2021 [JORF] [Official journal "Laws and Decrees" no. 0092 of 18 April 2021], 18 April 2021, Fr.

[118] BSI Knowledge, 'Plastic pellets, flakes and powders. Handling and management throughout the supply chain to prevent their leakage to the environment. Specification - PAS 510:2021101', 2021.

[119] The PAS provides requirements in the following areas: a) Organizational responsibilities; b) Leadership and commitment; c) Competence, training and awareness; d) Risk assessment of pellet loss to the environment; e) Operational controls, i.e. prevention, containment and clean-up, procurement and suppliers; f) Internal and external communication; g) Performance evaluation, i.e. monitoring and documentation, auditing and verification of conformity; h) Improvement, i.e. internal and external non-conformity and corrective action, and continual improvement.

[120] www.ospar.org/convention/strategy

a position to conclude on the most appropriate instrument for mandatory measures.[121] The Group noted that experience gained from the implementation of the voluntary measures could be useful in the further consideration of the most appropriate instrument for mandatory measures.

A similar international initiative is ongoing on containers lost at sea, and discussions are held on the possibility of making the information on containers lost at sea available publicly (to date, sufficient information is reported only to insurance companies). If retained, this measure would allow for a better understanding of the scale and magnitude of pellets lost at sea and would facilitate liability identification and compensation arrangements in line with the polluter pays principle.

5.1.3 Industry initiatives

In 1991, the industry-led Operation Clean Sweep (OCS) initiative was created by SPI (the US Plastics Industry Trade Association, now known as the Plastics Industry Association), with companies voluntarily signing a pledge to work towards zero plastic pellet loss.

Since 2015, the European plastic manufacturing industry has progressively adopted the Operation Clean Sweep® programme (OCS)[122] as a voluntary pledge. Under this programme, each company making or handling pellets recognises the importance of making zero pellet losses by:

1) improving worksite set-up to prevent and address spills;
2) creating and publishing internal procedures to achieve zero pellet losses;
3) providing employee training and accountability for spill prevention, containment, clean-up and disposal;
4) auditing performance regularly;
5) complying with all applicable local and national regulations governing industrial pellet containment;
6) encouraging partners to pursue the same objectives.

Recommendations on how to deliver on each of these six actions are given in the form of a manual.

While best practices are generally well understood by OCS signatories they have not been comprehensively implemented. As of September 2023, 2790 companies have committed to OCS[123]. This figure includes all PlasticsEurope's members (these are producers; adherence to OCS is mandatory for the members of this association). Only around 2% of EuPC's members (converters) have committed to OCS (around 1 000 converters out of 48 000); and only around 500 transport companies. As no precise reporting has been made available within OCS, it is not possible to say whether those who have committed have also effectively or fully implemented the programme, with

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[121] The three primary measures identified as relevant are: Packaging provisions for plastic pellets carried at sea; Provisions for notifying the carrier so that containers containing plastic pellets can be identified; Stowage provisions for freight containers containing plastic pellets. Among the options for mandatory measures, the Group considered the three following options/instruments: Assignment of an individual UN Number (class 9) for plastic pellets transported at sea in freight containers (UN Number); Amendment to Appendix I of MARPOL Annex III that would recognize plastic pellets as a "harmful substance" (Harmful substance); A new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

[122] www.opcleansweep.eu

[123] www.opcleansweep.eu

evidence showing the opposite. Both acute and chronic pellet incidents have been reported to continue over the last years, including at sites that are OCS signatories.[124]

The launch of the OCS Certification Scheme (OCS CS) aims to address these issues. Recognising the low uptake of OCS by the industry, in 2019, European plastic manufacturers (PlasticsEurope) and converters (EuPC) announced plans to develop a voluntary certification scheme building on OCS and including requirements, third-party, independent auditing, certification and some level of transparency (all aspects not foreseen under the current OCS programme). In January 2023, the new scheme was officially launched by its promoters following preparatory work by a Supervisory Board gathering producers, converters, representatives of some governments (Scotland, Germany and Spain), one NGO (Fauna & Flora International), some certification bodies (Aenor and Tuv-Nord) as well as one European Institution (the European Parliament). Representatives of the European Commission, the European Chemical Transport Association (ECTA) and Cefic took part in the discussions as observers.

Under the new scheme, companies are invited to comply with requirements from the following broad categories:

- Commit to making zero loss of pellets, flakes, and powder a priority;
- Improve worksite set to prevent and address spills, meaning site risk assessments;
- Create and publish internal procedures to achieve zero pellet loss goals meaning documented procedures, including, for instance, description of roles and responsibilities, but also recording, investigation and follow-up of incidents and effectiveness of procedures, equipment and instructions in place;
- Provide employee training, including theory and practical hands-on exercises and accountability for spill prevention, containment, clean-up and disposal;
- Audit performance regularly, meaning internal audits;
- Comply with all applicable local and national regulations governing pellet containment;
- Encourage partners to pursue the same objectives to be monitored, for instance, via the % of contracts containing an OCS clause.

Compliance will be verified at site level by third-party independent auditors. Once successfully audited, companies will be certified compliant and will have the name of the company and the site location listed in a public register. The certification will be valid for 3 years after the date of the first audit, subject to an annual follow-up control audit. First audits started in June 2023.

While it goes in the right direction, the new scheme does not encompass the whole supply chain and is, therefore, only a partial attempt to pursue zero pellet pollution effectively. First of all, while the requirements are in principle applicable to all companies handling pellets, and all companies can get audited and certified, the new scheme does not apply to the whole supply chain in the same way: it is mandatory for members of PlasticsEurope (adherence to the existing OCS programme is already mandatory for them) but is for the moment voluntary for key players in the pellet supply chain such as converters, transporters, warehousing operators and recyclers.

[124] Regarding chronic pellet losses in the Netherlands, Belgium and Spain, see https://www.plasticsoupfoundation.org/wp-content/uploads/2022/03/Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf; https://surfrider.eu/en/learn/news/ecaussinnes-belgium-surfrider-foundation-tackles-industrial-plastic-granules-1211028228325.html; https://goodkarmaprojects.org/2020/11/20/new-report-out-exposes-alarming-impacts-of-plastic-pellets-across-europe/?lang=en.

EuPC found it difficult to make adherence to the new scheme mandatory for their members (to date, adherence of converters to the existing OCS programme is very low). Members of EuPC are European and national associations representing close to 48 000 individual companies, out of which 66% are micro-companies. It is estimated that while the certification process is carried out over a relatively short period of time for producers (PlasticsEurope expect all their members to be certified by the end of 2024, some producers reporting however a longer period before certifying all their sites), this process will likely take much longer for converters, with no assurance that it would cover a major part of converters at all.

Transporters, warehousing operators and clean tankers are observers of the new OCS certification scheme and will be assessed (not certified) under the chemical industry's Safety and Quality Assessment for Sustainability (SQAS) system, which contains revised requirements to tackle pellet losses since March 2023[125]. Full alignment between the new OCS certification scheme and the SQAS system is still pending. In particular, there are no plans currently to oblige OCS-certified companies to work exclusively with SQAS-assessed transport, warehousing and cleaning companies. To date, there are approximately 3 000 transport companies which are SQAS-assessed and even more transport companies which are not SQAS-assessed. According to the sector, SQAS-assessed transport companies cover about 80% of the total pellet transport of virgin pellet producers in Europe. Cleaning stations are mostly SQAS assessed, while among warehousing operators, only a part is SQAS assessed.

To test the new scheme, nine pilot audits covering producers, converters and transporters were held in 2021 in five countries: Belgium, Netherlands, Portugal, Spain and France. The audits are conducted by well-known boddies like Aenor, Bureau Veritas, SGS, etc. All audited companies failed to pass.

At the end of 2021, Fauna and Flora International (FFI) decided to resign from the Supervisory Board of the new OCS certification scheme arguing that it does not fully align with the OSPAR Recommendation and citing issues with the governance of the scheme, the level of transparency, the lack of a formal standard from a recognised standardisation body, the fact that the whole supply chain is not captured adequately and that timelines for compliance have not been set. Instead, FFI called for the introduction of effective legislation applicable to all pellet handling companies and based on a supply chain approach to fully eliminate this source of pollution[126].

Recyclers are neither promoters nor observers of the new scheme and have their own certification scheme in place (RecyClass), which has a section on pellet losses requiring the implementation of a procedure to prevent leakages within the premises of and surrounding the recycling plant and the training of staff. To go a step further, recyclers are conducting a study on potential areas in the recycling processes where microplastics can be generated and released and on preventive measures. The recommendations of this study would be used to complete the RecyClass certification scheme on the pellet losses/microplastics requirements.

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125 SQAS questionnaires. A first addition to the SQAS assessment questionnaire was made in January 2022.

126 FFI call for the introduction of effective legislation that will require all pellet (flake and powder) handling companies across the whole supply chain to provide independent verification that pellet loss prevention measures have been implemented, maintained and monitored for effectiveness towards the goal of zero pellet loss to the environment, prior to materials being placed on the market. They also call for tighter restrictions on the packaging and labelling of pellets being prepared for transport to reduce the risk of loss and improve communication. Finally, EU legislation should complement international maritime legislation for pellets currently being considered by IMO to reduce the risk of catastrophic pellet pollution at sea.

5.1.4 The baseline

All in all, the above national and international initiatives are expected to contribute to a limited change in pellet loss reduction by 2030. The only national legislation adopted to prevent pellet losses via legal obligations (i.e. France) is relatively generic and does not cover transporters. An assumed reduction is considered for France. Both the BSI PAS and the OSPAR Recommendation provide are reference documents in the field as they provide a comprehensive but non-binding set of guidelines. However, in both cases, it is up to the companies or parties to implement such measures, and it was not possible, at the moment of the impact assessment, to evaluate their precise implementation. The IMO work on pellets focuses on one aspect only i.e. shipping of pellets, and has resulted so far in voluntary measures only, with very limited effects up to date.

Once fully in place, the new industry-led OCS certification scheme is expected to contribute to some reduction in pellet losses by 2030. However, the new scheme does not adopt a full supply chain approach and uncertainties persist about its enforceability. In particular, it is difficult to estimate the take-up of the new scheme by the industry, and therefore its effectiveness, and this counts equally for the schemes by the recyclers and logistic companies (respectively, RecyClass and SQAS). It is generally expected that smaller firms will implement voluntary schemes to a lesser degree than larger ones. This results in different assumptions for the producers (larger firms) compared to converters and logistics (smaller firms).

Therefore, for the baseline, it has been assumed that by 2030:

1) 90% of the total virgin pellet volume produced (by the members of Plastics Europe) and 5% for the non-Plastics Europe members will be certified compliant against OCS new rules and will be effectively implementing such rules with a success rate ranging from 60% to 80%;

2) 20% of the total recycled pellet volume will be certified compliant against RecyClass pellet provisions and will be effectively implementing the new provisions with a success rate ranging from 40% to 60%;

3) 30% of the total volume processed will be certified compliant against OCS' new rules and will be effectively implementing such rules with a success rate ranging from 40% to 60%;

4) 40% of the total volume handled by logistics companies will be SQAS assessed and will be effectively implementing such a scheme with a success rate ranging from 40% to 60%.

5) The French legislation will cover about 85% of the French pellet volume (about 10% of the EU volume), leading to a 60-80% pellet loss reduction in 2030.

Based on these assumptions, there will still be pellets lost in the range of 42 050 – 170 266 tonnes per year by 2030.

5.2 Description of policy options assessed in this impact assessment

This impact assessment considers four policy options addressing the general and specific objectives defined under Section 4. These options were selected based on literature review and input from stakeholders, either bilateral or in six stakeholder workshops, and a seventh workshop organised in December 2022 to specifically address pellets, the related baseline and preferred option. Information provided in response to the Inception Impact Assessment and the Public Consultation was also taken into account along with the findings of a survey carried out between January and February 2023 specifically targeting SMEs active in the pellet supply chain as requirements would affect them more than larger companies. Each selected option has been screened from a longer list of potential options developed with experts and stakeholders that are presented in detail in Annex 10. As the IA focussed on measures with direct impact and in alignment with the Commission's overall 30% reduction target by 2030, research actions were screened out at an early stage. However, they might still be needed to foster further innovation in actions that could have an impact in the longer term. It was also estimated that a full value chain approach should be privileged in order to assure that all parts would implement pellet reduction measures.

5.2.1 Option 1: Mandatory standardised methodology to measure pellet losses

Focus: Develop a mandatory standardised methodology to measure pellet losses.

Description: under this option, the Commission initiates the development of a mandatory standardised methodology to measure pellet losses from the range of relevant pellet-related industrial activities (i.e. production, conversion, recycling, transport and other logistic operations), to be used for the reporting on estimates of quantities released on an annual basis, as obliged under the REACH restriction. Reporting is needed to increase information on pellet losses and improve the quality of the information collected to assess the risks deriving from these microplastics in the future. This methodology would need to be coherent with the requirements of the restriction. The new standard will improve the quality of the reporting on the quantities released (one methodology for all instead of several, different ones) improving the information on the magnitude of pellet losses throughout the pellet supply chain, while also raising awareness among relevant actors as they can measure pellet spills and losses and assess their evolution over time.

This option would be developed via the European Standards Organisation (CEN), which typically takes 3-4 years to complete. The umbrella association of European converters (EuPC) is developing for the OCS certification scheme signatories a methodology for measuring pellet losses, named the Bow-tie model, and this work can serve as the basis of the mandatory harmonised methodology.

This option addresses mainly the problem drivers of market (imperfect information), but also of regulatory failures and support to SMEs. It would address the information failure problem and allow for the effective implementation of the other options. Indeed, a standard methodology is essential to monitor the implementation of Option 2 and the evolution of pellet losses. It would facilitate the comparison of different packaging solutions for pellets, under Option 3. It would also be necessary to set up an EU target under Option 4. It is therefore the best and fastest option to address information failure on pellets and monitor the possible success of the options.

5.2.2 Option 2: Mandatory requirements to prevent and reduce pellet losses in a new EU law

Focus: Impose mandatory requirements on proper handling of plastic pellets combined with mandatory certification.

Description: under this option, mandatory requirements are defined and imposed on the entire pellet supply chain thus maximising the opportunities of preventing and reducing pellet losses. The requirements to comply with at the site level are based on those already identified by stakeholders in the framework of the BSI PAS and OSPAR recommendation and the industry-led OCS certification scheme. Firms will need to provide evidence of the following:

1. The creation and publication of internal procedures such as defining organisational responsibilities, a pellet loss prevention policy with pellet loss prevention objectives, a regular risk mapping exercise and corresponding risk management assessment at site level;

2. Competence, training and awareness of staff to prevent, contain and clean up spills including maintaining a record of spills;
3. Operational controls including preventive, mitigating and clean up measures and equipment;
4. Communication of implemented policies, measures and objectives both within the organisation and externally, as well as of improvement as reaction to non-conformity.

A risk mapping exercise needs to be performed to identify the leakage potential of all necessary, handling steps in all high-risk areas and pathways to the external environment. Once this is done, there needs to be a risk management assessment performed to determine where actions are required for equipment, best practice handling, mitigation and remediation.

Knowing that the first step should be to avoid all unnecessary handling of pellets, preventive barriers include “Avoidance of unnecessary handling” (as the possibility of minimising the number of transfer points in the supply chain is the starting point for reducing spill opportunities) and “Best practice handling”. The latter can take the form of collection and retention trays. Mitigation and clean-up measures can take the form of filters, vacuum systems to remove accumulated pellets, and tools for immediate cleaning (shovel, broom, brush, vacuum cleaner).

To demonstrate compliance with the defined mandatory requirements, all pellet handling companies including transporters and logistic platforms must be externally audited and certified at the site level by independent certifying bodies selected among accredited organisms, as a condition to operate. This implementation approach is consistent with the OSPAR Recommendation, adopted by OSPAR contracting parties including the EU and 11 Member States, which promotes certification schemes for the entire supply chain. It is fully in line with the polluter pays principle as companies are required to bear the compliance costs referring to the needed measures. It allows for a harmonised implementation across the EU as a whole, ensuring a level playing field among operators in the single market. Certification obligations will be imposed in a phased manner. Once externally audited, companies or the auditors must notify the public authority about the outcome of the external audit (i.e. whether the site was successfully certified as compliant or not, following the external audit). In the case of non-compliance, the public authorities in the Member States are responsible for imposing corrective measures and, where relevant, penalties.

This option does not include reduction targets and it is assumed that over a period of time the certification process will deliver results. Once the measure under Option 1 is in place, the reduction targets could possibly be defined. The measure under Option 1 would enable measuring its possible success rate.

In light of concerns raised during a targeted SME consultation, **three sub-options were assessed** in the form of:

- lighter requirements for the micro companies (sub-Option 2a);
- lighter requirements for the micro and the small companies (sub-Option 2b); and
- lighter requirements for the micro, the small and the medium companies in the pellet supply chain (sub-Option 2c)

The possibility of lighter requirements was only considered for micro-, small and medium companies because large operators (mainly producers) did not raise concerns about the economic burden of complying with mandatory requirements during stakeholder consultations and bilateral meetings. Instead, they indicated that as long as these requirements would build on existing industry best practices (e.g. Operation Clean Sweep) then they would be relatively straightforward and quick to implement. In addition, the relative cost of these requirements is low for large entreprises.

This option addresses the problem drivers of market and regulatory failures, as well as support to SMEs.

5.2.3 Option 3: Improved packaging for pellet logistics

Focus: Impose packaging provisions for pellet logistics.

Description: this option imposes the use of specific types of bags and containers for transport, intermediate storage and handling during these operations. It aims to ensure that all bags and containers used for pellet logistics (transport, intermediate storage) are environmentally sealed, airtight and puncture-resistant to prevent damage and tears, which could lead to pellet losses. It can be set up as an independent legislation or can be implemented as part of the legal proposal in Option 2.

This option addresses the problem drivers of market and regulatory failures.

5.2.4 Option 4: EU target to reduce pellet losses

Focus: Introduce EU target to reduce pellet losses

Description: this option is to establish an EU emission reduction target for pellet losses in line with the Commission's overall microplastic releases reduction target of 30% by 2030. Companies must introduce the same preventive, mitigation and clean up measures as in Option 2. Each Member State must introduce the necessary transposing legislation and measures to ensure delivery, including compliance assurance, reporting by economic operators to track progress against the target, and enforcement. Periodic reporting by national public authorities to the Commission would also be necessary to ensure delivery and appropriate remedial action in case of shortfall in reducing pellet losses.

This first requires the establishment of a mandatory standardised methodology to measure pellet losses (Option 1). Without it, it would be challenging to establish a baseline and measure the achievement/non-achievement of the established target.

This option addresses the problem driver of regulatory failure.

5.3 Options discarded at an early stage

Overall, 173 ideas were identified during desk research and in stakeholder workshops. The main discarded ideas are presented below.

Voluntary commitments like the one under the industry-driven OCS and in particular its new certification scheme were considered as suitable options to address the identified problem driver 'Market failure (prices do not reflect negative externalities)'. It was discarded as the new scheme was in the meantime launched by its promoters. Therefore, this impact assessment considers such commitment as part of the baseline. In Annex 6, the actions of industry are detailed.

The option of developing voluntary verification of best practices using well-designed standards and certification schemes is ongoing under the work of the Commission of the regional convention for the protection of the Marine Environment of the North-East Atlantic (OSPAR) and in the framework of the above mentioned industry efforts. Therefore, this impact assessment considers such development as part of the baseline. Also, certification is an essential part of Option 2.

Information/awareness raising on the handling of pellets throughout the pellet supply chain, and the development of a universal information leaflet and labelling for packaging of plastic pellets for their transport, were not considered as suitable options as they are already partially covered by OCS, they would not trigger sufficient change, and where appropriate, they would be better taken up by the mandatory requirements in Option 2.

Training obligations (with regular updates) for all actors in the pellet supply chain are not sufficient as stand-alone measure, but would be better taken up by the mandatory requirements in Option 2. Indeed, training is an essential part of this option.

The possibility of using the Industrial Emissions Directive[127] to address pellet losses at relevant installations was discarded on the ground of effectiveness, efficiency and relevance. The IED is not suited to address pellet losses as a form of pollution occurring along the entire supply chain. While activities like the production of polymeric materials on an industrial scale fall under the scope of the IED, other activities like the conversion, transport or storage of pellets, usually operated by small and medium enterprises, are not covered. Moreover, the BAT Reference Document (BREF) for the production of polymers was adopted in 2007 and does not address the specific issue of pellet losses.

Supporting SMEs, including via financial incentives, is integrated in Option 2 as a way to mitigate the regulatory burden on SMEs.

The possibility of setting extended producer responsibility schemes and environmental damage remediation funds, financed by industry, were discarded on the ground of technical feasibility and relevance. EPR targets a product, while for pellets, we have different types of “producers”, those who manufacture the pellets, those who transform them into a product etc. Also, EPR aims to tackle the end-of-life, i.e. when the product becomes waste, while for pellets, it is a diffused pollution issue along the entire supply chain.

An initiative on classifying pellets as a “harmful substance” in the International Maritime Law is currently already ongoing in the International Maritime Organization with the support of the European Union. At the same time, the Ship Source Pollution Directive[128] is under revision, and one of the options could be to extend the scope of this Directive to cover this provision. Therefore, while addressing the maritime transport of pellets by means of more stringent packaging or stowing provisions may help reduce pellet losses at sea, this impact assessment considers such initiatives as part of the baseline. The same applies to developing a mandatory reporting system for containers lost at sea in international waters.

5.4 The intervention logic

The diagram below illustrates the logical connection between the problem, its drivers and the specific objectives and policy options, which are assessed in Section 6.

[127] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (recast).

[128] Directive 2005/35/EC of the European Parliament and of the Council of 7 September 2005 on ship-source pollution and on the introduction of penalties, including criminal penalties, for pollution offences.

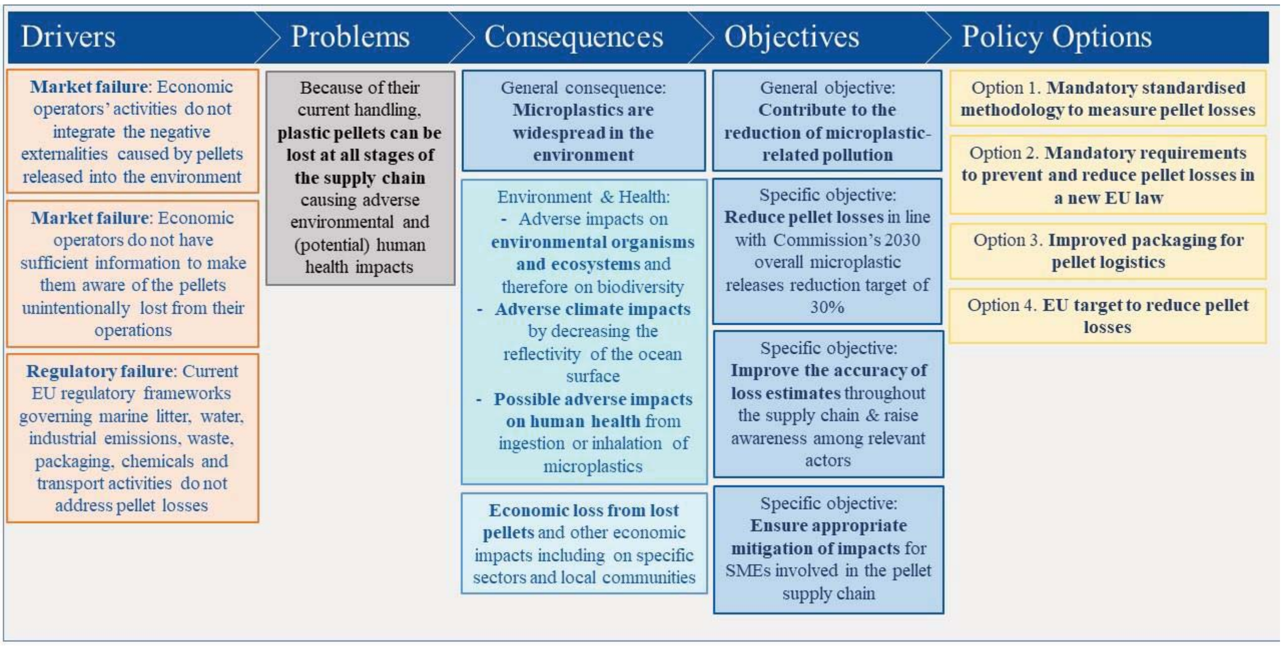

Figure 6: The intervention logic

6 WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

Each policy option is assessed as regards its expected environmental, economic and social consequences, as well as the costs and administrative burden it is likely to cause. This is based on a qualitative and, where possible, quantitative assessment. All calculations are made in relation to the baseline for 2030.

This assessment places particular focus on the pellet loss reduction that is possible under each policy option as a contribution to the Commission's 30% reduction target on microplastic releases to the environment (compared to releases in 2016).

Environmental consequences mainly refer to the specific objective of reducing 'pellet losses to a level consistent with the Commission's 30% reduction target'. A degree of uncertainty remains around the impact of the policy options on pellet losses as the baseline pellet loss data is based on incomplete data, as highlighted and addressed by the use of ranges to present pellet losses. Assumptions, including on the impact of policy options on pellet loss rates, are explained in Annex 4. Monetising benefits on the environment (e.g. benefits on ecosystems and biodiversity) is difficult due to the lack of available data. That is why a qualitative analysis is added.

Economic consequences refer to both the direct and indirect economic costs and benefits that are generated from taking measures to reduce pellet losses. Taking measures to reduce pellet losses will have positive knock-on economic effects on the pellet industry such as reduced waste, modernised equipment, improved reputation, a level playing field among operators and the economic gain of fewer pellets lost. These effects also include the positive knock-on economic effects on activities that are affected by pellet losses (i.e. commercial fishing, agriculture as well as recreation and tourism in affected areas). Taking measures will, however, generate direct compliance costs for the sector (both adjustment and administrative costs), especially for SMEs.

Social consequences mainly refer to whether the policy option increases or decreases the creation of jobs.

The administrative cost / burden on public authorities depends on the degree to which public authorities are involved in the design, implementation or enforcement of the policy option.

The benefit to cost assessments are relative to the other options to allow for more effective comparison of the different options. These impacts are presented in detail in Annex 11, along with the stakeholder groups affected. The following coding is used to present the likely impacts.

Table 4: Coding used to present likely impacts (relative scale)*

Score	Description
+++	Very significant direct positive impact or benefit
++	Significant direct positive impact or benefit
+	Small direct positive impact or benefit
(+)	Indirect positive impact or benefit
+/-	Both direct positive and negative impacts, and balance depends on how implemented
0	No impact or only very indirect impacts
(-)	Indirect negative impact or cost
-	Small direct negative impact or cost
--	Significant direct negative impact or cost
---	Very significant direct negative impact or cost
High	High benefits significantly outweigh costs of measure
Medium	Medium benefits on balance outweigh costs of measure
Low	Low benefits close to or even below costs of measure
Uncertain	Potential high benefits, but significant questions as to whether the measure can deliver outcome

(*): The benefit to cost comparison is done in a relative scale, not in absolute values. Indications of "high/medium/low" reflect therefor the comparison with the other option. E.g., "high" means that the benefit to cost ration of the option is higher than for the option that has "medium".

6.1 Option 1: Mandatory standardised methodology to measure pellet losses

Table 5: Summary of impacts of Option 1

Consequences/Impacts				**Assessment and considerations**	**Benefit to cost**
Environmental	Economic	Social	Cost		
(+)	(+)	0	(+)	A mandatory standardised methodology benefits all the other options by replying to the information failure. While it can imply some (development and testing) costs for the sector (but these might be taken up by the Commission), it will still result in cost savings as only one method needs to be developed and applied, also leading to lower verification costs. The benefit to cost ratio is considered to be high because the multiple benefits outlined above outweigh the costs of developing this methodology.	**High**

Under this option, there are **no direct reductions of pellet losses, but a mandatory standardised methodology to measure such losses.** Such a methodology will enable relevant actors to tackle pellet losses, thus reducing the impacts on the environment. One methodology for all will be used, instead of several, different ones that otherwise might be developed. The common standard will simplify the reporting on the quantities released improving also the information on the magnitude and evolution of pellet losses throughout the pellet supply chain, and raising awareness among relevant actors. Setting reporting obligation is a necessary step to measure any reduction measure's success rate.

This option benefits all other options as the magnitude of pellet losses is a critical knowledge gap which requires a standardised measurement methodology. In addition, it will contribute to their effective implementation and monitoring their success rate.

No significant social impacts are expected.

This option entails **both costs and cost savings**. The cost of developing (and testing) the methodology is one-off and depends on the time required to develop the methodology. The European Standards Organisation (CEN) typically takes 3-4 years to complete the process. Either the industry could bear this cost, or the Commission could provide support through a dedicated study. The latter approach is more likely if the standard has to be taken up in legislation.

When developing the common standard, CEN could take into account the methodology that is being developed under the OCS certification scheme.

This assessment has estimated the cost of developing the common standard to be between EUR 558 087 (12 months development) and EUR 1 674 263 (36 months development). The testing at one facility costs about EUR 700-1500 per test, depending on the installation size. Assuming that about 1 000 installations test the standard during the development phase, the testing therefore costs between EUR 700 000 and EUR 1 500 000. The total costs would thus be between EUR 1 258 000 and EUR 3 174 000 (rounded figures). As the common standard would be based on developments under the OSC certifications scheme, it is estimated that the lower end of the cost estimation is more likely.

The implementation costs incurred to use the common standard, once this is developed and tested, are already considered under the REACH restriction (as part of the reporting costs) and do not need to be taken into account here as the scope of companies is basically the same as it is in the REACH restriction and its requirement to report pellet losses (the REACH restriction encompasses all uses, while the upcoming pellet proposal would be limited to uses above 5 tonnes). These costs would consist of the costs for the companies to set up specific reporting systems and for the public authority to set up verification and evaluation systems[129].

At the same time, imposing a standardised methodology to measure pellet losses has the potential to save costs on different levels:

- The plastic industry is developing a methodology, however, it is not clear how much such a method would be accepted by the whole value chain. Some parts of the value chain and Member States might also develop a methodology on their own. Under Option 1, there is only one cost for developing the methodology, and not several;
- More importantly, businesses have to apply only one methodology in the different parts of the supply chain and in different countries; and
- The verification and evaluation of the reporting by the public authority is simplified.

[129] For the Committee for Socio-economic Analysis (SEAC), established under REACH, the total costs of reporting could be substantial as the number of companies affected is likely to be large. SEAC considers that there are different options to reduce such costs, e.g. by excluding certain actors (small or micro-sized companies) from the requirement or by setting a threshold for microplastics volumes used or released to be reported. However, SEAC did not draw a firm conclusion on how these different options would compromise the value of information obtained and hence the benefits of reporting in terms of facilitating better risk management.

While it is difficult to do an exact cost-benefit assessment, the cost savings would be higher than the development costs of the standard. These cost savings are fully in line with the Communication COM(2021) 219 final on joining forces to make better laws[130].

Stakeholder views: Stakeholders generally agree on this option. In the targeted SMEs consultation conducted early 2023, a standardised methodology to measure pellet spills and losses was mentioned by 51% of respondents as a support measure that could best help them to take action to reduce pellet losses. The testing costs for one facility would be around EUR 700 per test, which means a proportionally greater cost for small compared to large companies. However, these costs are already covered under the REACH restriction.

Summary: This is the basis for setting up the framework to measure pellet losses and thus fundamental for monitoring pellet losses and their evolution in the future. This option will therefore be instrumental to achieving the objective of improving the availability of data on pellet losses. It will facilitate and improve the quality of the reporting on pellet losses required by the REACH restriction on intentionally added microplastics. Coherence with the REACH restriction will need to be assured. It will also raise awareness among relevant actors as they can measure pellet spills and losses and assess their evolution over time. While an exact cost-benefit assessment could not be made, the cost savings are expected to be higher than the development costs of the standard.The measures in this option are considered to be proportional to the objectives it aims to achieve.

[130] COM(2021) 219 final of 29 April 2021 on joining forces ro make better laws.

6.2 Option 2: Mandatory requirements to prevent and reduce pellet losses in a new EU law

Table 6: Summary of impacts of Option 2 and suboptions

	Impacts				Assessment and considerations	Benefit - cost
	Env	Eco	Soc	Cost		
2	+++	+	+	---	Mandatory requirements & certification have the highest reduction in pellet losses, and highest direct compliance costs for the sector. This option was awarded a medium benefit to cost ratio because while there are costs associated with these requirements for both authorities and industry, the benefits to the environment, human health and affected communities still outweigh these costs. However, relative to option 2b it scores a bit less good.	**Medium**
2a	+++	+	+	--	The reduction of pellet losses is still very high, but costs are lower than under 2 thanks to lighter requirements for micro-enterprises. This sub-option has a medium benefit to cost ratio because the benefits outweigh the associated costs, but a bit less good then 2b.	**Medium**
2b	+++	+	+	-	Reduction of pellet losses is still very high; costs are lower than under 2a thanks to lighter requirements for micro- & small enterprises. This sub-option has a high benefit to cost ratio because the economic operators for whom associated costs would be the most burdensome, are subject to lighter requirements, which reduces costs. The benefits are still high and therefore significantly outweigh the costs compared to the other options.	**High**
2c	++	+	+	-	The reduction of pellet losses is lower than under the other sub-options, and costs are only slightly lower than under Option 2b due to lighter requirements for micro-, small, and medium enterprises. This sub-option has a medium benefit to cost ratio because while the costs to industry have been significantly lowered, the resulting benefits have also lowered due to more companies being eligible for the lighter requirements. The lower costs for medium enterprises are less important than for micro- and small ones.	**Medium**

In this option, imposing mandatory requirements and certification for all pellet handling companies is the EU's responsibility, while the sector bears the costs of the measures to implement and of the audits, and the public authorities in the Member States are responsible, in the case of non-compliance, for imposing corrective measures and, where relevant, penalties.

As it is a mandatory approach covering the full supply chain with explicit requirements, a certification obligation and checks and enforcement activities by public authorities in the case of non-compliance, we estimate that the sector will have a high degree of compliance (95% of the total virgin pellet volume handled) and will be effectively implementing such rules with a success rate ranging from 80 to 95% (meaning that pellet losses would reduce with these percentages).

The economic impacts are primarily related to the direct compliance costs for the sector of implementing the measures. **Lighter requirements are assessed for SMEs in sub-options**. The environmental impacts are primarily related to the environmental benefits associated with the reductions in pellet losses. **A derogation for companies making and handling pellets in quantities**

lower than 5 tonnes also applies (as done in the existing French legislation[131] - this limit was decided as a consequence of a public consultation in France), which avoids requiring costly investments with very limited environmental benefits in terms of pellet loss reduction.

Environmental impacts

As this option requires that all actors of the supply chain comply with mandatory requirements and certification (with the only exception of companies making and handling pellets in quantities lower than 5 tonnes), the main expected environmental impact from this option is **a significant reduction of pellet losses** that are likely to be harmful to ecosystems and biodiversity and may affect human health.

Under this option, the reduction of pellet losses is expected to be between 27 128 tonnes/year (low emission scenario) and 148 879 tonnes/year (high emission scenario), representing respectively a 65% and 87% reduction overall, compared to the baseline. This also leads to a saving of 106 to 583 ktCO_2e, representing 11 – 58 M€/year in savings[132].

When providing for lighter requirements for the micro-enterprises, the reduction of pellet losses ranges from 26 730 tonnes/year to 147 227 tonnes/year (105 – 576 ktCO_2e). With lighter requirements for the micro- and small enterprises, the reduction of pellet losses ranges from 25 142 tonnes/year to 140 621 tonnes/year (98 – 551 ktCO_2e). Similarly, with lighter requirements for micro-, small and medium-enterprises, the reduction of pellet losses ranges from 21 569 tonnes/year to 125 757 tonnes/year (84 – 492 ktCO_2e).

Economic impacts

This option will entail **both economic benefits and costs**. These are presented below with the indication of the stakeholder group affected.

Direct compliance costs for the sector

There is limited direct information available regarding the costs to companies of taking measures to adhere with best practice handling over the value chain. Discussions with stakeholders in the course of this IA suggest that the costs of implementing Option 2 would be limited for some parts of the plastics industry, as these actors (producers and some converters and logistic companies) are already moving towards measures and a system of external auditing and certification based on OCS. At the same time, costs of this option vary significantly according to the types of companies. For example, micro and small companies (which constitute 89% of all converters in numbers, but only 20% in terms of turnover) would be significantly affected by the costs incurred by the upgrade of their facilities, the introduction of procedures including internal and external audit and the training of their personnel. There is also a significant number of transport companies handling pellets.

Stakeholder views: the NGOs active in the field have strongly supported harmonised minimum requirements for pellet handling to be established at the EU level, along with a comprehensive and transparent certification scheme requiring a secure chain of custody. The umbrella association of European manufacturers, PlasticsEurope, has agreed that the most effective approach to tackling

[131] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official “Lois et Décrets” no. 0092 du 18 avril 2021 [JORF] [Official journal “Laws and Decrees” no. 0092 of 18 April 2021], 18 April 2021, Fr.

[132] 1 tonne of CO^2 estimated value is 100 €/t.

pellet losses is mandatory external auditing and certification building on OCS and applied to all actors throughout the supply chain. Producers therefore consider a legislative proposal requiring certification of an OCS-like pellet loss prevention management system would be very quickly implementable throughout the whole supply chain because it would benefit from the existing industry initiative and would reinforce it. The umbrella association of European converters, EuPC, has pointed to limited resources as a barrier to implementing voluntary measures under the industry-driven OCS programme. The umbrella association of European recyclers, PRE, favour an EU-wide legally binding instrument to enable a level-playing field in the single market among all actors in the supply chain and across all Member States.

A second consultation targeting all SMEs handling pellets was conducted from January to February 2023 in all EU languages (Annex 12). Based on the 330 replies received, it emerges that a majority of respondents prefers a lighter version of requirements. Specifically, they reported that the requirement on the training of staff should be made mandatory in the same way for all companies, but the obligation of being externally audited and certified should not be imposed on SMEs. The survey also indicates that the direct economic impacts of this option would be too high to be sustainable for micro and small companies, as well as companies with capacities below 1000 t. Among the various best handling practices, the mandatory use of specific equipment and of specific packaging (i.e. airtight, puncture-resistant and environmentally sealed) is identified as the most expensive measure. Generally, the cost per tonne of the measures to be implemented would become insignificant for companies with capacities above 5000 t. Finally, financial support and standardised methodology to measure pellet losses are identified as the support that would best help respondents.

Costs of Option 2 are presented in Annex 11. They were calculated using industry estimates, where available, on one hand, for producers (including recyclers) and converters and, on the other hand, for logistic operators (transporters and storage/warehouse operators). As the industry has already started implementing some of the proposed measures through their voluntary commitments (i.e. OCS CS, RecyClass and SQAS), some of these costs are already incurred under the baseline.

The costs were calculated for micro, small, medium and large plastic enterprises. The upfront investment costs and costs per tonne of pellets handled are relatively more important for SMEs, especially for micro-and small enterprises than for other enterprises. It was therefore estimated that lighter requirements would be needed to alleviate a part of these costs to mitigate concerns from SMEs (e.g. lack of staff/time, lack of information on risks and solutions and lack of financial resources). This is also consistent with the replies and requests received throughout the stakeholder consultations. In light of the above, **three sub-options were assessed** in the form of:

- lighter requirements for the micro companies (sub-Option 2a);
- lighter requirements for the micro and the small companies (sub-Option 2b); and
- lighter requirements for the micro, the small and the medium companies present in the pellet supply chain (sub-Option 2c).

These lighter requirements include, for example, additional time before entry into force of the requirements and for renewal of the certificate and no costly investments (in particular into sewage treatment system). It is estimated that this lighter regime will help reduce the costs of compliance by 10% (e.g. due to less paperwork).

The costs of applying lighter requirements for micro, small and medium sized companies for typical plant capacities are presented in Annex 11. With these reduced requirements, we assume that the pellet losses will be 35% higher from converters and 20% higher from logistics providers than under the main scenario. This assumption means that the remaining requirements are still the most important ones to reduce pellet losses, but that there is already a significant increase in pellet loss.

Overall, the cost of implementing Option 2 would be 742 and that of sub-options 2a, 2b, and 2c would be 615, 516 and 479 million EUR/year respectively.

In particular for the converters, the lighter requirements reduced the cost per tonne to about half of the ones under Option 2. For medium enterprises, this difference is smaller. Option 2 represented already less than 0,5% of their turnover. An important reasons for the relatively high cost of converters compared to the producers is that it is assumed that producers would already subscribe to the OCS CS, while only a limited number of converters would do so.

The cost-effectiveness of the options ranges from 2 672 EUR/tonne avoided per year to 26 342 EUR/tonne avoided per year, depending on the sub-option and the lower/higher estimation of losses.

What would the costs be for the public authorities?

The costs will depend on its implementation in Member States, which may vary significantly. The focus is on administrative costs, including monitoring, delays, complaint-handling mechanism, and access to justice. Further costs for competent authorities can be related to the setting up and maintaining of the system, including enforcement of the regulation. However, it may be covered by existing systems through other legislation. In addition, the public authorities in the Member States could be required to hold a public register of certified companies to ensure full transparency and traceability of the supply chain and compliance with the requirements. This registry could be set up in pre-existing systems to lower the costs. There might also be minor reporting costs (188 000 € per year) for the economic operators (to notify the outcome of the certification), as reporting already exists under REACH (see option 1).

The processing and enforcement costs for the public authorities in the Member States would be EUR 313 000 for the first year and EUR 125 000 per year for the whole EU (see Annex 11). These cost will vary across Member States as they would be higher for larger ones and lower for smaller ones.

What would the benefits be for the sector?

For businesses owning the pellets, this option could prevent the estimated economic loss of EUR 42 to 170 million associated with about 42 050 to 170 266 tonnes of pellets being lost per year (1000 EUR/t)[133].

For SMEs implementing similar requirements under the international initiative of the BSI PAS, the following benefits were reported:

- modernised equipment thanks to grants they secured;
- less legacy pellet pollution, which had previously been extensive around the sites;
- reduced waste (and lower waste management costs);
- improved staff awareness and training;
- reduced fire risk because proper and regular site assessments revealed build-up of dust in areas previously unchecked;
- involvement of suppliers/customers – all site visitors are required to read and accept rules relating to proper pellet management; and
- improved reputation.

[133] Prices of plastics are fluctuating and depend on the exact polymer type and the stage of processing.

What would the benefits be for the economy at large and society?

Under this option, reducing pellet losses may have positive knock-on economic impacts on sectors such as commercial fishing, agriculture, tourism and recreation, in areas where these activities are affected by the releases with significant harm to ecosystems and biodiversity. In particular, there would be fewer pellets lost to the marine environment and, thus, fewer perturbations to all marine organisms, including economically important organisms such as oyster and seabass[134]. Considering that the ecosystem services provided by the oceans are estimated to be worth over USD 24 trillion, the regulation of microplastics to help the protection of marine ecosystems and organisms seem to be of significant importance[135]. Similarly, there would be fewer pellets lost in the installations' wastewater and in the sludge resulting from their treatment. Consequently, there will be less pellets lost to the soil after the application of sludge on agricultural land.

Benefits would also include avoided costs to society such as those related to clean up and remediation activities by local communities that are affected by the releases, that are normally challenging to these communities in terms of technological, human and financial resources.

Social impacts

This measure requires additional staff to prevent pellet losses and for training. With the same assumptions made on the share of the volume between micro, small, medium and large factories, implementing the measure would need from 3 772 to 4 103 FTE personnel.

Since this option may increase the cost of plastic raw materials, the general public may be impacted by an increase in the cost of plastic goods. Since plastic is used everywhere, any increase in its cost is felt in society. However, the cost increase is likely to be limited as the cost of the measure is small compared to the turnover of the sector. For large companies, in particular, it is possible that the manufacturer would absorb such a slight increase in its production costs and that consumers would be unaffected.

Summary: The introduction of mandatory requirements and certification would result in significant reductions of pellet losses and plug a clear regulatory gap. This option would therefore be critical to achieving the overall objective of this initiative of preventing and reducing pellet losses, while mitigating its impacts on SMEs through its sub-options. The more losses are avoided, the greater the positive impacts are for the environment and for economic activities like commercial fishing, agriculture, tourism and recreation. The costs incurred by the sector under Option 2 and its sub-options (without micro/without micro and small /without micro, small and medium companies) may increase the cost of plastic goods produced and/or converted in the EU.

This option has less risks as to the probability of reaching the objectives and massively reduces the number of free riders that exist in the voluntary approach. The system is set up in a way to limit public costs as it involves third party auditing and certification. The possibility of a public register of certified companies at national level would further increase the transparency and traceability of the supply chain, with limited processing costs for the public authorities in the Member States. The measures in this Option are therefore considered proportional to its objective.

[134] Zhu, X. et al. (2020) 'Bioaccumulation of microplastics and its in vivo interactions with trace metals in edible oysters', Marine Pollution Bulletin, 154, 111079. doi: https://doi.org/10.1016/j.marpolbul.2020.111079 83 Barboza, L.G.A et al. (2018) 'Microplastics cause neurotoxicity, oxidative damage and energy-related changes and interact with the bioaccumulation of mercury in the European seabass, Dicentrarchus labrax (Linnaeus, 1758)', Aquatic Toxicology, 195, pp. 49-57. doi: https://doi.org/10.1016/j.aquatox.2017.12.008.

[135] WWF Report 2015; Reviving the ocean economy

Although the net costs of sub-option 2c are only slightly lower than sub-option 2b, the reduction in pellet losses is also lower so sub-option 2c's effectiveness and efficiency are slightly lower than 2b's. In addition, the reductions in costs are much more significant for micro- and small companies (under option 2b) than medium companies (option 2c). Indeed, the costs to comply with requirements represent less than 0.5% of medium companies' turnover. Therefore, option 2c alleviates costs which are less significant for medium enterprises, while significantly reducing the reduction of pellets lost to the environment. In contrast, option 2b significantly alleviates the burden of the costs for micro- and small enterprises, while nevertheless achieving a relatively high reduction in pellet losses.

The comparison of different options 2 and its sub-options 2a-c needs to take into account what the ranges consist of (lower and higher figures under each option). The ranges are determined by the uncertainty around pellet loss. Therefor, when comparing these ranges, one should always keep in mind to compare either a low pellet loss scenario, a high pellet loss scenario or any intermediate one. Therefore, the lower end figure of the costs of option 2 is linked with a lower end figure of the costs of the other options 2a, 2b or 2c as these are all linked with the scenario of lower pellets losses. Higher costs within the range of a specific option should be compared with the higher costs within a range of another option, as they are linked to higher pellet reductions.

Table 7: Summary of impacts in 2030 of Option 2 and sub-options 2a, 2b and 2c

	Option 2	**Option 2a: Lighter requirements for micro-enterprises**	**Option 2b: Lighter requirements for micro-and small enterprises**	**Option 2c: Lighter requirements for micro-, small and medium-enterprises**
Environmental impacts (reduced pellet losses) (tonnes)	27 128 – 148 879	26 730 – 147 227	25 142 – 140 621	21 569 – 125 757
Environmental impact (Savings of GHG emission) (tonnes of CO^2 eq)	106 210 – 582 890	104 655 – 576 424	98 437 – 550 560	84 446 – 492 366
Reduction in trucks (number, of 25 t microplastics)	1085 – 5595	1069 – 5889	1006 – 5625	863 – 5030
Economic impacts				
Cost of the measure (MEUR/y)	742	615	516	479
Savings from the pellet losses (MEUR/y)	27 – 149	27 – 147	25 – 141	22 – 126
Net cost to businesses (MEUR/y)*	593 – 715	468 – 588	376 – 491	353 – 457
Cost-effectiveness (EUR/tonne/y)	3 982 – 26 342	3 177 – 22 005	2 672 – 19 536	2 805 – 21 186

	Option 2	Option 2a: Lighter requirements for micro-enterprises	Option 2b: Lighter requirements for micro-and small enterprises	Option 2c: Lighter requirements for micro-, small and medium-enterprises
Savings from GHG emission (MEUR/y)	11 – 58	10 – 58	10 – 55	8 – 49
Other economic impacts	**Public Administrations**: increased costs for data collection (i.e. public register) and overall monitoring of the implementation, intervention in case of non-compliance (i.e. enforcement of the sanctions) **Citizens**: limited increase of the cost of plastics goods **Tourism and recreation:** increased attractivity through the reduction of pellets in coastal areas and other vulnerable areas **Fisheries:** fewer pellets released in water and improved ecosystem services due to fewer pellets absorbed by marine organisms and animals in areas affected **Agriculture:** fewer pellets released on soils and improved ecosystem services due to fewer pellets affecting soil properties in areas affected **Society**: fewer costs related to clean up and remediation activities by local communities in affected areas			
Social impacts (jobs in FTE)	4 103	4 004	3 858	3 772

*Net cost: cost – savings. In every option there are 2 scenarios of the projection of the pellet losses. Therefore, higher pellet loss reduction refers to lower costs and vice versa.

6.3 Option 3: Improved packaging for logistics of pellets

Table 8: Summary of impacts of Option 3

Consequences/Impacts				Assessment and considerations	Benefit to cost
Env	Eco	Soc	Cost		
+	-	0	--	Improved packaging reduces pellet losses throughout the supply chain (not quantified), but generates more GHG emissions (subject to the packaging type), while entailing potentially quite high investment costs for the sector. This option's benefit to cost ratio is considered medium to low because while it could significantly reduce pellet losses, its costs could be high for industry.	**Medium** to **Low**

This option specifically targets the producers of plastic pellets and logistics operators to prevent and reduce pellet losses from transport (in case of re-packaging), intermediate storage and handling during these operations. It could also be included in the mandatory requirements under Option 2.

Current packaging materials used to transport pellets are:

- plastic bags (up to 25kg of pellets) stacked on pallets;
- octabins (cardboard containers containing between 0.5 and 1.3 tonnes of pellets);
- big bags, containing from 0.5 to 1 tonne of pellets;
- containers, containing up to 25 tonnes of pellets; and
- silo trucks, containing up to 35 tonnes of pellets.

These different packaging materials do not present the same pellet loss risks, with plastic bags holding the most risks for pellet losses and silo trucks the least. However, the plastic bags also hold several advantages over rigid HDPE barrels and intermediate bulk containers (IBC) because they allow for more flexibility in the size of shipments and prevent dust contamination. They also allow for more volume to be transported per unit of transport, thus reducing GHG emissions and transport costs. Silo trucks have airtight suction mechanisms and the loading and unloading of these trucks leave little room for pellet spills, but if they are spilled, then they are collected for disposal.

Plastic bags are the packaging material which would be targeted first because of their poor resistance to tears during operations. OSPAR[136] mentions that plastic bags and octabins could be replaced with reusable rigid HDPE barrels or with IBC (Intermediate bulk containers). Replacing existing machinery and processes might also generate extra costs. Another approach could be to propose thicker plastics bags which are more resistant to tears. The IMO Correspondence Group on Marine Plastic Litter from Ships considered packaging provisions for plastic pellets carried at sea as primary measures to take forward for further assessment.

The proposal for a packaging and packaging waste regulation[137] includes a provision that requires transport packaging to be reusable. The impact of this proposal was not examined as the focus of this option is on the increased resistance of packaging.

Environmental impacts

This option could **potentially significantly reduce pellet losses** during logistics operations (transport, intermediate storage and handling during these operations) thus bringing potentially significant environmental benefits. However, there is not data available to quantify the losses due to torn plastic bags or octabins. Also, replacing plastic bags with alternatives would increase GHG emissions. Indeed, rigid HDPE barrels and IBC do not offer the same flexibility as plastic bags. When not entirely filled up with material, they increase storage volume for a given quantity of material, increasing the GHG emissions incurred by the storage. If thicker bags would be chosen, there would only be a minor increase of GHG emissions (due to more use of plastics).

Economic impacts

What would the costs of this option be for the sector?

This option could **potentially entail quite high costs**, especially for producers, who may have to change their production lines since plastic bags are automatically filled on-site through their own manufacturing chain, and for SMEs. Similarly, logistics operators would have to adapt their transport and storage approaches depending on the type of packaging. However, due to important data gaps, it was not possible to quantify the direct compliance costs (mainly investment costs) for the sector deriving from this option.

The cost per tonne of pellet losses avoided is expected to be higher than with Option 2 because it would force the industry to overhaul their production lines to effectively remove the bagging lines and replace for instance plastic bags with reusable and resistant rigid HDPE barrels or IBC. Imposing thicker more resistant plastic bags could lower such costs. However, as all these solutions mainly represent an investment cost, smaller enterprises would be affected more than bigger ones respective to their size.

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[136] OSPAR Commission, Background document on pre-production plastic pellets, 2018, https://www.ospar.org/documents?v=39764. Accessed 12 Apr 2022.

[137] COM(2022) 677 final. Proposal Packaging and Packaging Waste (europa.eu)

Social impacts

There are no social impacts foreseen for this measure. However, moving towards more automated solutions like silo trucks could reduce the number of jobs (more workforce is needed for manual loading and unloading of pellet containers/bags).

Stakeholder views: NGOs often emphasise the importance of improving packaging to reduce pellet losses, while industry is less convinced, especially in light of the expected high costs of improved packaging. Plastics Europe, representing producers, considers that addressing packaging does not address the root cause of the problem. From the second consultation conducted early 2023 targeting all SMEs handling pellets, it emerged that while two-thirds of respondents consider the use of specific packaging effective to reduce pellet losses, only 54% do it always or often (and a third never does it or has no opinion). Views on whether this should become a mandatory requirement are mixed: 33% in favour, 20% in favour if lighter requirements for SMEs, and 27% against, while the use of specific packaging is estimated as the most costly measure both in terms of person/days and euros/tonne/year. Financial support was identified as the support that would best help respondents along with a standardised methodology to measure pellet losses.

Summary: The use of more resistant packaging materials and spill-proof packaging options would reduce pellet losses throughout the supply chain. However, the impacts differ according to the type of improved packaging chosen. While switching out plastic bags for barrels would likely present a greater reduction in losses, it would also increase the GHG emissions and costs of transport, in addition to require greater investment costs (as infrastructure will need to be replaced). Opting for thicker more resistant plastic bags would avoid these investment costs and allow for greater volumes to be transported per unit of transport. This option could be incorporated into a more comprehensive set of requirements, such as those laid out in Option 2. Therefore, while this option would help contribute to a reduction in pellet losses at certain stages of the value chain (eg. transport), it is considered to be less effective than the more comprehensive Option 2. Due to the high associated investment costs and the impact on pellet losses being limited to transport, the measures in this Option were not considered proportional to the overall objectives of this initiative.

6.4 Option 4: EU target to reduce pellet losses

Table 9: Summary of impacts of Option 4

Consequences/Impacts				**Assessment and considerations**	**Benefit to cost**
Env	Eco	Soc	Cost		
++	+	+	---	An EU emission target has potentially a high reduction of pellet losses, as operators have to adopt preventive, mitigation and clean-up measures, but the enforcement might be challenging. Its costs are comparable / slightly higher than those of Option 2 and higher than those under sub-options 2a-c. As it depends on Option 1, it can only be implemented afterwards, leading to a delay in implementation time. This option is considered to have a low benefit to cost ratio because while its costs are similar to option 2, its benefits would be delayed and will likely not be as high due to the challenges linked to its enforcement.	Low

An EU emission reduction target for pellet losses is set in this option. This option can only be achieved in the medium to long term as it first requires the establishment of a mandatory standardised methodology to measure pellet losses (Option 1) (including its testing in various sites of different sizes over a significant period of minimum 12 months). Further to that, knowledge should be gathered on quantities released, through the REACH reporting requirement, before implementing this option. Once developed, the standard would need to be applied over 12 to 36 months to generate a statistically strong database including prevention, mitigation and clean-up measures. The target could be defined as the result of this observation phase.

The target could be set either for the whole plastics industry, or at sector level. In the latter case, there could be differentiated targets depending on the place in the supply chain. These approaches are presented in Annex 11.

This measure could be implemented by including the emission threshold in legislation. It is a medium to long-term measure, as time is necessary for the data to become available and for identifying the relevant threshold. Once the threshold is defined, it could be possible to include it in legislation.

Environmental impacts

The reductions of pellet losses are expected to be in the same order of magnitude as in Option 2. However, **implementation and enforcement by Member States seem more challenging in this option than in Option 2, which might lead to less reduction of pellet losses**.

Economic impacts

The costs of this option are expected to be comparable to those in Option 2 as similar prevention, mitigation and clean-up measures would be implemented. The cost of setting the target would depend on the mandatory standardised methodology developed under Option 1.

However, other considerations seem equally important, **possibly increasing costs of this option compared to those of Option 2**. First, accurate monitoring following the standardised methodology developed under Option 1 would be needed to ensure that the target is respected (not included in Option 2 which focuses on mandatory requirements and certification). Further, each Member State must introduce the necessary transposing legislation and measures to ensure delivery, including compliance assurance, reporting by economic operators to track progress against the target and enforcement. Periodic reporting by national public authorities to the Commission would also be necessary to ensure delivery and appropriate remedial action in case of shortfall in reducing pellet losses. Similarly to Option 2, lighter requirements would be needed for SMEs, especially for micro- and small firms, as achieving the same reduction objective would be more costly for smaller than larger firms.

Social impacts

The main social impact is additional job creation mainly for the industry (for reducing pellet losses and reporting) and some for competent authorities (for enforcement) – these are relatively similar to Option 2.

Stakeholder views: This option was not discussed by stakeholders in detail. It was however mentioned that setting up a performance monitoring system would be costly.

Summary: Defining an EU emission reduction target for pellet losses, once a mandatory standardised methodology has been developed, tested and applied, can significantly reduce pellet losses as it requires preventive, mitigation and clean-up measures to be taken. Both implementation and enforcement are the tasks of the Member States, which are required to introduce transposing legislation and measures to ensure delivery. However, this option only looks at the objective, and not at the means to achieve it. It requires setting up a new system, instead of fully benefiting from the existing good practices in industry, such as under OCS. Implementing a reduction target will also take considerably more time. For these reasons, this Option is considered to be as efficient as Option

2 but less effective. It leaves it up to Member States to design their own regimes so this Option is nevertheless considered proportional to the objectives of the initiative.

7 How do the options compare?

The qualitative analysis and comparison of the different options is done in a relative scale as there is few evidence on absolute values. Also, using ranges for the estimation of the costs in options is linked to the respective pellet loss. Option 1 has the potential to benefit all options by improving information on and accuracy of pellet losses, thus ensuring the identified information failure is tackled. It also presents synergies with the REACH reporting requirement on estimates of quantities released. It is therefore considered that all options should build upon option 1 to ensure all identified problems are addressed in the preferred option. Option 2 significantly contributes to the Commission's 2030 overall microplastic releases reduction target, as proposed in the Zero Pollution Action Plan, increasing policy coherence, and its sub-options 2a-c respond to the need to limit EU action to what is necessary and proportional by building on industry commitments and by providing lighter requirements for smaller businesses. While there was not enough data to calculate the exact costs of Option 3, this option would entail quite high investment costs for the sector, and it was estimated that the cost effectiveness of this option would be lower than for Option 2. Option 4 requires a performance monitoring system first, which would take time, its implementation seems more challenging and its costs would be slightly higher than under Option 2 (because of Member State involvement) and its sub-options 2a-c. This option is not favoured in the short term.

Although the exact impact of each option cannot be assessed in detailed way, the relative scale to compare different options will show which option would be relatively the best option and therefor the preferred option. The estimation of costs is linked to the pellet volume that would be lost (in case of higher costs there would be lower pellet losses and in case of lower costs there would be higher pellet losses). The net costs per tonne avoided microplastic emission of the preferred policy option are 3-4 times lower than costs under the REACH restriction[138] on microplastics intentionally added to products. The net costs of the options can also be compared to those calculated in the Impact Assessment for single-use plastics (SUP), for the relevant Directive[139] (see section 8.2.1).

There are some data gaps and uncertainties in the comparison of different options. The principal uncertainty comes from the pellet loss rates used for production, recycling, processing and logistics phases. There are uncertainties regarding the potential success of existing and upcoming measures on the reduction of pellet loss. There are data gaps on the structure of the sector (except for converters and producers), as well as on the exact costs and benefits that should be attributed under the different options, leading to some uncertainties. Therefore, assumptions are used (more detail can be found in Annex 4). Table 10 gives an overview of how the assessed policy options compare.

[138] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

[139] SWD(2018) 254 final (EUR-Lex - 52018SC0254 - EN - EUR-Lex (europa.eu))

Table 10: Summary of impacts of all options (and sub-options)

	Impacts				**Assessment and considerations**	**Benefit - cost**[140]
Option	Env	Eco	Soc	Cost		
1	(+)	(+)	**0**	(+)	A mandatory standardised methodology benefits all other options as it targets the information failure. While it can imply costs (development and testing) for the sector (or the Commission can take this up), it will result in cost savings as only one method needs to be developed and applied, also leading to lower verification costs.	**High**
2	+++	+	+	---	Mandatory requirements and certification have the highest reduction in pellet losses, with the highest direct compliance costs for the sector.	**Medium**
2a	+++	+	+	--	The reduction of pellet losses is still very high, but costs are lower than under Option 2 thanks to lighter requirements for micro-enterprises.	**Medium**
2b	+++	+	+	-	The reduction of pellet losses is still very high, and costs are lower than under Option 2a thanks to lighter requirements for micro- and small enterprises. This has the highest cost-effectiveness of the (sub)options 2, 2a-c.	**High**
2c	++	+	+	-	The reduction of pellet losses is lower than under the other sub-options, and costs are only slightly lower than under Option 2b due to lighter requirements for micro-, small, and medium enterprises.	**Medium**
3	+	-	**0**	--	Improved packaging reduces pellet losses throughout the supply chain (not quantified) but generates more GHG emissions (subject to the packaging type), while entailing potentially quite high investment costs for the sector.	**Medium - Low**
4	++	+	+	---	An EU emission target has potentially a high reduction of pellet losses, as operators have to adopt preventive, mitigation and clean-up measures, but the implementation and enforcement might be challenging. Its costs are comparable / slightly higher than those of Option 2 and higher than those under suboptions 2a-c. As it depends on Option 1, it can only be implemented afterwards, leading to a delay in implementation time.	**Low**

Table 11 provides an overview of the relative effectiveness, efficiency, coherence and proportionality of the options assessed in this initiative.

A simple relative scoring system has been used to assess each option along the dimensions of effectiveness, efficiency, coherence and proportionality ranging from "+" to "++++" with "+" being the lowest score and "++++" the highest. Brackets "(+)" indicate a half-point. Effectiveness considers how successful each option would be in achieving or progressing towards the objectives of this initiative. Efficiency considers the resources used by each option to achieve the desired changed.

[140] The benefit to cost comparison is done in a relative scale, not in absolute values. Indications of "high/medium/low" reflect therefor the comparison with the other option.

Coherence considers how each option fits with existing or forthcoming EU legislation. Proportionality considers whether the means required by each option are suitable and necessary to achieve the desired end. These assessments are based on each option's relative costs, economic, environmental and social impacts, laid out in Section 6.

Table 11: Comparison of options according to effectiveness, efficiency, coherence and proportionality

Option	Effectiveness	Efficiency	Coherence	Proportionality
1	++	++++	+++	++++
2	+++	++	++++	++
2a	+++	+++	++++	++
2b	+++	++++	++++	+++
2c	++(+)	+++(+)	++++	+++
3	++	+	++++	++
4	++	+++	++++	+++

Explanation of the scores (relative scale, based on impacts described in Table 7 and Table 10):

- Effectiveness: No option got score "++++" as each option would need other option(s) to be most effective. Options 2 and sub-Options 2a and 2b scored "+++" as being most effective options to achieve the objectives outlined in section 4 (better information and reduce pellet loss). Sub-Option 2c has slightly lower effectiveness with less pellet loss reduced than previous options, scored "++(+). Options 1, 3 and 4 have scored "++" as having lower effectiveness than Options 2 and sub-Options 2a-2c with less clear evidence on achieving the objectives.

- Efficiency: Options 1 and sub-Option 2b scored "++++" with Option 1 requiring low costs and sub-Option 2b being the most cost-efficient. Sub-Options 2c, 2a and Option 2 have a decreasing degree of pellet loss versus costs. Option 4 scored "+++" having high costs, but also high impacts. Option 3, with high costs and limited reduction in pellet losses, scored "+".

- Coherence: All options, besides Option 1, got the highest score as being coherent with existing or forthcoming EU legislation. Option 1 got lower score "+++" due its linkages to REACH legislation where coherence is slightly less (but it can be managed).

- Proportionality: Option 1 got highest score "++++" as being the basis of achieving the objectives. Sub-Options 2b, 2c and Option 4 got scored "+++" as being proportional regarding the costs and impacts they would achieve, but lower than Option 1. Options 2 and sub-Option 2a got scored "++" considering the costs and impacts they would entail. Option 3 got scored "++" due to the high associated investment costs and the impact on pellet loss reduction being limited to transport.

8 PREFERRED OPTION

8.1 Elements of the preferred option

Following the analysis of the different policy options, a preferred option has been constructed with a view to addressing the problem identified in section 2 and achieving the specific objectives outlined in section 4, in particular contributing to the Commission's 2030 overall reduction target.

The preferred policy option is a combination of Option 1 (Mandatory standardised methodology to measure pellet losses) and sub-Option 2b (Mandatory requirements in a new EU law with lighter requirements for micro and small companies). The identified problem is about the mishandling of pellets by businesses and consequential impacts, so public intervention is warranted.

Option 1 is needed to address the specific objective "To improve information on the magnitude of pellet losses throughout the pellet supply chain, in particular the accuracy of loss estimates". This will be done through the REACH reporting requirement, which would be applied to all companies. In that context, it could also be decided to exclude companies handling less than 5 tonnes per year.

Sub-Option 2b is needed to address the specific objective "To reduce and prevent pellet losses in an economically proportionate manner to a level consistent with the Commission's overall microplastic releases reduction target of 30% by 2030" and the specific objective "To ensure the appropriate mitigation of impacts on SMEs involved in the pellet supply chain". This assessment shows that **sub-Option 2b has the highest benefit-to-cost ratio**. It also aligns with the results of the targeted SME survey where micro- and small companies expressed the main concerns about the burden of complying with mandatory requirements. It will have a strongly positive environmental impact in terms of reduced pellet losses compared to the baseline, reducing microplastic pollution, preserving ecosystems and biodiversity and decreasing potential health impacts. Indeed, it could reduce pellet releases into the environment by 60% to 83% compared to the baseline. The reduction potential is expressed using a range due to a lack of reliable and comparable data creating uncertainty around the baseline figure for pellet losses. However, the comparison of the different options is relatively more certain as it shows how options rank as a relative scale is used to compare different options (see Table 10). This sub-option should represent on average a 7%[141] reduction of the total amount of microplastic releases. It is estimated that this initiative will contribute to around 1/4th of the Commission's 30% reduction target for microplastics.

Sub-Option 2b will have positive knock-on economic impacts on sectors such as commercial fishing, wastewater management, agriculture, recreation and tourism. It will also increase transparency and significantly reduce the number of free riders. Costs for business (65 000 companies are expected to be impacted of which 7 700 are medium or large companies) are expected to be higher in the beginning as some initial investments are needed to be done. There will also be a learning curve which will reduce process costs later on. However, costs are mitigated for micro and small companies, and kept within acceptable limits for the other companies, ensuring a level playing field in the single market (reinforcing the position of companies applying reduction measures vis-à-vis companies not applying such measures). Those companies could also benefit from phased implementation, financial and non-financial support (see examples in Annex 13). In light of the impacts of microplastics (including pellets) on the environment and possibly health, it was judged that the benefits of significantly reducing microplastic releases (by 1/4th) would outweigh the additional cost for industry. In addition, the existing industry scheme OCS has been mainly taken up by larger companies who produce pellets, meaning that most of the pellets value chain does not abide

[141] Based on 2018 data.

by these best practices. It is also difficult to assess the successful implementation of OCS and therefore whether it is significantly reducing pellet losses. Option 2 addresses these issues by ensuring all actors in the supply chain are subject to these requirements (thus preventing free riders and levelling the playing field), and enforcing implementation of the requirements (thus reducing pellet losses to the environment).

There is a balance to be sought between the magnitude of cost effects, in particular on SMEs, and reducing pellet losses. It is observed that the preferred policy option reaches the appropriate balance, but should the college want to go further, additional lighter requirements (not foreseen in sub-Option 2b) are described, mainly for micro- and small companies. These additional lighter requirements would help reduce further administrative costs for micro-, small and medium companies, along with carriers transporting pellets, but are assumed to increase pellet losses. Box 4 captures all requirements for all operators, including additional lighter requirements conceived to mitigate further burden on SMEs. As carriers do not have permanent facilities, they also warrant a differentiated approach.

Box 4: Overview of all requirements for all operators, including additional lighter requirements conceived for SMEs (the latter <u>not</u> yet foreseen in sub-Option 2b)

A standard to measure pellet losses will be requested to help tackle the market and regulatory failure and facilitate companies' reporting on pellet losses, as required by the REACH restriction.

Large companies (Operators with 250 or more employees) with a capacity of over 1000t/year will be subject to the following regime:

(1) Set up, implement and keep up-to-date a risk assessment;
(2) Train their staff;
(3) Monitor and keep records of relevant implementation actions and of estimates of losses;
(4) Internal assessment to monitor compliance with the pellet handling requirements, plus some other additional requirements (i.e. formal management meetings reviewing compliance and awareness and training programme);
(5) External audit by certifiers, based on data from internal assessment, to monitor compliance; and
(6) Certification, using the results of the external audit, to certify compliance and be listed in a public register set up by public authorities in Member States.

Medium companies (operators with 50 to 249 employees) with a capacity of over 1000t/year will be subject to the following regime:

(1) Set up, implement and regularly review a risk assessment;
(2) Train their staff;
(3) Monitor and keep records of relevant implementation actions and of estimates of losses;
(4) Internal assessment to monitor compliance with the pellet handling requirements, plus some other additional requirements (i.e. formal management meetings reviewing compliance and awareness and training programme);
(5) External audit by certifiers, based on data from internal assessment, to monitor compliance; and
(6) Certification, using the results of the external audit, to certify compliance and be listed in a public register set up by Member States, with a longer transitional period before first certification (36 months instead of 24) and longer validity of the certificate (four years instead of three).

Micro- and small companies (operators with fewer than 50 employees) and companies with a capacity of less than 1000t/year will be subject to the following regime:

(1) Set up, implement and keep up-to-date a risk assessment; the risk assessment is sent to public authorities in Member States alongside the self-declaration (below) and made available to them on demand at all times;
(2) Train their staff;
(3) Monitor and keep records of relevant implementation actions and of estimates of losses;

(4) No obligation of independent, third-party certification but self-declaration of compliance, as well as a longer validity of their assessment (five years);
(5) No obligation to carry out internal assessments;
(6) No obligation to review compliance assessments at formal management meetings; and
(7) No obligation to establish an awareness and training programme and schedule.

Carriers providing transport of pellets will be subject to the following regime:

(1) Implement actions to prevent, contain and clean up losses;
(2) Train their staff;
(3) Monitor and keep records of relevant implementation actions and of estimates of losses;
(4) No obligation to carry out internal assessments;
(5) No obligation to obtain certification, or third-party environmental audit;
(6) No obligation to acquire certain equipment;
(7) No obligation to review compliance assessments at formal management meetings; and
(8) No obligation to establish an awareness and training programme and schedule;

Stakeholder feedback: In the OPC responses (Annex 2), stakeholders agree that there is improper handling of pellets. There is also awareness that the measures undertaken so far are voluntary, at the industry level, which needs more control to ensure compliance. The NGOs active in the field as well as a group of Member States have strongly supported a regulatory approach at the EU level as the only way to tackle pellet losses effectively. Converters have pointed to high costs and limited resources as a barrier to implementing mandatory requirements, especially for SMEs. Producers have considered a legislative proposal requiring certification of an OCS-like pellet loss prevention management system as quickly implementable throughout the whole supply chain because it would benefit from the existing industry initiative and would reinforce it.

This assessment showed that the preferred policy option does not go beyond what is necessary to achieve the objectives of the initiative. It aligns with what the industry had indicated would be appropriate to effectively reduce pellet losses, and includes lighter requirements for micro and small companies, who had indicated the necessity of this.

Table 12: Preferred policy option gives an overview of the preferred policy option, based on the comparison of options and the analysis of synergies and complementarities across options.

Table 12: Preferred policy option

Preferred option	**Benefit to cost**[142]
Mandatory standardised methodology (Option 1)	**High**
Mandatory requirements (sub-Option 2.b lighter requirements for micro- and small companies)	**High**

[142] The benefit to cost comparison is done in a relative scale, not in absolute values. Indications of "high/medium/low" reflect therefor the comparison with the other option.

Table 13 summarises the policy options that are not retained to their full extent (these may be still addressed partially, also due to positive spill-over effects from the preferred policy option).

Table 13: Discarded policy options

Options discarded	Benefit to cost
Mandatory requirements (Option 2)	**Medium**
Mandatory requirements (sub-Option 2.a lighter requirements for micro-companies)	**Medium**
Mandatory requirements (sub-Option 2.c lighter requirements for micro-, small and medium companies)	**Medium**
Improved packaging for pellets logistics (Option 3)	**Medium - Low**
EU target to reduce pellet losses (Option 4)	**Low**

8.2 Impacts of the preferred policy option

8.2.1 Costs and benefits

The following table sets out the different types of costs and benefits of the preferred option – more information is available on this in Annex 3.

Table 14: Overview of the preferred policy option's benefits and costs

Benefits	
Direct	The preferred option will reduce pellet losses to the environment by 2030 with 25 142 to 140 621 tonnes (saving 98 – 551ktCO_2e). This will benefit the environment and society thanks to higher environmental quality. There will be positive knock-on economic benefits including job creation.
	The measurement standard will help improve understanding around pellet loss quantities, pathways and impacts by increasing the quality and availability of data on pellet losses. This will allow industry to adapt their operations to reduce pellet losses, and enable public authorities to monitor more effectively reduction measures.
	The measurement standard will also make it easier for industry to measure their pellet losses and for authorities to collect and verify data related to pellet losses, leading to cost savings.
	The preferred option will help the level playing field in the single market across the supply chain in the EU and improve the global reputation of the EU industry around environmental protection.
Indirect	It will decrease possible risks to human health. It is a precautionary measure.
	It will increase employee safety by reducing injury risks, due to fewer pellet spills to the work floor.
	It will result in healthier soil and water due to less pellets directly lost or indirectly through the use of sewage sludge, improving ecosystem services and benefiting agriculture and fisheries.
	It will reduce the quantities of pellets in affected areas, thus benefiting tourism and recreation.
	It will prevent local populations from having to finance clean-up operations following losses.

<table>
<tr><th colspan="6">Costs</th></tr>
<tr><td colspan="2">Citizens/consumers</td><td colspan="2">Businesses</td><td colspan="2">Administrations</td></tr>
<tr><td>One-off</td><td>Recurrent</td><td>One-off</td><td>Recurrent</td><td>One-off</td><td>Recurrent</td></tr>
<tr><td rowspan="2">None</td><td rowspan="2">Possible minor increase in the price of plastic products.</td><td>Developing a measurement standard will entail adjustment costs of EUR 1.3 to 3.2 million, but compensated by recurrent savings in reporting.</td><td>Applying the new requirements will cost an additional EUR 376 – 491 million (including administrative costs). Businesses could absorb these or pass them on to consumers.</td><td>Costs if the EU directly supports the development of the measurement standard.</td><td rowspan="2">There will be minor costs for Member States associated with the processing of the certification and enforcement of the regulation EUR 125 000 per year for the whole EU).</td></tr>
<tr><td>Operators need to adapt their administrative procedures to the new requirements, entailing one off costs (EUR 0.1 million)[143].</td><td>Businesses will face administrative costs for internal assessments, external auditing and certification of about EUR 43.9 million):
- internal assessment – EUR 30.8 million
- external audit and/or certificate – EUR 12.9 million
- filling forms and tables – EUR 0.2 million (for notifying public authorities of the certification).</td><td>Costs to set up at national level a public register of certified companies (EUR 36 700[144] per year for the whole EU).</td></tr>
</table>

There is a balance to be sought between the magnitude of cost effects, in particular on SMEs, and reducing pellet losses. It is observed that the preferred policy option reaches the appropriate balance, but should the college want to got further, additional lighter requirements (not foreseen in sub-option 2b) are assessed. These additional lighter requirements would help reduce further administrative costs for micro-, small and medium companies, along with carriers transporting pellets, but are assumed to increase pellet losses. The overall measures and procedures are described in Box 4. Possible further reductions in administrative costs are quantified in Box 5 and they are different from other figures in the Impact Assessment.

Box 5: Possible further reductions in administrative costs due to additional lighter requirements conceived for SMEs (<u>not</u> yet foreseen in sub-Option 2b)

Possible **<u>additional</u>** lighter requirements for SMEs and transport providers would further reduce costs for internal assessments, external audit and/or certification and notification by EUR 24.6 million (from EUR 44 million down to EUR 19.4 million) compared to sub-option 2b. These include: • For micro- and small companies and for transport providers: a EUR 12.7 million additional reduction in costs due to carry out risk assessments only instead of the obligation to carry out risk assessments and internal assessments (foreseen in sub-option 2b[145]) and 9.2 million additional reduction in costs due to no obligation to obtain external audit and/or certification (foreseen in sub-option 2b);

[143] Total initial costs are EUR 0.5 million for businesses, which have been annualised over a 5 year period using a discount rate of 3% (0.5 hour for medium and large businesses and 0.25 hour for small and micro businesses and using EU average wages (29 €/hour)). It is estimated that the internal assessment is already covering most of the related cost.

[144] Total initial costs are EUR 313 000 million for public authorities, which have been annualised over a 10 year period using a discount rate of 3% (50 person days in average for each Member State using EU average wages (29 €/hour)).

[145] Although micro and small companies and the transport providers do not need to carry out *internal* assessment, it is still estimated that 50% of the related cost needed to carry out *risk* assessments and compile the self-declaration.

- For medium companies: EUR 1.9 million additional reduction due to a reduced frequency of certification (every 4 years instead of every year as foreseen in sub-option 2b);
- For large companies: EUR 0.8 million additional reduction due to a reduced frequency of certification (every 3 years instead of every year as foreseen in sub-option 2b).

In addition to the reduction of EUR 24.6 million described above, it can be assumed that these measures would also lead to an additional 10% reduction in personnel costs (related to pellet reduction measures) for micro- and small enterprises and for all transport providers (in addition to the 10% reduction already foreseen in sub-option 2b). This would translate to an additional cost reduction of EUR 16.9 million.

The sum of the possible additional reduction of costs of EUR 41.5 million would be around 8-11% of the total net cost as calculated for sub-option 2b. For micro and small enterprises, the additional reduction is equivalent to almost 15% of the net cost.

It is difficult to estimate the consequence of these additional lighter requirements on the reduction of pellet losses; there is no data available. It is probable that additional lighter requirements lead to an increase in pellet losses.

If assumed that pellet losses would increase with 10%, then these additional lighter requirements would lower the reduction in pellet losses by about 2 500 to 14 000 t/year compared to sub-option 2b.

The net costs of the preferred policy option can be compared to those calculated for the REACH restriction on microplastics intentionally added to products[146]. The REACH restriction would result in a cumulative emission reduction of approximately 500 000 tonnes of microplastics (central scenario) over the 20-year period following its entry into force (including an 8-year transitional period for fragrance encapsulates); the corresponding total restriction costs would be EUR 9.3 billion (between EUR 2.1 billion and EUR 20.6 billion)[147]. While the costs calculated for the preferred option 2b would be similar the ones in REACH, the preferred option 2b would reduce significantly more microplastics (83 000 tonnes per year) than under the REACH restriction (an average of 25 000 tonnes per year). Therefor the preferred policy option 2b is about 3 to 4 times more efficient than the REACH restriction.

The net costs of the preferred policy option can also be compared to the Impact Assessment for single-use plastics (SUP), for the relevant Directive[148]. It was estimated that the SUPD would save around 9 000 tonnes of SUP, for a loss of business turnover of around 3.8 billion EUR and additional costs of 2.8 billion on information, compliance and waste management. While the methodologies used in both IA are clearly different, the cost efficiency ratio on pellets is clearly higher than for the SUPD, as this analysis estimates a minimum reduction in pellet losses to the environment of 25 000 tonnes for net costs of 491 million EUR per year.

The proposal will also make a significant contribution to the EU reduction target for microplastic releases, as outlined in Box 6.

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[146] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

[147] Compiled opinion of the Committee for Risk Assessment (RAC) and of the Committee for Socio-economic Analysis (SEAC)

[148] SWD(2018) 254 final (Circabc (europa.eu))

Box 6: Contribution of the preferred option to Zero Pollution Action Plan target

This Impact Assessment concludes that the preferred option could contribute to achieving ¼ of the Zero Pollution Action Plan target for a 30% reduction in releases by 2030. This is a relatively high contribution compared to its contribution to microplastic releases (7-10%) and suggests that this course of action should be pursued.

8.2.2 SMEs

A consultation targeting specifically SMEs handling pellets was conducted from January to February 2023 in all EU languages (Annex 12). For a majority of the 330 replies received, only a lighter version of requirements could be imposed. Specifically, they reported that the requirement on the training of staff should be made mandatory for all companies, but that the obligation of being externally audited and certified should not be imposed at all on SMEs. The survey also indicated that the direct economic impacts of all the requirements would be proportionally more significant for micro and small companies, considering their limited staff compared to medium and large companies. They also appeared to be too burdensome for companies with a capacity below 1 000 tonnes per year. Among the various best handling practices, the mandatory use of specific equipment and of specific packaging (i.e. airtight, puncture-resistant and environmentally sealed) was identified as the most expensive measure. Generally, the cost per tonne of the measures to be implemented would become insignificant for companies with capacities above 5000t. Finally, financial support and a measurement standard for pellet losses were identified as the support that would best help respondents.

In order to reply to the survey and minimise burden, sub-Options were assessed, and sub-Option 2b with lighter requirements for micro- and small enterprises chosen. Medium companies are not included in the lighter regime as the costs are significantly less burdensome to them, as emerged both during the targeted survey and our cost analysis. Further mitigating measures can be envisaged, such as a delayed phasing-in of the requirements, longer validity periods for the auditing results, differences in obligations (external audit or certification) and financial and non-financial support to tackle concerns raised by SMEs (lack of staff/time, lack of information on risks and solutions and lack of financial resources, see Box 5 and Annex 12). In addition, SMEs can benefit from various EU programmes and support mechanism to help them implement this initiative (COSME, Enterprise Europe, InvestEU, Horizon), along with national support through Cohesion policy and NEXTGEN EU.

The Commission and Member States could provide some non-financial support. For example, a project could be supported by the Commission which would:

1. develop SME-specific guidance and training materials and tools to help compliance with the new legal requirements and certification;
2. deliver advisory services; and
3. establish a help desk/expert pool to assist first-level advisers and deal with more difficult questions or issues.

Such support can be open potentially to larger companies. This non-financial support would incur costs for the competent authorities and/or the Commission (with a budget of around EUR 1 million).

8.2.3 Competitiveness

According to EUPC, the turnover of the plastics sector in the EU27 in 2021 was EUR 405 billion. Therefore, the additional estimated cost of option 2b would represent about 0.13% of the EU plastics sector turnover. The additional costs are likely to have a very minor negative impact on the competitiveness of the EU pellet producers, as their competitors outside the EU will not be subject to the requirements (logistical operators importing pellets will have to comply within the EU). Annex 5 further details the preferred option's impact on the competitiveness of the sector and of SMEs.

8.3 REFIT & administrative costs

There are no administrative costs for citizens.

There are administrative costs of EUR 44 million for businesses:

- One-off costs (EUR 0.1 million[149]) of setting up systems in businesses for administrative procedures to report pellet losses;
- Reccurent costs (EUR 43.9 million) for internal assessments, external auditing and certification:
  - internal assessment – EUR 30.8 million;
  - external audit and/or certificate – EUR 12.9 million;
  - filling forms and tables – EUR 0.2 million (for notifying public authorities of the certification).

These costs are calculated for the preferred option 2b; they do not take into account the additional reductions described in Box 5.

8.4 Policy instrument

A Regulation would be best suited to delivering the mandatory requirements foreseen under the preferred option, as it will ensure pellet-handling companies will only have to comply with one set of requirements across the Union that will be directly applicable ensuring equal implementation in the Member States. The entire pellet supply chain will be subject to these requirements, and Member States will be responsible for enforcement.

9 HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

Whilst the existing data is sufficient to underpin a policy response, more monitoring is needed to further understand the dimension and impacts of the problem, inform further policy developments and track the possible success of the proposed actions. Therefore, Option 1 was proposed under the preferred options. In order to track performance against the 30% microplastic emission reduction target (by 2030), an estimate of total pellet losses is required. An initial estimate has been compiled for this IA, but further work should continually improve and expand this into the coming years. Based on the results of the monitoring in 2030, a review of this initiative will take place.

[149] Total initial cost are EUR 0.5 million for businesses, which have been annualised over a 5 year period using a discount rate of 3% (0.5 hour for medium and large businesses and 0.25 hour for small and micro businesses and using EU average wages (29 €/hour)). It is estimated that the internal assessment is already covering most of the related cost.

In the OPC, apart from business associations who somewhat agree, all other stakeholders completely agree with a system to monitor and report microplastic releases throughout the life-cycle.

The following monitoring of microplastics could be helpful:

- The proposed monitoring of microplastics at the inlet and outlet of UWWTPs, as well as in the sludge, included in the proposal for the revision of the UWWTD.
- The obligation to monitor and assess microplastics (including pellets) in coastal and marine environments, in the framework of the MSFD. Regulatory thresholds for the concentration of microlitter, including microplastics, are under preparation.
- The preparatory work for the revision of the list of polluting substances under the EQSD, the GWD and the Water Framework Directive, including the setting of a methodology to monitor microplastics in the aquatic environment as well as in the Drinking Water Directive.

In addition, standardised measurement measures could be developed for the unintentional releases of microplastics from the other five main sources. These could be pursued through Research and Innovation Programmes by relevant research projects or under the Standardisation Regulation.[150]

The information will need to be reported at Member State level and collated at EU level in order to create synergies and consistency between policies. This could also help identify new sources of microplastics that would need to be addressed by specific measures in the future

[150] Regulation (EU) No 1025/2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC.

EUROPEAN
COMMISSION

Brussels, 16.10.2023
SWD(2023) 332 final

PART 2/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Combatting microplastic pollution in the European Union

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE

on preventing plastic pellet losses to reduce microplastic pollution

{COM(2023) 645 final} - {SEC(2023) 346 final} - {SWD(2023) 330 final} -
{SWD(2023) 333 final}

TABLES OF CONTENTS

Annex 1:
Procedural information

1 LEAD DG, DECIDE PLANNING/CWP REFERENCES

The preparation of this file was led by the Directorate–General: DG Environment (ENV). It was included as the following items in the DECIDE/Agenda Planning database: PLAN/2020/8355 - ENV - Measures to reduce microplastic pollution.

2 ORGANISATION AND TIMING

The initiative is a deliverable under the European Green Deal and was further set out in the **Circular Economy Action Plan**[1] (CEAP).

The **Inception Impact Assessment Roadmap** was published in 2020.

The Call for Evidence[2] was published on 30 November 2021 with a feedback period until 18 January 2022.

The Open Public Consultation[3] was published on 22 February 2022 with a feedback period until 18 May 2022.

The Inter Service Steering Group (ISSG) for the Impact Assessment was set up by the Secretariat-General (SG). It included the following DGs and services: AGRI (Agriculture), BUDG (Budget), CLIMA (Climate Action), CNECT (Communications Networks, Content and Technology), COMM (Communication), COMP (Competition), EMPL (Employment, Social Affairs and Inclusion), ENER (Energy), ESTAT (Eurostat), FISMA (Financial Stability, Financial Services and Capital Markets Union), FPI (Foreign Policy Instruments), GROW (Internal Market, Industry, Entrepreneurship and SMEs), I.D.E.A. (Inspire, Debate, Engage and Accelerate Action), INTPA (International Partnerships), JRC (Joint Research Centre), JUST (Justice and Consumers), MARE (Maritime Affairs and Fisheries), MOVE (Mobility and Transport), OLAF (European Anti-Fraud Office), REGIO (Regional and Urban policy), RTD (Research and Innovation), SANTE (Health and Food Safety), SJ (Legal Service), TAXUD (Taxation and Customs Union) TRADE (Trade), NEAR (Neighbourhood and enlargement) as well as EEAS (European External Action Service). Meetings were organised between autumn 2021 and spring 2023.

The ISSG discussed the Inception Impact Assessment and the main milestones in the process, in particular the consultation strategy and main stakeholder consultation activities, key deliverables from the support study, and the draft Impact Assessment report before the submission to the Regulatory Scrutiny Board.

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[1] European Commission, Commission communication - A new Circular Economy Action Plan For a cleaner and more competitive Europe; COM(2020)98 final, 2020.

[2] European Commission, Commission call for evidence - Microplastics pollution: measures to reduce its impact on the environment, 2022 (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12823-Microplastics-pollution-measures-to-reduce-its-impact-on-the-environment/feedback_en?p_id=27539989).

[3] European Commission, Commission public consultation - Microplastics pollution: measures to reduce its impact on the environment, 2022 (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12823-Microplastics-pollution-measures-to-reduce-its-impact-on-the-environment/public-consultation_en).

3 CONSULTATION OF THE REGULATORY SCRUTINY BOARD

In January 2022, the authors consulted the Regulatory Scrutiny Board (RSB) about the Impact Assessment (IA) during an upstream support meeting.

The RSB received the draft version of the IA report on 17 October 2022. Following the meeting with the RSB on 16 November 2022, the RSB gave a negative opinion on 18 November 2022. The opinion included recommendations that were addressed in the revised IA report as outlined in the table below. The major recommendation of the RSB was to restructure the scope of the IA around pellets, where it had previously equally considered the other identified sources of unintentional microplastic releases (paints, tyres, textiles, geotextiles and detergent capsules). Contextual information and preliminary analyses of these sources can now be found in Annex 15 of this IA.

The revisions to this IA were also the subject of an additional Inter Service Steering Group meeting on 05.05.2023.

Table 1: RSB recommendations and how they were addressed

RSB Comment	*How the comment has been addressed*
Main Points in the RSB's first opinion	
The report does not set out the **exact scope of the initiative**. It is not clear upfront on the issues that will be dealt with in parallel and future initiatives. It does not sufficiently explain the coherence with other legislation.	The report's structure has been completely revised to streamline the scope of the analysis and make clear from the beginning that pellets are the focus of the impact assessment. The introductory text makes this clear, and also indicates the reasons for targeting pellets: sufficient information and best handling practices are available and existing EU legislation does not specifically address pellets as a form of pollution along the entire supply chain. It mentions the other sources that had also been initially investigated, and explains why those sources are no longer dealt with in the main body of this IA. The other pieces of legislation and related initiatives are covered in section 2.3.2, as well as Annex 6, 8 and 9.
The **objectives** of the initiative are not specific enough and do not clearly relate to the **problems**. The report is not clear on how much this initiative is expected to contribute to the 30% reduction target.	Due to the change in scope, the problems have been revised and made specific focussing on pellets. The objectives have also been further specified. The intervention logic graph in section 4.3 provides a clear overview of this initiative's objectives and the problem it aims to tackle i.e. poor handling of pellets. Pellet losses account for 7-10% of total microplastic releases to the EU environment (intentional and unintentional), being the third largest source of releases as calculated by this IA. The preferred option (i.e. Option 2.b) would lead to an estimated reduction potential of 25 142 – 140 621 tonnes of pellet losses.

	Therefore, it would lead to an estimated 60-83% reduction in total pellet microplastic releases, which averages at around 7% in total microplastic releases. This option is therefore expected to contribute roughly to 1/4th of the 30% overall reduction target set out in the Zero Pollution Action Plan.
The presentation of **measures and options** is not sufficiently clear or focused on the precise problems to be tackled by this initiative. The impact analysis is not sufficiently clear and the level of uncertainty is not defined.	Due to the revised structure, the measures analysed have been reduced and are now specific to the problem of poor handling of pellets and subsequent harmful losses. Section 5.2. describes the identified four policy options and then sections 6 & 7 assess their impacts including on the different stakeholder groups, and how they compare. The levels of uncertainty (mainly related to measuring pellet losses and to the reduction potential of ongoing pellet initiatives) are clearly expressed and taken into account in section 5.1 where the baseline is explained.
The presentation of **stakeholder views** is too general and does not allow to understand their different views.	Annex 2 on the consultation of stakeholders has been completed to better present stakeholder views and provide more insight into how this initiative is perceived. To further deepen our understanding of SMEs' opinions, an additional survey targeting only SMEs was carried out between January and March 2023. The results of this survey are captured in Annex 12 and where relevant throughout the report, notably under each option assessed.
Points on what to improve from the first opinion	
The report should clearly frame **the scope of the initiative in its wider context**, better describing its boundaries and limits. It should clearly describe why it focuses on unintended emissions at source level and discuss why, for example, the degradation of macroplastics is not considered as in scope. It should clearly describe and analyse the **problems** posed by microplastics released in the environment. It should present the risks to human health and the environment, including climate impact. This analysis should be supported by solid evidence. Where such evidence is lacking or is uncertain, the report should indicate this clearly and discuss the robustness of the available evidence.	Section 1 has been revised to clearly explain the political and legal context where unintentional microplastic releases at source had been identified as a priority. Once in the environment, such releases are almost impossible to capture and their mobility across all environments is an aggravating factor. Therefore end-of-pipe measures are all but effective. The IA explains that a legislative framework is already in place to reduce the presence of macroplastics in the environment, which is the most effective way of tackling the degradation of macroplastics as a source of microplastics. It also covers the upcoming REACH restriction proposal targeting intentionally added microplastics. This first section also clearly states that the scope of this initiative is now reduced to pellet losses at source level. Section 2.2.1 outlines the adverse impacts of pellet losses on the environment, the climate, human health and the economy. Further information on these

	impacts are provided in Annex 7. Specifically, the report, clearly states that there is no scientific consensus with regards to the health impacts of pellets (and microplastics more generally), while explaining why the application of the precautionary principle is warranted (due to the observation of microplastics throughout the human body and food chain).
The report should better describe the **existing and on-going relevant initiatives** to enable a better understanding of the problems and their scale posed by different sources of microplastics. The dynamic baseline should include other EU initiatives, measures already taken by Member States, industry-led initiatives, and best practices around circularity. It should set out the overlap and complementarity with existing initiatives in reaching the 30% reduction target and clearly present the specific contribution of this initiative to meeting the target.	The revised IA now only focuses on pellet losses where there is a market and regulatory gap, demonstrated in section 2.3.2. The baseline has been revised to ensure that all existing initiatives that might contribute to reduce pellet losses (i.e. the French legislation, the industry-led OCS certification scheme and the SQAS assessment scheme) are taken into account according to their estimated reduction potential – this is clearly explained in section 5.1 and then further detailed in Annex 9. The limited contribution of the upcoming REACH restriction proposal as to pellet losses (i.e. improving data but not effectively reducing pellet losses) is also explained in that Annex. As laid out in section 4.2, the contribution to the 30% overall reduction target set out in the Zero Pollution Action Plan is now one of the specific objectives of this IA, and of the accompanying legislative proposal. The preferred option, which builds on industry-led efforts, is expected to contribute to 1/4th of the 30% overall reduction target set out in the Zero Pollution Action Plan. The REACH restriction is expected to contribute to a 500 000 tonnes reduction in microplastic releases over 20 year. Initiatives on tyres would possibly contribute to a 10% reduction (with a considerable range, depending on the final measures decided). This leaves a gap (probably around 10%) to reaching the 30% overall reduction target, which will eventually be dealt with via future initiatives. This initiative should also act as a market signal making products which release microplastics less popular, thus market transformation through demand-side.
The report should clarify upfront that **only one specific sectorial issue** together with a limited horizontal one will be tackled in this initiative and the issues related to microplastics releases from other sources are left to future or parallel initiatives, subject to further analysis. The specific objectives are not precise enough to link them	The scope of the current IA has been completely revised, so only the specific issue of pellet losses is being dealt with. The preliminary analysis for the other sources can now be found in Annex 15. As a result of this change in scope, the objectives are now much more specific to the problem identified with the

accurately to the revised set of specific problems. They should be expressed in more SMART terms.	poor handling of pellet losses. The main pellet objective is formulated in SMART terms.
Following a comprehensive problem definition and a clear and redefined scope of this initiative, the report should present those **measures that remain useful** for tackling the specific problems to be addressed by the initiative, discarding all measures clearly outside the scope upfront. It should then present a clear and consistent intervention logic showing how alternative set of measures could deliver on the refined set of specific objectives.	Section 2 lays out the problem definition for the specific problem of pellet losses, following the revised scope of the IA. Section 4 defines the general and specific objectives of the IA. Section 5 then presents in detail the measures and policy options identified as relevant to tackle pellet losses, and includes a graph of the intervention logic. The measures relating to the other sources have all been moved to Annex 15.
The report should revise the impact analysis so that it follows the redefined scope of the initiative. It should analyse the **impacts of the remaining measures** in sufficient depth and be clear about the stakeholder groups affected. It should ensure analytical consistency throughout. It should present the methodologies used for assessing the measures, comparing them and constructing the preferred option. The level of certainty in the analysis and conclusions should be clear.	The identified four policy options of relevance to the issue of pellet losses are outlined in Section 5, and their impacts on the environment, economy and society, as well as administrative burden for public authorities are assessed in Section 6. Insights into stakeholder opinions are also provided for each option. The various policy options are then directly compared in a summary table in Section 7. The methodology used to construct the preferred option is described in Annex 4, which explains the various assumptions that have been made notably to calculate chronic pellet losses and the estimated reduction potential of ongoing pellet initiatives. The resulting preferred option is outlined in Section 8.1. The measures proposed in this option are the ones that, in the short term and with a view of contributing to 30% overall reduction target, are possible to implement at the light of the present state of knowledge and in an economically cost-effective way.
The **views of the different stakeholders** should be discussed throughout the report from the scope of the initiative, the problem definition to the proposed options and their impacts. Dissenting views need to be presented and discussed in the main report.	Stakeholder views have been mainstreamed throughout the revised version of the IA. Section 2.1 outlines stakeholders' unanimous support for the need for action against microplastics. Section 6 assesses the impact of each policy option and includes stakeholders' opinions (where known). Annex 2 has been revised so further information is available about the results of the stakeholder consultation. An additional survey was undertaken during January-March 2023 to specifically target SMEs handling pellets and collect their views on possible actions to reduce pellet losses. The results of this survey are used throughout the IA and summarised in detail in Annex 12 (including dissenting views). Sub-options 2.a, 2.b and 2.c were conceived and assessed specifically to take account of these results.

The revised version of the IA report was submitted to the RSB on 17.05.2023. The RSB consequently gave a positive opinion with reservations on 12.06.2023. The opinion included recommendations, outlined in the table below.

<table>
<tr><th>RSB Comment</th><th>How the comment has been addressed</th></tr>
<tr><td colspan="2">(B1) The report does not sufficiently justify why only measures for pellets are proposed at this stage and not for other sources, given that the precautionary principle is invoked.</td></tr>
<tr><td>(C1) The report should reinforce the narrative as to why this impact assessment focusses solely on pellets given that it states that the need to act is justified by the precautionary principle.</td><td>The text and structure in section 1 (pp. 10-12) was changed to clarify why pellets are the sole focus of this initiative and highlight several factors that justify the application of the precautionary principle and allow for immediate action:
• Contrary to other sources of microplastics unintentionally released, for which an EU legal framework exists or is being negotiated with the European Parliament and the Council, there is no existing or forthcoming EU legislation specifically preventing and reducing pellet losses as a form of pollution occurring along the entire supply chain in the EU. The proposal would remedy a loophole in the current EU legislative framework;
• Sufficient evidence is available documenting the problem and the impacts, justifying intervention and allowing the design of specific policy measures, while this is not yet the case for most other sources of unintentionally released microplastics;
• Contrary to other sources of microplastics unintentionally released, pellet losses are due to poor handling and therefore largely preventable today in a cost-effective manner. No changes to product or consumer behaviour are required to prevent and reduce pellet losses. They are the third source of releases and account for 7-10% of microplastics unintentionally released in the EU.
• Techniques to prevent pellet losses are already available to economic operators at an acceptable cost; and
• Preventing and reducing pellet losses now does not impede any future action on other sources later, as there is no interference between the different sources of microplastics.</td></tr>
<tr><td>The report should clarify what additional information would be needed to trigger action for the other sources of unintentional microplastic pollution to improve the analysis.</td><td>The changes brought to this section of the report provide further clarity on why the other sources were not pursued in the context of this impact assessment. In particular, the changes point to (1) the importance of the data gaps preventing effective policy action on paints, textiles, detergent capsules and geotextiles at this moment in time; and (2) the existing EU legislative framework or to legislative proposals currently being negotiated by the co-legislators which would allow specific measures to be taken on all other identified sources. In particular:
• the Construction Product Regulation and its proposed revision for paints and geotextiles;
• the Euro 7 proposal for a Regulation to tackle microplastic releases from tyres by defining abrasion limits for the placing on the market and the existing Tyre Labelling Regulation for the labelling of tyres;</td></tr>
</table>

	• the current Ecodesign Directive and the proposal for an Ecodesign for Sustainable product regulation to address microplastics from textiles, and possibly paints; • delegated acts under the future revision of the Detergents Regulation to tackle releases from detergent capsules if new scientific evidence points to the need). This is reflected in the updated conclusions of the preliminary analysis undertaken for the other sources, which can be found in Box 1 & Annex 15.
(C2) The report should discuss the contribution of action on pellets to solving the entire problem of microplastics released in the environment, including from the degradation of macroplastics and define the relative scale of the microplastics from pellets problem. It should discuss if taking measures on pellets first would be most effective and efficient to reach the target of 30% reduction of microplastics from the Action Plan or if measures on other sources would be more urgent and contribute more to this target.	Box 6 (Contribution of the preferred option to the Zero Pollution Action Plan target) has been added to section 8.2 (pp. 60) specifically addressing the contribution of the 'pellets' proposal towards the Zero Pollution Action Plan target. Pellet losses currently account for 7-10% of the microplastics released into the EU environment. It is estimated that the preferred option would result in a 60-83% decrease in these releases. Therefore, it could contribute to achieving a quarter of the target. This is a high contribution relative to its share of microplastic releases (up to a tenth), demonstrating why it is an effective course of action. In addition, this reduction does not require any costly product design changes, but rather the consistent application of existing pellet handling best practices at all stages of the supply chain and by all actors (not just a few as it is now). The preferred option would help bridge a regulatory and market gap to achieve this across the supply chain. There is potential to reduce microplastic releases from sources other than pellets but for the reasons presented in the report, it is not appropriate to pursue them in this initiative. However, based on the data available, a preliminary investigation shows a high cost-effectiveness of measures to reduce pellet losses compared to measures for the other sources (see the abatement curves in Figures 83 and 84). Measures on pellets are clearly 'no regret' measures therefore. The contribution of tyres would further need to be estimated within the context of the EURO 7 Regulation proposal. Regarding paints, textiles, detergent capsules and geotextiles, further data is first needed to allow for effective measures, where necessary, to be drawn up. Only then, their contribution to the target can be fully estimated, which can be done in the context of relevant, upcoming impact assessments. In contrast, enough evidence was available to justify action on pellets and estimate its contribution to the target.
Moreover, it should clarify if this 30% target refers to microplastics in general (including degradation of macroplastics) or if it is for intentionally and unintentionally added microplastics, i.e. excluding degradation from macroplastics.	The introduction of the report has been reworked (pp.9) to clarify that degradation of macroplastics is not addressed as a source in this impact assessment. The 30% reduction target does not apply to microplastics generated by the degradation of macroplastics improperly disposed of into the environment. This is because it is not possible to estimate the volume of microplastics from this source and the most effective policy action is reducing the presence of macroplastics in the environment. The Zero Pollution Action Plan therefore includes a 50% reduction target on marine litter which will help contribute to tackling this source.
(C3) The report should further discuss the magnitude of the environmental impact of	Further evidence has been added to the report to further explore the adverse impacts of microplastics in the environment, on climate and on human health both in the section 2.3 (pp. 21-24) and Annex 7. The introductory text (pp. 21) has also been reworked to highlight the uncertainties surrounding the health

pellets and the reliability of the estimates, including reference to scientific studies to support anecdotal evidence. It should identify the potential harmful climate and human health impacts from pellets specifically and be clear about the strength of scientific evidence in this area, justifying the invocation of the precautionary principle.	impacts of microplastics, which do not preclude the application of the precautionary principle. Further explanations have also been provided (pp. 21) to justify the use of studies that are more general to microplastics to explain the harm of pellets. Indeed, there is a lack of data specific to the adverse impacts of pellets (apart to a certain extent for those related to the ingestion of pellets by a range of marine and costal species like sea turtles, seabirds and shellfish),but as they are a subset of microplastics, it is assumed that most of their impacts are comparable to those of microplastics more generally. In this context, it should be underlined that approximately 80 % of all plastic raw materials produced are approximately 2 mm to 5 mm in diameter, therefore well within the usual size of microplastics (up to 5mm). Of the remaining 20%, a significant portion is even smaller than 2 mm, such as powders, and a minor part can be slightly bigger. In particular, the portion with the smallest size can have an impact on health.
(B2) The design of the options does not bring out clearly all available policy choices.	
(C4) The design of options should bring out clearly the available policy choices. On the one hand, the report should identify and clarify which actors in the supply chain are responsible for most losses.	The estimated losses for the different actors in the value chain have been added to section 2.2 (pp. 20). This IA found that logistics contribute to the most losses (27 870 – 111 480 tonnes, followed by converters (15 600 – 46 800 tonnes), producers (7222 – 21 665 tonnes) and recyclers (1448 – 4345 tonnes). This results in between 52 140 tonnes and 184 290 tonnes of pellets lost to the environment in the EU in 2019, equivalent to 0.08% to 0.28% of total pellet volumes in the EU. A detailed table is added to Annex 8.
It should be more specific on the measures proposed, in particular, on the operational controls, the equipment and the lighter regimes for SMEs, and consider if more targeted alternative options would be feasible regarding some of these measures.	Box 4 (Overview of the measures and procedures included in the preferred option) has been added to the report to provide a clear overview of the measures included in the preferred option (pp. 56-57). It differentiates between micro-, small, medium and large enterprises to clarify the lighter requirements designed for small and micro- companies, in light of the concerns these firms have raised during the consultation targeting SMEs handling plastic pellets (producers, converters, recyclers and transporters/logistics - cf Annex 12). It was determined that the burden would also be too significant for enterprises with capacities below 1 000 t (the average volume handled by small companies). The consultation also indicated that medium enterprises did not require lighter requirements. The design of options was based on best practices already applied in industry, by both large companies and SMEs, in particular for Option 2 where these best practices become mandatory requirements. In line with their current application by the industry (e.g. under Operation Clean Sweep), these requirements were considered a package (regrouping essential actions under prevention, containment and clean-up) and the option of assessing each individual requirement was not considered. The wide variety of actors in the supply chain would make it very complicated to determine which actors could be relieved of certain requirements, what the cost implications would be, and what impact each of these requirements would have on pellet loss reduction. Nevertheless, the possibility of lightening these requirements for smaller firms was assessed due to results of the SME survey. This was done in the form of

	sub-options under Option 2. Further reflections have since led to possible additional lighter requirements, which are explained in box 5 (but which are not part of the preferred option).
It should explain how these measures go beyond existing environmental management systems.	Existing environmental management systems do not explicitly cover pellet losses. Industry's existing voluntary scheme on pellets, Operation Clean Sweep (OCS), is of direct relevance to pellet losses. The measures in Option 2 do not go beyond OCS's best practices. However, OCS has been mainly taken up by larger companies who produce pellets, meaning most of the pellets value chain does not abide by these best practices. In addition, it is difficult to assess the successful implementation of OCS and therefore whether it is significantly reducing pellet losses, although some evidence shows that at certain OCS signatories' sites, pellet losses continue. Option 2 addresses these issues by ensuring all actors in the supply chain are subject to these requirements (thus preventing free riders and levelling the playing field) and enforcing implementation of the requirements (thus reducing pellet losses to the environment).
On the other hand, if combinations of options are considered necessary to tackle all identified problems (such as Option 1 and 2b and potentially different requirements within option 2b) these should be identified up-front and subsequently compared to the other options.	The description of Option 1 (pp. 36) has been updated to clarify that this Option would be beneficial to the success of all of the other options and should feature in the Preferred Option. This has also been clarified in Section 7 where the different options are compared. Indeed, Option 1 should be pursued because it addresses the information failure problem driver. Therefore, its combination with other Options will allow for a more comprehensive response to the identified problems. In addition, Option 1 is complementary to the other Options as it would allow for their effective implementation. A standard methodology is essential to monitor the implementation of Option 2 and the evolution of pellet losses. It would facilitate the comparison of different packaging solutions for pellets, under Option 3. It would also be a necessary condition to set up an EU target under Option 4. Additional wording has also been added to the description of Option 2 (pp. 37) to clarify that lighter requirements were only considered for SMEs (sub-options 2a, 2b and 2c) because large operators did not raise any concerns about the economic burden of complying with mandatory requirements. Indeed, large operators had indicated (see stakeholder consultation, the reaction of PlasticsEurope) that implementation of such requirements would be relatively straight forward and quick as long as they built on existing industry best practices (e.g. Operation Clean Sweep).
(B3) The impact analysis is not sufficiently developed. The comparison of options is not based on an assessment of their effectiveness, efficiency, coherence and proportionality.	
(C5) The report should further clarify and develop the impact analysis. It should quantify the costs to businesses related to the implementation (testing and reporting) of the mandatory standardised methodology to measure pellet losses or better explain why it is	The cost of reporting pellet losses is already accounted for in the REACH restriction on pellets; this proposal brings no additional reporting costs. Further costs related to the definition of a mandatory standardised methodology by mandating CEN to work on a harmonised standard would be paid by the European Commission. These costs are described under Option 1 in the range of 1.3 to 3.2 EUR million in the sections 6.1 (pp. 42) and 8.2.1 (pp. 59), in Annex 3 and Annex 11. Again, the implementation costs incurred to use the common standard, once this is developed and tested, are already considered under the upcoming REACH restriction (as part of the reporting costs) and do not need to be taken into account here as the scope of companies is basically the same (the REACH restriction encompasses all uses, while the upcoming pellet proposal would be

considered that those costs are accounted for under the upcoming REACH proposal given the likely broader scope of businesses covered by this initiative.	limited to uses above 5 tonnes). These costs would consist of the costs for the companies to set up specific reporting systems and for the public authority to set up verification and evaluation systems.
It should also quantify the costs to businesses of the notification of the outcomes of the certification to demonstrate compliance with the defined mandatory requirements to prevent and reduce pellet losses or better explain why those costs are considered "minimal".	There might also be minor reporting costs that were added to the section 6.2 (pp. 47) and in annex 11 (188 000 € per year) for the economic operators (to notify the outcome of the certification), as reporting already exists under REACH.
The report should make an effort to further quantify and monetise the expected benefits. It should monetise the estimated reduction in CO2 emission.	Due to their nature, it is very difficult to monetise the expected benefits: on the environment through improved ecosystems and biodiversity; on the economy through improved eco-systems services; on the sector itself via for instance modernised equipment or reduced waste; on society via reduced costs for monitoring or clean up. There is no data available that would allow further quantification or monetisation of the expected benefits. However, the estimated reduction in CO2 emissions has been monetised and added in the section 6.2 (pp. 45), table 7 (pp. 49) and in Annex 11. Under Option 2 and its sub-options 2a-2c, the reduction of pellet losses is expected to lead to an emission reduction of 84 to 583 ktCO2e, leading to savings of 8 – 58 M EUR/year.
It should also explore whether it is possible to monetise the expected reduction in the spill clean-up costs and improvements in work safety.	There is no data available on the costs of spill clean-ups. Pellet spills refer to situations where pellets escape their primary containment. These spills do not necessarily result in losses to the environment if they are contained inside the operating boundaries. However, the costs of cleaning up spills are considered to be minor, especially when compared to the costs of cleaning up losses (i.e. when the pellets are no longer contained and released into the environment) where efficiency will be much lower. Only limited anecdotal evidence is available on the costs of pellet loss clean-ups making it impossible to extrapolate an EU-wide estimation.
It should provide clear overview tables of costs and benefits. The report should better explain the qualitative scoring of the environmental, economic and social impacts. As most of the impacts are not monetised, it should justify the conclusions on	The summary tables, highlighting the impacts of each policy option in section 6, have been reworked to clarify the benefit to cost assessments for each option. These assessments are not absolute but relative to the other options to allow for more effective comparison of the different options. Table 4 presents the coding used to classify the impacts, and the benefit to cost ratios.

"Low", "Medium" and "High" Benefit Cost Ratios for each option.	
(C6) Once the impact analysis is improved, the report should compare all relevant (combinations of) options in terms of effectiveness, efficiency, coherence and proportionality and present this comparison in a clear comparison table.	The report now includes a new table 11 comparing each option's effectiveness, efficiency, coherence and proportionality (section 7, pp. 55). Text has also been added to the "summary" of the assessment of the individual options' impacts to clarify their effectiveness, efficiency, coherence and proportionality. A simple scoring system has been used to assess each option along the dimensions of effectiveness, efficiency, coherence and proportionality. These assessments are based on each option's relative costs, economic, environmental and social impacts, laid out in Section 6.
It should better justify the selection of the preferred option given the high uncertainties around the scale of the problem and their impacts. These uncertainties should be clearly set out throughout and included when addressing and qualifying the costs and benefits of the measures.	Relevant text has been added to section 6 (pp. 40) and section 8.1 (pp. 50). The report emphasises that the data on pellet losses is the most uncertain, and that there is a degree of uncertainty regarding the efficiency of the measures. This is due to a lack of reliable and comparable data on pellet losses at source. A degree of uncertainty remains around the impact of the policy options on pellet losses as the baseline pellet loss data is based on incomplete data, as highlighted and addressed by the use of ranges to present pellet losses. The preferred option includes a standardised measurement methodology to tackle this information failure and ensure better data is available. The quantification of the costs and comparison of different options has a higher degree of certainty as it is based on data provided by industry which are relatively well informed due to the existing implementation of the OCS-scheme. Therefore, the comparison of the different options is relatively certainty as it shows, how options rank.
When selecting the preferred option, the report should better justify its proportionality.	Relevant text has been added to section 8.1 (pp. 57). The report concludes that this preferred option is a case of formalising best practices in industry which will have an important positive impact on the issue of microplastic releases. Box 4 (overview of the measures and procedures included in the preferred option) has also been added to this section to further clarify the contents of the option, including the different regimes for different sized operators, thus emphasising the efforts put into ensuring the preferred option is proportional. Small and micro companies will benefit from lighter requirements to reduce the costs of the requirements, and further schemes to support these SMEs will be set up. Overall, the costs are low compared to the turnover of the supply chain (estimated cost of option 2b would represent about 0.13% of the EU plastics sector turnover), while still representing a clear cost to the smaller firms. However, the benefits to the environment, to human health and to affected economies and communities are undeniable. It will also be an important contributor to the achievement of the Zero Pollution Action plan target for a 30% reduction in microplastic releases.
It should explain how it was concluded that the benefits significantly outweigh the costs given that the monetised costs	Additional text has been added to section 8.1 (pp. 56) to clarify how the preferred option was constructed. It sets out that the preferred option was selected in light of the impacts of microplastics, including pellets, on the environment and possibly health, and that the benefits of significantly reducing microplastic releases (1/4th) would outweigh the additional costs for industry.

<table>
<tr><td>are much higher than the monetised benefits.</td><td></td></tr>
<tr><td colspan="2">(B4) The analysis of the impacts on SMEs and EU sector competitiveness is inadequate.</td></tr>
<tr><td>(C7) The concerns of SMEs, even for the lighter regimes, should be highlighted throughout the report.</td><td>Relevant text has been added to the sections 6 (pp. 48) and 8 (pp. 60), along with Annexes 3 and 11, to highlight the concerns raised by SMEs which were collected during the targeted SME survey. These concerns included a lack of staff/time, a lack of information on risks and solutions and a lack of financial resources, making certain mandatory requirements too burdensome. The upfront investment costs and costs per tonne of pellets handled are more significant for SMEs, especially for micro-and small enterprises, relative to other enterprises. References to these concerns are made throughout the report and most notably in the sections outlining the impact of each option on SMEs. In light of these, lighter requirements for micro- and small companies were deemed essential to mitigating the impacts on these smaller players present throughout the value chain. These lighter requirements also complement existing EU programmes and support mechanisms which will help SMEs implement these requirements (COSME, Enterprise Europe, InvestEU, Horizon). National support could also be provided through Cohesion policy and NEXTGEN EU.</td></tr>
<tr><td>The report should explain why not all SMEs would be included in the lighter regime, in particular in light of the response of SME stakeholders to the specific consultation.</td><td>Relevant text has been added to the section 8.2.2 to clarify why medium companies have not been included in the lighter regime. The targeted SME survey showed that it was micro & small companies who expressed the main concerns about the burden of complying with any mandatory requirements (see Annex 12). In addition, the cost analysis carried out in the context of this impact assessment confirmed that the costs were much less burdensome for medium companies. The preferred option therefore only has lighter requirements for micro & small companies, as well as larger companies who handle less than 1000 tonnes of pellets every year. This threshold was selected because it corresponds to the average volume handled by small companies.</td></tr>
<tr><td>The report should analyse the impact of the preferred option on international competitiveness of the sector as well as SME competitiveness.</td><td>A new annex assessing the impact of the preferred option on international and SME competitiveness (Annex 5) has been added to the report to specifically address concerns about competitiveness. It emphasises that:
• The costs of the preferred option would represent about 0.13% of the EU plastics sector turnover (2021 was EUR 405 billion) and are considered to be limited.
• The additional costs are likely to have a very minor negative impact on the international competitiveness of the EU pellet producers, as their competitors outside the EU will not be subject to the requirements (although logistical operators importing pellets will have to comply within the EU).
• There will be some cost savings as a result of reduced losses to the environment (as pellets are a raw material).
• EU companies will have a first mover advantage if/when other countries adopt similar requirements, e.g. through an international agreement such as the Global Plastic Treaty.
• The proposal will make a positive impact on the capacity to innovate as different actors of the value chain will develop solutions to minimise pellet spills in order to optimise their costs for controlling pellet losses.
• The proposal includes lighter requirements for micro and small companies and for all companies with pellet capacities below 1000t and a longer</td></tr>
</table>

	implementation period for medium companies to mitigate any potential impacts on their competitiveness, as well as support actions for SMEs.
For the development of the measuring methodology, full coherence with REACH requirements should be further discussed.	Relevant text has been added to the section 5.2.1 to explicitly state that the methodology will need to be fully in line with REACH requirements. In addition, the report now clarifies that the scope of the companies covered by the REACH reporting requirements for pellet losses is similar to this proposal with the exception that this proposal only applies to uses above 5 tonnes.
Other	
(C8) The report should quantify the administrative costs and differentiate those that are in scope of the 'One In, One Out' approach.	The administrative costs for public authorities and businesses have been further detailed in section 8.2.1 and Annex 3, where they are classified into recurrent and one-off costs. This allows for a clearer identification of administrative costs associated with the Commission's one-in-one-out policy. Relevant text has also been added to section 6.2 and in Annex 11. The administrative costs for businesses are associated with internal assessments, external auditing and certification. There will also be minor costs for notifying the public authority of the certification. For micro- and small companies (and companies with a capacity of less than 1000t/year) will be subject to lighter requirements that are described in the new box 4. Costs for internal assessment, external audit and/or certification and notification are expected to be EUR 44 million: internal assessment for businesses – EUR 30.8 million; carrying out external audit and/or application for certificate – EUR 12.9 million; notification (i.e. filling forms and tables) – EUR 0.2 million; setting up systems in businesses for administrative procedures to report pellet losses – EUR 0.1 million (for annualised total net present value over the five year period). For public authorities, administrative costs, the processing costs are estimated, including data collection, verification, correction, and enforcement to be EUR 313 000 (total annualised one-off administrative costs of EUR 36 700, discounted at 3% over 10 years) for the first year and EUR 125 000 per year for the whole EU. These costs will vary across Member States as it would be higher for larger ones and lower for smaller ones.
(C9) As the report is now focused on pellets, this approach should be coherently adopted in the annexes, which should also focus on supporting the assessment for this specific source.	To better reflect the scope of this report, the investigation initially undertaken for the other sources (paints, tyres, pellets, textiles, geotextiles) has been moved to the very last annex (Annex 15). Annex 15 can help serve as a basis for future research into paints, pellets, textiles and geotextiles, as well as guide future analysis and impact assessments for measures tackling microplastic releases. Annex 15 also provides information about the relative merits of action on pellets (compared to other sources) as asked for by the Board. The detailed analysis in the other annexes focuses on pellets.

4 MAIN LITERATURE SOURCES USED

ADAC (2021) Tyre abrasion: wear and burden on the environment / 31940 RMU

Air Quality Expert Group (2019) Non-Exhaust Emissions from Road Traffic. Available from: https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf

AISE (2022) Report on SOLUBLE FILMS IN SINGLE-DOSE DETERGENT PRODUCTS: Information on their purpose, technical characteristics, testing and usage (April 2022)

AISE (2020) A.I.S.E.'s pan-European habits survey 2020, 2020

AISE (2018) A.I.S.E. Pan-European Consumer Habits Survey 2017, 2018

Alava, J.J. et al. Microplastics and Macroplastic Debris as Potential Physical Vectors of SARS-CoV-2: A Hypothetical Overview with Implications for Public Health. Microplastics 2022, 1, 156–166. https://doi.org/10.3390/microplastics1010010

Alfonso, María B. et al. (2021) "Continental Microplastics: Presence, Features, And Environmental Transport Pathways". Science Of The Total Environment, vol 799, 2021, p. 149447. Elsevier BV, doi:10.1016/j.scitotenv.2021.149447. Accessed 25 Mar 2022.

Allen, S. et al. (2021) "Evidence Of Free Tropospheric And Long-Range Transport Of Microplastic At Pic Du Midi Observatory". Nature Communications, vol 12, no. 1, 2021. Springer Science And Business Media LLC, doi:10.1038/s41467-021-27454-7. Accessed 25 Mar 2022.

Alonso Raposo et al. (2019) The future of road transport, EUR 29748 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-14319-2, doi:10.2760/524662, JRC116644.

Apostolidis, A., Kokarakis, J., & Merikas, A. (2012). Modelling the Dry-Docking Cost-The Case of Tankers. Journal of Ship Production & Design, 28(3)

Arthur, C., Bamford, H. & Baker, J. (2009) 'Proceedings of the International Research Workshop on the Occurrence, Effects and Fate of Microplastic Marine Debris. Sept 9-11, 2008'. NOAA Technical Memorandum NOS-OR&R-30.

As You Sow, 'Plastic Pellet Pollution', 2021 (https://www.asyousow.org/our-work/waste/plastic-pellets).

Baensch-Baltruschat et al. / Science of the Total Environment 733 (2020) 137823

Bai, Xue et al. (2022) "Weathering Of Geotextiles Under Ultraviolet Exposure: A Neglected Source Of Microfibers From Coastal Reclamation". Science Of The Total Environment, vol 804, 2022, p. 150168. Elsevier BV, doi:10.1016/j.scitotenv.2021.150168. Accessed 21 Mar 2022.

Bertling, Jürgen; Zimmermann, Till; Rödig, Lisa (2021) Kunststoffe in der Umwelt: Emissionen in landwirtschaftlich genutzte Böden, Oberhausen, Fraunhofer UMSICHT 220 Seiten

Bhashyam, S. et al. (2021). Microplastics in the marine environment sources, impacts and recommendations. Research@THEA

BIO by Deloitte (2014) Development of Guidance on Extended Producer Responsibility (EPR)", 2014 by , in collaboration with Arcadis, Ecologic, Institute for European Environmental Policy (IEEP), Umweltbundesamt (UBA). https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/sustainability-services/deloitte_sustainability-les-filieres-a-responsabilite-elargie-du-producteur-en-europe_dec-15.pdf

Boag et al. (1999) The pathology of interstitial lung disease in nylon flock workers. Am J Surg Pathol.

Boomerang Alliance (2015), Submission into Senate Inquiry on the Threat of Marine Plastic, October 2015

Boulter, P. G. (2006) Review of emission factors and models for road vehicle non-exhaust particulate matter." Project Report PPR0065, Department for the Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government, and the Department of Environment in Northern Ireland, 2006.

Brennecke, D., Duarte, B., Paiva, F., Caçador, I. and Canning-Clode (2016) J. Microplastics as vector for heavy metal contamination from the marine environment. Estuar. Coast. Shelf Sci. 2016, 178, 189–195.

Byrne, Dominic et al. (2021) "Biodegradability Of Polyvinyl Alcohol Based Film Used For Liquid Detergent Capsules". Tenside Surfactants Detergents, vol 58, no. 2, 2021, pp. 88-96. Walter De Gruyter Gmbh, doi:10.1515/tsd-2020-2326. Accessed 16 Nov 2021

BSI Knowledge, 'Plastic pellets, flakes and powders. Handling and management throughout the supply chain to prevent their leakage to the environment. Specification - PAS 510:2021101', 2021 ().

Cai Y, Mitrano DM, Heuberger M, Hufenus R, Nowack B (2020) The origin of microplastic fiber in polyester textiles: The textile production process matters, Journal of Cleaner Production

California Assembly (2020), A.B. 1952.

California Assembly (2018), A.B. 129.

California Environmental Protection Agency, 'Preproduction Plastic Debris Program', 2008 (https://www.waterboards.ca.gov/water_issues/programs/stormwater/plasticdebris.shtml).

Carneiro, José Ricardo et al., 2018, "Laboratory Evaluation Of Interactions In The Degradation Of A Polypropylene Geotextile In Marine Environments". Advances In Materials Science And Engineering, vol 2018, 2018, pp. 1-10. Hindawi Limited, doi:10.1155/2018/9182658. Accessed 28 Mar 2022.

CBD – Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel – GEF (2012): Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions. In: CBD Technical Series No. 67, 61 pages.

CEDR (2016) Management of contaminated runoff water: current practice and future research needs

Chand, R.; Rasmussen, L.A.; Tumlin, S.; Vollertsen, J. (2021) The occurrence and fate of microplastics in a mesophilic anaerobic digester receiving sewage sludge, grease and fatty slurries, Science of the Total Environment 2021, 798, 149287

Changing Markets Foundation (2021) Fossil fashion, 2021

Chronopoulos G., Cakmak, G. E., Tempany, P., Klein, G., Brinkmann, T., Zerger, B., & Roudier, S. Best Available Techniques (BAT) Reference Document on Surface Treatment Using Organic Solvents including Preservation of Wood and Wood Products with Chemicals.)CircularInnoBooster Fashion and Textile project (2021) Second-hand fashion, a new impetus for clothing consumption, 2021

Cole, M.; Lindeque, P.; Halsband, C. & T.S. Galloway (2011): Microplastics as contaminants in the marine environment: A review. In: Marine Pollution Bulletin 62: 2588-2597

Draft COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles. Comitology Register (europa.eu), Accessed on 15 March 2023.

Connecticut, S. (2018), Substitute House Bill No. 5360, http://www.cga.ct.gov/2018/ACT/pa/2018PA-00181-R00HB-05360-PA.htm.

Correia Prata Joana, João P. da Costa, Armando C. Duarte, Teresa Rocha-Santos (2019) Methods for sampling and detection of microplastics in water and sediment: A critical review, TrAC Trends in Analytical Chemistry, Volume 110, 2019, Pages 150-159, ISSN 0165-9936, https://doi.org/10.1016/j.trac.2018.10.029.

Cox et al. (2020) Human consumption of microplastics. Environ. Sci. Technol. 2019, 53, 12, 7068–7074

Danopoulos, E., Twiddy, M., West, R., & Rotchell, J. (2022). A rapid review and meta-regression analyses of the toxicological impacts of microplastic exposure in human cells. Journal Of Hazardous Materials, 427, 127861. doi: 10.1016/j.jhazmat.2021.127861

DAWE (2021), National Plastics Plan 2021.

Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l’environnement.

Deltares and TNO (2016) Emissieschattingen Diffuse bronnen Emissieregistratie - Bandenslijtage wegverkeer

Diaz et al. (2020) European vehicle market statistics 2020/21

Dibke et al. (2021) Microplastic Mass Concentrations and Distribution in German 39 Waters by Pyrolysis–Gas Chromatography–Mass Spectrometry/Thermochemolysis Reveal Potential Impact of Marine Coatings: Do Ships Leave Skid Marks? https://doi.org/10.1021/acs.est.0c04522

Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (recast)

Dixon, N. et al. (2016) "Sustainability Aspects Of Using Geotextiles". Geotextiles, 2016, pp. 577-596. Elsevier, doi:10.1016/b978-0-08-100221-6.00026-7. Accessed 4 May 2022.

Dris et al. (2017) A first overview of textile fibres, including microplastics, in indoor and outdoor environments. Environ Pollut.

Dris et al. (2015) Microplastic contamination in an urban area: a case study in Greater Paris. Environmental Chemistry.

Dutch Government (2020), "Towards Osaka Blue Ocean Vision: G20 Implementation Framework for Actions on Marine Plastic Litter" https://www.naturvardsverket.se/amnesomraden/plast/om-plast/mikroplast/

Dutch Ministry of Infrastructure and Water Management, 'Monitoring of pellets and mesoplastic fragments on Dutch beaches in 2021: a pilot study', 2022 (https://puc.overheid.nl/rijkswaterstaat/doc/PUC_721767_31/1/)

Dusza, H.M. et al, 'Uptake, Transport, and Toxicity of Pristine and Weathered Micro- and Nanoplastics in Human Placenta Cells', *Environmental Health Perspectives*, Vol; 130, No 9, 2022 (https://ehp.niehs.nih.gov/doi/10.1289/EHP10873).

EC Group of Chief Scientific Advisors (2019) Environmental and health risks of microplastic pollution

ECHA (2022) "Microplastics - ECHA". Echa.Europa.Eu, 2022, Microplastics - ECHA (europa.eu) Accessed 14 Apr 2022.

EDANA (2022) "Nonwovens Markets". Default, 2022, https://www.edana.org/nw-related-industry/nonwovens-markets. Accessed 21 Mar 2022.

EEA (2019) ETC/WMGE, Textiles and the environment in a circular economy, November 2019

Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions

Esiukova, Elena & Chubarenko, Boris & Simon, Franz. (2018). Debris of geosynthetic materials on the shore of South-Eastern Baltic (Kaliningrad Oblast, Russian Federation).

Essel, Roland et al. (2014) Sources of microplastics relevant to marine protection, Report for Federal Environment Agency (Germany), November 2014

Expertmarketresearch.Com (2022) "Global Plastic Market Report And Forecast 2022-2027". https://www.expertmarketresearch.com/reports/plastic-market. Accessed 24 Mar 2022.

ETRMA. (2019) Circular Economy. Available at: https://www.etrma.org/key-topics/circular-economy/

ETRMA. (2018) End of Life Tyres Management – Europe 2018 Status: https://www.etrma.org/wp-content/uploads/2020/09/Copy-of-ELT-Data-2018-002.pdf

Eunomia (2016), Report for Fidra on Study to Quantify Pellet Emissions in the UK, March 2016GESAMP. (2015). Microplastics in the ocean. A global assessment. GESAMP, The Joint Group of Experts on Scientific Aspects of Marine Environmental Protection, Working Group 40.

EurEau, 'Microplastics and the water sector', 2019 (https://www.eureau.org/resources/briefing-notes/3940-briefing-note-on-microplastics-and-the-water-sector/file); Koelmans, A., Hazimah Mohamed Nor, N., Hermsen, E., Kooi, M. et al., 'Microplastics in freshwaters and drinking water: Critical review and assessment of data quality', *Water Research*, Vol. 155, 2019, pp. 410-422.

European Chemicals Agency, Opinion of the Committee for Risk Assessment and Opinion of the Committee for Socio-economic Analysis on an Annex XV dossier proposing restrictions on intentionally-added microplastics, ECHA/RAC/RES-O-0000006790-71-01/F and ECHA/SEAC/RES-O-0000006901-74-01/F, 2020, p.49 (https://echa.europa.eu/documents/10162/a513b793-dd84-d83a-9c06-e7a11580f366).

European Commission, Commission evaluation – Water pollution: EU rules on urban wastewater treatment (update), 2022 (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12405-Water-pollution-EU-rules-on-urban-wastewater-treatment-update-_en).

European Commission (2020) Regulation (EU) 2020/740 of the European Parliament and of the Council of 25 May 2020 on the labelling of tyres with respect to fuel efficiency and other parameters, amending Regulation (EU) 2017/1369 and repealing Regulation (EC) No 1222/2009 (Text with EEA relevance)

European Commission (2019) Commission staff working document. Evaluation of the Council Directive 91/271/EEC of 21 May 1991, concerning urban waste-water treatment {SEC(2019) 448 final} - {SWD(2019) 701 final}. https://ec.europa.eu/environment/water/water-urbanwaste/pdf/UWWTD%20Evaluation%20SWD%20448-701%20web.pdf

European Commission (2019) Review study on household tumble driers, June 2019

European Commission (2018) SWD 254 final Commission Staff Working Document: Reducing Marine Litter: action on single use plastics and fishing gear, Accompanying the document « Proposal for a Directive of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment »

European Commission/Eunomia (2016), Report to DG Environment on Study to support the development of measures to combat a range of marine litter sources, January 2016

European Committee for Standardization (2012) EN 12226, Geosynthetics—General Tests for Evaluation following Durability Testing, European Committee for Standardization, Brussels, Belgium, 2012.

European Committee for Standardization (2004) EN ISO 13438, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Oxidation, European Committee for Standardization, Brussels, Belgium, 2004.

European Committee for Standardization (2001) EN 12447, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Hydrolysis in Water, Brussels, Belgium, 2001.

European Committee for Standardization (2001) EN 14030, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Acid and Alkaline Liquids, European Committee for Standardization, Brussels, Belgium, 2001.

European Committee for Standardization (2000) EN 12224, Geotextiles and Geotextile-Related Products-Determination of the Resistance to Weathering, European Committee for Standardization, Brussels, Belgium, 2000.

European Environment Agency, 'Microplastics from textiles: Towards a circular economy for textiles in Europe', 2022 (https://www.eea.europa.eu/publications/microplastics-from-textiles-towards-a).

European TRWP Platform (2019) Way Forward Report

Eurostat data on number of companies in the production of plastic in primary forms and turnover (https://ec.europa.eu/eurostat/databrowser/view/SBS_SC_OVW__custom_5884920/default/table?lang=en).

Federal Ministry of Food and Agriculture (2021) BioSinn – Products for Which Biodegradation makes sense, Renewable Carbon publication, edited in May 2021

Fibre2Fashion (2017), Man-made fibres driving growth

Folkö Amanda (2015) Quantification and characterization of fibres emitted from common synthetic materials during washing, Report for Käppala, 2015.

French Senate (2021) Amendement n°2143 au projet de loi relatif à la lutte contre le dérèglement climatique, 10 juin 2021

Gebbe et al. (1997) Quantifizierung des Reifenabriebs von Kraftfahrzeugen in Berlin

Geilenkirchen et al. (2020) Methods for calculating the emissions of transport in the Netherlands

German Federal Ministry for Economic Cooperation and Development (2019), Circular Economy in the Textile Sector

Gewert B, Plassmann MM, MacLeod M. 2015. Pathways for degradation of plastic polymers floating in the marine environment. Environ Sci Process Impacts 17:1513–1521

Good Karma Projects, New report out exposes alarming impacts of plastic pellets across Europe, 2020 (https://goodkarmaprojects.org/2020/11/20/new-report-out-exposes-alarming-impacts-of-plastic-pellets-across-europe/?lang=en).

Grand View Research Inc (2022) Geotextiles Market Size & Share, |Industry Report, 2020-2027. (2022). Retrieved 6 January 2022, from https://www.grandviewresearch.com/industry-analysis/geotextiles-industry

Grand View Research Inc (2014) https://www.estormwater.com/grand-view-research-forecasts-global-geotextiles-market

Grigoratos T, Martini G. (2014) Non-exhaust traffic related emissions – Brake and tyre wear PM. EUR 26648. Luxembourg (Luxembourg): Publications Office of the European Union; 2014. JRC89231Kosuth et al., (2018) Anthropogenic contamination of tap water, beer, and sea salt, https://doi.org/10.1371/journal.pone.0194970

Group of Chief Scientific Advisors, Scientific opinion on the environmental and health risks of microplastic pollution, April 2019.

Hann et al. (2018) Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products

Hollman, P.C.H.; Bouwmeester, H.; Peters, R.J.B. (2013) Microplastics in Aquatic Food Chain: Sources, Measurement, Occurrence and Potential Health Risks; RIKILT-Institute of Food Safety: Wageningen, The Netherlands, 2013; No. 2013.003.

Hurley, R., & Nizzetto, L., 'Fate and occurrence of micro(nano)plastics in soils: Knowledge gaps and possible risks', Current Opinion in Environmental Science & Health, Vol. 1, 2018, pp. 6-11, Elsevier BV.

International Baltic Earth Secretariat (2020) 3rd Baltic Earth Conference Earth system changes and Baltic Sea coasts, accessed October 15, 2021

International Pellet Watch - Where can we find the plastic resin pellets? (pelletwatch.org/where)

International Union for Conservation of Nature, 'Primary Microplastics in the Oceans: A Global Evaluation of Sources', 2017 (https://portals.iucn.org/library/sites/library/files/documents/2017-002-En.pdf).

ISO (2020) ISO 22182 :2020, Geotextiles and geotextile-related products — Determination of index abrasion resistance characteristics under wet conditions for hydraulic applications

IUCN (2017), Primary Microplastics in the Oceans: A Global Evaluation of Sources, February 2017

IUCN (2016) Biodiversity Risk and Opportunities in the Apparel Sector

Jenner et al. (2022) Detection of microplastics in human lung tissue using μFTIR spectroscopy. Science of The Total Environment, Volume 831

Johannesson, M., & Lithner, D. (2022). Potential policy instruments and measures against microplastics from tyre and road wear: mapping and prioritisation

Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), Global assessment on microplastics in the ocean, Joint Group of Experts on Scientific Aspects of Marine Environmental Protection, 2015.

JRC (2019) Best available techniques (BAT) Reference Document for the Textiles Industry, 2019

JRC (2014) Environmental Improvement Potential of textiles (IMPRO Textiles), January 2014.

Julinova M. et al. (2018) Water-soluble polymeric xenobiotics – Polyvinyl alcohol and polyvinylpyrrolidon – And potential solutions to environmental issues: A brief review J. Environ. Management 2018, 218, p. 6027

K 2022 - Trend Report Europe https://www.k-online.com/en/Media_News/Press/Technical_article/K_2022_-_Trend_Report_Europe

Kieran D. Cox, Garth A. Covernton, Hailey L. Davies, John F. Dower, Francis Juanes, and Sarah E. Dudas (2019) Human Consumption of Microplastics. Environmental Science & Technology 2019 53 (12), 7068-7074 DOI: 10.1021/acs.est.9b01517

KIMO, 'Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines', 2020 (https://www.kimointernational.org/news/plastic-pellets-spill-pollutes-danish-norwegian-swedish-coastlines/).

Kole PJ, Löhr AJ, Van Belleghem FGAJ, Ragas AMJ (2017). Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. Int J Environ Res Public Health. 2017;14(10):1265. Published 2017 Oct 20. doi:10.3390/ijerph14101265

Klein et al. (2019) Methods for calculating the emissions of transport in the Netherlands.

Kreider, Marisa L., Julie M. Panko, Britt L. McAtee, Leonard I. Sweet, und Brent L. Finley (2010) Physical and chemical characterization of tire-related particles: Comparison of particles generated using different methodologies." Science of The Total Environment, Vol. 408, 2010: 652-659

Lacroix C. et Huvet A. (2019) Table ronde n°1 : Devenir et gestion dans les ports et les milieux littoraux – introduction scientifique : caractérisation de la pollution et risques associés. Conférence Journée Plastiques et Environnement 27-28 juin 2019

Lares, Mirka et al. (2018) "Occurrence, Identification And Removal Of Microplastic Particles And Fibers In Conventional Activated Sludge Process And Advanced MBR Technology". Water Research, vol 133, 2018, pp. 236-246. Elsevier BV, doi:10.1016/j.watres.2018.01.049. Accessed 22 Oct 2021.

Lassen, C., S. Foss Hansen, K. Magnusson, F. Norén, N. I. Bloch Hartmann, P. Rehne Jensen, T. Gissel Nielsen and A. Brinch (2015). Microplastics - Occurrence, effects and sources of releases to the environment in Denmark.

Lechner, Aaron, and David Ramler (2015) "The Discharge Of Certain Amounts Of Industrial Microplastic From A Production Plant Into The River Danube Is Permitted By The Austrian Legislation". Environmental Pollution, vol 200, 2015, pp. 159-160. Elsevier BV, doi:10.1016/j.envpol.2015.02.019. Accessed 28 Mar 2022.

Lei, L.; Hu, X.; Yue, P.L.; Bossmann, S.H.; Göb, S.; Braun, A.M. (1998) Oxidative degradation of poly vinyl alcohol by the photochemically enhanced Fenton reaction. J. Photochem. Photobiol. A Chem. 1998, 116, 159–166.

Leslie, H.A., (2014) Review of microplastics in cosmetics. Scientific background on a potential source of plastic particulate marine litter to support decision-making. V.U. Institute for Environmental Studies, Amsterdam.

Leslie, Heather A. et al. (2022) “Discovery And Quantification Of Plastic Particle Pollution In Human Blood”. Environment International, 2022, p. 107199. Elsevier BV, doi:10.1016/j.envint.2022.107199. Accessed 28 Mar 2022.

Li, J.; Zhang, K.; Zhang, H. (2018) Adsorption of antibiotics on microplastics. Environ. Pollut. 2018, 237, 460–467.

Loubet et al. (2021) Life cycle inventory of plastics losses from seafood supply chains:Methodology and application to French fish products. Science of the Total Environment

Lyn, T.E., ‘Sinopec pledges help to clear Hong Kong plastic spill’, Reuters, 2012 (https://www.reuters.com/article/us-pollution-hongkong-sinopec-idUSBRE8780I920120809). https://www.reuters.com/article/us-pollution-hongkong-sinopec-idUSBRE8780I920120809

Maisner et al. (2019) Geosynthetics in traffic infrastructure construction in contact with groundwater and surface water – Environmental aspects. Georesources Journal (special issue)

Marketsandmarkets (2022) "Geotextile Market Size & Share | Global Industry Forecast To 2022&| Marketsandmarkets". Marketsandmarkets.Com, 3399, https://www.marketsandmarkets.com/Market-Reports/geotextiles-market-492.html. Accessed 21 Mar 2022.

Mason, Sherri A. et al. (2018) “Synthetic Polymer Contamination In Bottled Water”. Frontiers In Chemistry, vol 6, 2018. Frontiers Media SA, doi:10.3389/fchem.2018.00407. Accessed 25 Mar 2022.

Mato Y, Isobe T, Takada H, Kanehiro H, Ohtake C, Kaminuma T. (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment.

Methacanon, P., Weerawatsophon, U., Sumransin, N., Prahsarn, C., & Bergado, D. (2010). Properties and potential application of the selected natural fibers as limited life geotextiles. Carbohydrate Polymers, 82(4), 1090-1096. doi: 10.1016/j.carbpol.2010.06.036

Miao, Lingzhan, Peifang Wang, Jun Hou, Yu Yao, Zhilin Liu, Songqi Liu, Tengfei Li, Distinct community structure and microbial functions of biofilms colonizing microplastics, Science of The Total Environment, Volume 650, Part 2, 2019, Pages 2395-2402, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2018.09.378.

Ministry of Environment and Food of Denmark; Microplastics: Occurrence, effects and sources of releases to the environment in Denmark, Environmental project No. 1793, 2015

Miszkowska A, Lenart, A & Koda, E. (2017) Changes of Permeability of Nonwoven Geotextiles due to Clogging and Cyclic Water Flow in Laboratory Conditions doi:10.3390/w9090660

Müller, Werner W, and Fokke Saathoff (2015) "Geosynthetics In Geoenvironmental Engineering". Science And Technology Of Advanced Materials, vol 16, no. 3, 2015, p. 034605. Informa UK Limited, doi:10.1088/1468-6996/16/3/034605. Accessed 21 Mar 2022.

Nola.com, 'No cleanup planned as millions of plastic pellets wash up along Mississippi River and flow to the Gulf', 2020 (https://www.nola.com/news/environment/article_b4fba760-e18d-11ea-9b0b-b3a2123cf48b.html).

Nova Institute (2023) Bio-based Building Blocks and Polymers Global Capacities, Production and Trends 2022–2027 https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2022-2027-short-version-pdf/

OCS (2019) OCS-Progress-Report-2019-Web-LR-151020.pdf (opcleansweep.eu)

Norén, F. & Ekendahl, S. (2009) Microscopic Anthropogenic Particles in Swedish Waters: many more than believed. Schwerin, Germany: Helsinki Commission

OECD (2022) Global Plastics Outlook: Policy Scenarios to 2060

OECD (2021) Policies to Reduce Microplastics Pollution in Water: Focus on Textiles and Tyres https://www.oecd-ilibrary.org/environment/policies-to-reduce-microplastics-pollution-in-water_7ec7e5ef-en

OECD (2021) Modulated fees for Extended Producer Responsibility schemes (EPR), OECD Environment Working Papers No. 184

OECD (2020) Non-exhaust Particulate Emissions from Road Transport

OECD (2009) Emission Scenario Document On Adhesive Formulation, 2009

OPC Clean Sweep - www.opcleansweep.eu

OSPAR (2021) Guidelines in support of Recommendation 2021/06 on the reduction of plastic pellet loss into the marine environment https://www.ospar.org/documents?v=46269

OSPAR (2018) Background document on pre-production plastic pellets, 2018, https://www.ospar.org/documents?v=39764. Accessed 12 Apr 2022.

OSPAR (2017) Assessment document of land-based inputs of microplastics in the marine environment, 2017. Accessed March 28, 2022, from: https://www.ospar.org/documents?v=38018

Partow, H.L., C., Le Floch, S., & Alcaro, L. (2021) X-PRESS PEARL MARITIME DISASTER SRI LANKA REPORT OF THE UN ENVIRONMENTAL ADVISORY MISSION JULY 2021. 2021, UN Environmental Advisory Mission

Paruta et al. (2022) Plastic Paints the Environment, EAEnvironmental Action 2022, ISBN 978-2-8399-3494-7

Peano et al. (2020) Plastic Leak Project. Methodological Guidelines.

Persson et al. (2022) Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. (2022). Environmental Science & Technology. Retrieved from https://pubs.acs.org/doi/10.1021/acs.est.1c04158

Pew Research (2022) Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions

Pew Research (2020) Breaking the waves, Pew Charitable Trusts and SystemiQ https://www.systemiq.earth/wp-content/uploads/2020/07/BreakingThePlasticWave_MainReport.pdf

Pimentel et al. (1975) Respiratory disease caused by synthetic fibres: a new occupational disease. Thorax 30

"Plastic Pellets — As You Sow". As You Sow, 2021, https://www.asyousow.org/our-work/waste/plastic-pellets. Accessed 21 Oct 2021.

Plastics Europe (2017) Operation Clean Sweep® Report

Plastics Europe (2021) Plastics the Facts https://plasticseurope.org/wp-content/uploads/2021/12/Plastics-the-Facts-2021-web-final.pdf

Plastics Recyclers Europe, Plastics Recycling Industry in Europe: Mapping of Installed Plastics Recycling Capacities 2021 Data, 2023

Plastic Soup Foundation _ Do clothes make us sick? 2022

Prambauer, M., Wendeler, C., Weitzenböck, J., & Burgstaller, C. (2019). Biodegradable geotextiles – An overview of existing and potential materials. Geotextiles And Geomembranes, 47(1), 48-59. doi: 10.1016/j.geotexmem.2018.09.006

Prata et al., Methods for sampling and detection of microplastics in water and sediment: A critical review, TrAC Trends in Analytical Chemistry, 2019, 110: 150-159.

Qing-Zhou Wang, Nan-Nan Wang, Ming-Lang Tseng, Yu-Man Huang, Ning-Li Li, (2019) Waste Tire Recycling Assessment: Road Application Potential and Carbon Emissions Reduction Analysis of Crumb Rubber Modified Asphalt in China, Journal of Cleaner Production (2019), https://doi.org/10.1016/j.jclepro.2019.119411

Ragusa, Antonio et al. (2021) "Plasticenta: First Evidence Of Microplastics In Human Placenta". Environment International, vol 146, 2021, p. 106274. Elsevier BV, doi:10.1016/j.envint.2020.106274. Accessed 28 Mar 2022.

RDC Environment (2000) Emploi et investissements liés aux activités de collecte sélective, tri et recyclage des projets FOST PLUS, 2000

République Française (2021) Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement.

Rethink Plastic alliance (2021) PLASTIC PELLETS UNDER REACH: Strengthening requirements to enable effective supply chain legislation, Position Paper, March 2021, https://rethinkplasticalliance.eu/wp-content/uploads/2021/04/plastic_pellets_under_reach.pdf Accessed 14 April, 2022.

Revell et al., Direct radiative effects of airborne microplastics, Nature, 2021, 598: 462–467. Center for International Environmental Law (CIEL) (2019). Plastic & Climate: The Hidden Costs of a Plastic Planet

Rochman (2019) Rethinking microplastics as a diverse contaminant suite – Environmental Toxicology and Chemistry – Wiley Online Library

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries:exploring the safe operating space for humanity. Ecology and Society 14(2): 32. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art32/

Rodrigues et al., Microplastic contamination in an urban estuary: Abundance and distribution of microplastics and fish larvae in the Douro estuary, Science of The Total Environment, 2019, 659: 1071-1081.

Rolsky, Charles, and Varun Kelkar (2021). "Degradation Of Polyvinyl Alcohol In US Wastewater Treatment Plants And Subsequent Nationwide Emission Estimate". International Journal Of Environmental Research And Public Health, vol 18, no. 11, 2021, p. 6027. MDPI AG, doi:10.3390/ijerph18116027. Accessed 16 Nov 2021.

Royer, Sarah-Jeanne et al. “Production Of Methane And Ethylene From Plastic In The Environment”. PLOS ONE, vol 13, no. 8, 2018, p. e0200574. Public Library Of Science (Plos), doi:10.1371/journal.pone.0200574. Accessed 28 Mar 2022.

Ryan, P. G. (2008) ‘Seabirds indicate changes in the composition of plastic litter in the Atlantic and south-western Indian Oceans’. Marine Pollution Bulletin

Ryberg, Morten W. et al. (2019) “Global Environmental Losses Of Plastics Across Their Value Chains”. Resources, Conservation And Recycling, vol 151, 2019, p. 104459. Elsevier BV, doi:10.1016/j.resconrec.2019.104459. Accessed 25 Mar 2022.

Sanad, R. A. (2016). Consumer attitude and purchase decision towards textiles and apparel products. World, 2(2016), 16-30.

Scholz, Philipp et al. (2021) "Environmental Impact Of Geosynthetics In Coastal Protection". Materials, vol 14, no. 3, 2021, p. 634. MDPI AG, doi:10.3390/ma14030634. Accessed 21 Mar 2022.

Schonberger, H.; Baumann, A.; Keller, W. (1997) Study of microbial degradation of polyvinyl alcohol (PVA) in wastewater treatment plants. Am. Dyest. Report. 1997, 86, 9–18.

Schwabl, Philipp et al. (2019) “Detection Of Various Microplastics In Human Stool”. Annals Of Internal Medicine, vol 171, no. 7, 2019, pp. 453-457. American College Of Physicians, doi:10.7326/m19-0618. Accessed 28 Mar 2022.

Schymanski et al., (2018), Analysis of microplastics in water by micro-Raman spectroscopy: Release of plastic particles from different packaging into mineral water, https://doi.org/10.1016/j.watres.2017.11.011

Seas at Risk (seas-at-risk.org) - Microplastic pollution in the marine environment and its climate implications: how to overcome the impacts?

Secretariat of the Convention on Biological Diversity, 'Impacts of marine debris on biodiversity: Current status and potential solutions', *CBD Technical Series*, No 67, 2012.

Sheavly et al. (2007) Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions

Shopova et al., 'Risk assessment and toxicological research on micro- and nanoplastics after oral exposure via food products', EFSA Journal, 2020 https://doi.org/10.2903/j.efsa.2020.e181102

Sivan A. 2011. New perspectives in plastic biodegradation. Curr Opin Biotechnol 22:422–426

SOLAS(2002) Chapter VII. Carriage Of Dangerous Goods". Rise.Odessa.Ua, 2022 http://rise.odessa.ua/texts/solas02_glVIIe.php3. Accessed 12 Apr 2022.

Sommer, F., Dietze, V., Baum, A., Sauer, J., Gilge, S., Maschowski, C. and Gieré, R. (2018). Tire Abrasion as a Major Source of Microplastics in the Environment. Aerosol Air Qual. Res. 18: 2014-2028. https://doi.org/10.4209/aaqr.2018.03.0099Sun et al. (2019) Microplastics in wastewater treatment plants: Detection, occurrence and removal. Water Research

SQAS (2022) Questionnaire and Guidelines, 2022, Accessed April 15, 2022, from: https://www.sqas.org/downloads/core2022/SQAS%202022%20Core%20Questionnaire%20and%20Guidelines%20(English).docx

Sun, W.; Chen, L.; Wang, J. (2017) Degradation of PVA (polyvinyl alcohol) in wastewater by advanced oxidation processes. J. Adv. Oxid. Technol. 2017, 20.

Sundt, P.; Schulze, P-E.; Syversen, F. (2014) Sources of microplastics-pollution to the marine environment. Norwegian Environment Agency (Miljødirektoratet)

Surfrider Foundation Europe, Rethink Plastic, 2020. "Plastic giants polluting through the back door"

TextileMission (2021) Microplastics of Textile Origin - A Holistic View: Optimized Processes and Materials, Material Flows and Environmental Behavior, https://bmbf-plastik.de/en/joint-project/textilemission

The Guardian, 'Sri Lanka faces disaster as burning ship spills chemicals on beaches', 2021 (https://www.theguardian.com/world/2021/may/31/sri-lanka-faces-disaster-burning-ship-spills-chemicals-beaches).

"The Industrial Emissions Directive - Environment - European Commission". Ec.Europa.Eu, 2022, https://ec.europa.eu/environment/industry/stationary/ied/evaluation.htm. Accessed 14 Apr 2022.

The Nature Conservancy, Bain & Company (2021) Toward eliminating pre-consumer emissions of microplastics from the textile industry, 2021

Timothy Elliott, R. B., Chiarina, D., Laurence, E., Chris, S., Ayesha, B., Mathilde, B., & Hilton, M. (2018). Assessment of measures to reduce marine litter from single-use plastics. ICF Consulting Services Limited and Eunomia, M. European Commission, Brussels

Tromp, Peter et al. (2021) Comparison and improvement of analytical techniques for quality data on TWP in the environment / Setac Europe 2021

Turner A. (2021) Paint particles in the marine environment: An overlooked component of microplastics, https://doi.org/10.1016/j.wroa.2021.100110)

Two Oceans Aquarium, 'The Great Nurdle Disaster: What to do if you find nurdles', 2017 (https://www.aquarium.co.za/blog/entry/the-great-nurdle-disaster-what-to-do-if-you-find-nurdles). https://www.aquarium.co.za/blog/entry/the-great-nurdle-disaster-what-to-do-if-you-find-nurdles

TyreWearMapping (2021) Digitales Planungs- und Entscheidungsinstrument zur Verteilung, Ausbreitung und Quantifizierung von Reifenabrieb in Deutschland. Final Report 19F2050A-C

UN Environment (2018) Mapping of global plastics value chain and plastics losses to the environment with a particular focus on marine environment

United Nations Environment Programme, 'X-Press pearl maritime disaster Sri Lanka – Report of the UN Environmental Advisory Mission', 2021 (https://www.unep.org/resources/report/x-press-pearl-maritime-disaster-sri-lanka-report-un-environmental-advisory-mission).

US Congress (2021) Break Free from Plastic Pollution Act of 2021, accessed October 21, from: Text - H.R.2238 - 117th Congress (2021-2022): Break Free From Plastic Pollution Act of 2021 | Congress.gov | Library of Congress

US Department of Agriculture (1995) Geotextiles, A special Application of biofibers Retrieved 13 January 2022, from https://www.fpl.fs.fed.us/documnts/pdf1995/engli95a.pdf

US Environmental Protection Agency, 'Industrial Stormwater fact sheet: Sector Y: Rubber, Miscellaneous Plastic Products, and Miscellaneous Manufacturing Industries', 2006 (https://www3.epa.gov/npdes/pubs/sector_y_rubberplastic.pdf).

USEPA (1992) Plastic Pellets in the Aquatic Environment: Sources and Recommendations

Venghaus et al. (2021) RAU - "Reifenabrieb in der Umwelt" Abschlusskonferenz "Plastik in der Umwelt" (20./21.04.2021)

Venghaus et al. (2021) Report "Tire Wear in the environment - RAU" Berlin, 2021 BMBF-Vorhaben, Förderkennzeichen 13NKE011A

Verschoor A.J. and E. de Valk, RIVM (2017) Potential measures against microplastic emissions to water, RIVM Report 2017-0193

Verschoor et al. (2016) Emission of microplastics and potential mitigation measures

Vogelsang et al. (2019) Microplastics in road dust – characteristics, pathways and measures

Wang, W. et al., ‘Environmental fate and impacts of microplastics in soil ecosystems: Progress and perspective’, Science of the Total Environment, Vol. 708, 2020.

Water Briefing. (2016, November 7). Sewage sludge: new research warns over microplastics in soil.

WBCSD. (2019) Global ELT Management. Available at: https://docs.wbcsd.org/2019/12/Global_ELT_Management%E2%80%93A_global_state_of_knowledge_on_regulation_management_systems_impacts_of_recovery_and_technologies.pdf

WBCSD. (2018) Managing End-of-Life Tires. Available at: https://docs.wbcsd.org/2018/02/TIP/End_of_Life_Tires-Full-Report.pdf

WHO (2019) Microplastics in drinking-water. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO.

Welden, Natalie A.C., Phillip R. Cowie (2016) Environment and gut morphology influence microplastic retention in langoustine, Nephrops norvegicus, Environmental Pollution, Volume 214, 2016, Pages 859-865, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2016.03.067.

Werner S; Budziak A; Van Franeker J; Galgani F; Hanke G; Maes T; Matiddi M; Nilsson P; Oosterbaan L; Priestland E; Thompson R; Veiga J; Vlachogianni T. Harm caused by Marine Litter. EUR 28317 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC104308.

Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf (plasticsoupfoundation.org)

Wheatley, Q.; Baines, F., (1976) Biodegradation of polyvinyl alcohol in wastewater, AATCC, 1976, 8, 28

Wicke et al. (2015) Relevanz organischer Spurenstoffe im Regenwasserabfluss Berlins. Hg. v. Kompetenzzentrum Wasser Berlin. Kompetenzzentrum Wasser Berlin.

Wik, Anna et al. (2009) Occurrence and effects of tire wear particles in the environment – A critical review and an initial risk assessment, Environmental Pollution, Volume 157, Issue 1, 2009, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2008.09.028.

Winternitz, K, Heggie, M & Baird, J (2019) 'Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands', Waste Management, vol. 89, pp. 386-396. https://doi.org/10.1016/j.wasman.2019.04.023

Wood et al. (2021) Support to the evaluation of the Sewage Sludge Directive – Exploratory Study Final Report

Wright S.L. et al., ‘Atmospheric microplastic deposition in an urban environment and an evaluation of transport’, Environ Int, Vol. 136, 2020.

WWF (2019) Solving plastic pollution through accountability, 2019, Accessed 28 Mar 2022. From: http://awsassets.panda.org/downloads/solving_plastic_pollution_through_accountability_eng_spread.pdf.

Www3.Epa.Gov, 2021, https://www3.epa.gov/npdes/pubs/sector_y_rubberplastic.pdf. Accessed 21 Oct 2021.

Ya-Qi Zhang, Marianna Lykaki, Mohammad Taher Arajoula, Marta Markiewicz, Caroline Kraas, Sabrina Kolbe, Kristina Klinkhammer, Maike Rabe, Robert Klauer, Ellen Bendt and Stefan Stolte (2021) Microplastics from textile origin – emission and reduction measures, Institute of Water Chemistry, June 2021

Annex 2:
Stakeholder consultation (Synopsis report)

1 INTRODUCTION

The Impact Assessment accompanying the revision of this proposal included a thorough consultation process that included various consultation activities. During the process, the measures proposed for this proposal were consulted with stakeholders through bilateral meetings and stakeholder workshops (general and thematic). Furthermore, an Open Public Consultation and a Targeted Experts Survey and seven Stakeholder workshops have been conducted.

These consultation activities aimed to engage with stakeholders, inform them about the progress of the ongoing analysis, and gather information for the analysis. The starting point for these activities was the consultation strategy which was presented in the inception report. The main consultation activities included an Open Public Consultation (OPC), several workshops and bilateral consultation with different stakeholders. Initially, the consultation activities focused on the unintentional release from three sources: 1) plastic pellets; 2) synthetic textiles; and 3) tyre abrasion. Later, the activities were extended to three additional sources, viz. paints, detergent capsules, and geotextiles.

A summary of these consultation activities is presented below.

2 CONSULTATION STRATEGY

The consultation had the objective of gathering data and information to close the gaps in knowledge related to the following:

- sources, pathways and impacts of microplastics on the environment as well as the potential impact on human health;
- identification of measures to reduce the release of microplastics in the environment, e.g. labelling, standardisation, certification, voluntary and regulatory measures;
- views on possible reduction measures; and
- possible impacts of these measures on different stakeholders.

Through consultation activities, information was gathered on the state of awareness and knowledge of the general public regarding microplastic pollution and more information from experts and stakeholders involved directly or indirectly linked to microplastics release and on who can play an active role in reducing it.

The consultation strategy included these five main elements:

- Stakeholder identification and mapping;
- Open public consultation (OPC) (12-week long), with both closed and open-ended questions and the possibility to upload/send additional material;
- Several workshops with stakeholders; and

- Interviews with selected stakeholders to clarify and/or complement the information received through the targeted stakeholder survey.

3 Mapping of stakeholders

In the initial steps relevant stakeholders were identified. A dedicated website[4] for the underpinning study for this impact assessment was created where interested stakeholders could register; in total 327 stakeholders registered through the website. Some stakeholders are common to the six sources, while others are specific to each source area. The following are the views of the main groups of stakeholders:

- **Competent authorities in Member States**: Some Member States (e.g. France) have already started taking actions in this regard, and consulting them is crucial to ensure a coordinated effort to efficiently reduce microplastic pollution. In addition, the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) has adopted a recommendation on pellets as well as guidelines.

- **Relevant economic actors** along the value chain of the three sources (manufacturers, users, transporters, etc. covered by individual companies and trade associations). Being one of the main actors, they could provide an in-depth understating of microplastics release in the environment and potential reduction measures. Both voluntary commitments and business initiatives need to be understood as there are different industry initiatives that have already been set up by industry members to reduce and/or prevent microplastic pollution.

- **Civil society organisations**: Some NGOs are raising awareness about microplastic pollution and conducting monitoring at local, national and/or international levels.

- **Certification bodies and monitoring organisations**: There is still a lack of standardised methods for monitoring microplastics. These organisations can provide information on what can be achieved with the current state of analytical methods and information on standardisation efforts.

- **Academia, research and think tanks**: Microplastic pollution is an active field of research, and this has helped raise awareness about the impacts of this pollution. They will be able to contribute the latest research evidence and help bridge the science-policy interface.

- **EU Citizens**: User behaviour is an important issue in the case of textiles, tyres, paints and capsules and consulting citizens could provide useful insights on this aspect.

[4] European Commission, Website dedicated to 'Study on unintentional release of microplastics', 2021 (https://microplastics.biois.eu).

4 OPEN PUBLIC CONSULTATION

4.1 Scope and Objective

This public consultation aims to support the European Commission's initiative on microplastic pollution. This initiative focuses on microplastics that are unintentionally released into the environment such as resulting from the use of a product, for instance by fragmentation or abrasion. It focuses on the sources with the highest known releases:

1. Plastic Pellets (intermediate materials used for the fabrication of plastic items)

2. Synthetic Textiles

3. Tyre Abrasion

4. Paints, including Architectural and Marine Paints, Road Markings

5. Geotextiles (used for civil engineering works such as road construction, coastal erosion prevention, drainage, etc.)

6. Detergent Capsules for Laundry and Dishwashers.

This initiative does not address:

- Intentionally added microplastics to products (e.g., cosmetics, detergents, fertilisers coatings): they are subject to a separate initiative under the REACH Regulation.

- Microplastics resulting from the fragmentation of macroplastics: they are addressed by existing legislation such as the Single Use Plastics Directive.

This public consultation will help gather data and information to close the gaps in knowledge related to the following:

- Sources, pathways, and impacts of microplastics on the environment and on human health;

- Identification of measures to reduce the release of microplastics in the environment, e.g., labelling, standardization, voluntary and regulatory measures, behavioural change; and

- Views on possible reduction measures.

4.2 Data Preparation

In total, 411 responses were received, and 410 responses were used for the final analyses, see in Table 2: Final analyses of the received responses. Based on the division of the survey in various sections, some of which were not mandatory to answer, the team employed standard and specific cleaning procedures. Standard procedures consist of dealing with null values and spurious entries, where a respondent may have skimmed through the questionnaire without providing consistent answers. The team also employed a split and pivot to separate and transpose the responses of multiple-choice questions in individual rows.

Table 2: Final analyses of the received responses

Cleaning Criteria	Number
Total Raw Responses	411 (100%)
Number of responses omitted due to spurious personal information	0 (0%)
Number of responses omitted due to being duplicates	0 (0%)
Number of responses omitted for blank or unmeaningful submissions	1 (~2%)
Number of responses requiring altered metadata/stakeholder types	0 (0%)
Responses after Primary Cleaning	410

4.3 Clustering of Responses and Special Processing

The general section of the questionnaire detailed demographic information of the respondents, along with the sources of microplastic emissions that they would like to answer for, with each source having a detailed section later. Hence, the team had to first split and transpose respondents who answered for multiple sources and filter inconsistent answers.

Moreover, the division of general and expert sections of the questionnaire implies that respondents will skip the expert sections if they do not have technical knowledge on the specific industry in question. Here, we encounter primarily two responses for further processing – null values and responses marked *I don't know/Not Applicable*. Since the design of the questionnaire did not separate the latter response, the team was not able to filter spurious entries from the ones where the respondent knows the industry but does not know the answer to specific questions.

The cleaning problem at hand is further accentuated because of the low number of responses in the expert section – in general, nulls/*I don't know* accounted for more than 50% of the total responses and hence, omitting them across all sections will not be valuable.

Table 3: Special Cleaning of the Data

Cleaning Criteria	Number
Sample Size after Primary Cleaning	410 (100%)
Total number of responses after splitting multiple entries	410 (100%)
Number of responses omitted for duplicates after splitting multiple entries	0 (0%)
General Range of Responses in the Expert Sections after filtering	35-154 (8.5% -38%)
Number of responses requiring altered metadata/stakeholder types	0 (0%)
Total Responses for Analysis	410 (100%)

4.4 Open Answer Questions and Campaign Identification

The survey across all sections extracted other information and general comments on specific questions for measures to prevent microplastic emissions, if the respondent believes that more options can be assessed apart from the ones outlined in the survey. Here, the data extracted is qualitative and open ended. Hence, we need to highlight duplicate responses and plagiarized comments that are usually meant for lobbying purposes and to skew the distribution of responses. Using Tableau Prep, we remove duplicates and null values from the dataset using aggregation and filtering. Owing to the non-mandatory nature of the questions, a vast majority of the responses for open-text questions were nulls (~60-80%). Hence, textual and thematic duplicates that account for more than 2 responses per question were excluded from analysis. Moreover, irrelevant or comments duplicated from the questions themselves were excluded from thematic analysis. A detailed breakdown of the responses is provided in the thematic analysis.

4.5 Methodologies Employed

4.5.1 Analysis of Closed Questions

The questionnaire in general uses a five-pronged scale of agreeability ranging from *completely agree* to *completely disagree* with another response for respondents that do not possess sufficient knowledge to reply. The questionnaire is divided into four sections:

1. General information about the respondent
2. General views and opinions on microplastic and prevention measures
3. Specific sections on each highlighted source of microplastic emissions and prevention measures (subsections A-F)
4. Questions directed at all sources of microplastic emissions and prevention measures

The analysis of the consultation responses is purely descriptive, using visuals such as pie and stacked bar charts for composition of respondents based on demographics and general responses. For the bulk of the questionnaire including the expert sections, the team has employed highlighted tables. Such tables are quite informative as they are colour coded based on the observed frequency of the agreeability scale used for each question – the highest frequency of agreeability is coded with the deepest shade. Based on highlighted tables, one can immediately infer the general attitude towards an aspect of microplastic emissions and associated policy measures. For questions that outline a list of potential policy measures, the tables are broadly segregated into themes wherever applicable to enable a better understanding of thematic measures. Tables for each question per section are captioned with the number of respondents and an associated brief on frequencies as percentages of total count.

4.5.2 Analysis of Open Text Questions

The questionnaire includes 15 open text questions where respondents can provide more information about their attitude and position on a specific aspect of microplastics and associated policy. In such questions, respondents primarily are asked to provide more information if they agree with other aspects of microplastics than those specifically identified in the question. The thematic analysis of responses is done manually with the following broad steps:

> **Step 1:** *Exploring an analytical framework and discovering general content. We identified keywords and an inspection of the topics relating to the key word. Then, we logically deduce general topics for inclusion into the analytical framework. We also highlight and discard the presence of campaigns and duplicate/plagiarized responses in absolute number and percentage of total count. The purpose of this analytical framework is to ensure that the analysis is rooted in and builds upon core topics of interest.*

Step 2: *Revising keywords and exploring themes. We revisit the keywords defined in Step 1 and check for dominating correlations among them. Recurrent and similar keywords are discarded or merged to form another synonymous keyword. Based on the assignment outlined, we then segment responses based on the frequency of the keyword embedded in it using tables with grand totals.*

4.6 Part I. Respondent Profile

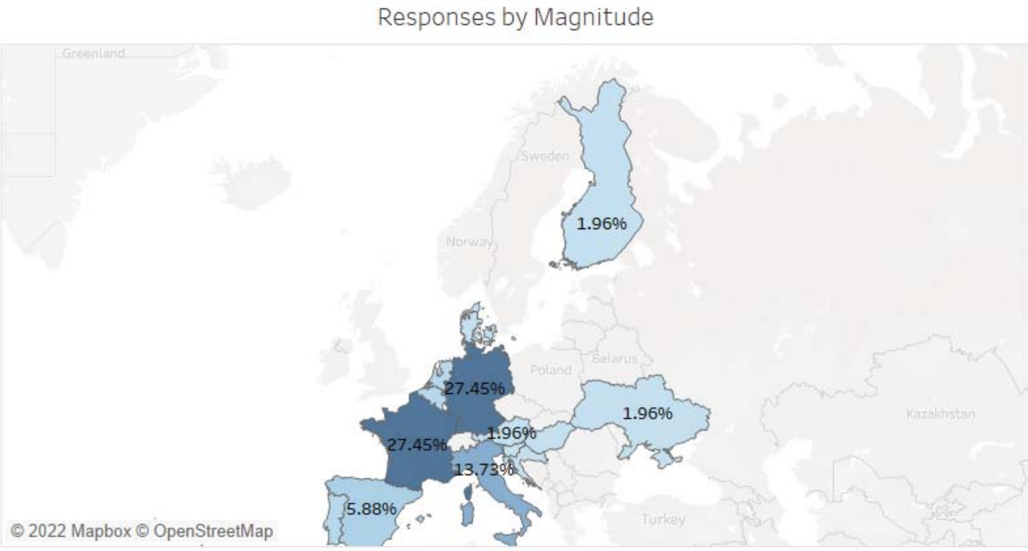
This section summarizes the distribution of respondents across Europe and other general indicators of their demographics such as the percentage share of stakeholders, composition of organization respondents, and sources of microplastic emissions answered for. Figures 7-9 visually detail the same.

Most respondents were from France and Germany, with an equal split of about 28%, followed by Italy and Spain with 14% and 6% respectively.

EU citizens represented the highest share in total responses (30%), followed by company/business organisations (20%), business associations (18%), consumer and environmental NGOs (14%) and academic/research institutions (10%). Public authorities represented 4% of the respondents, and non-EU citizens and other respondents 2% each, as shown in Figure 2.

Among Company/Businesses Organizations, respondents were divided into four groups depending on company size. Micro enterprises (1-9 employees) were represented by 24%, small enterprises (10-49 employees) 11%, medium enterprises (50-249 employees) 15%, large-sized companies (employing 250 or more employees) about 50%. A full breakdown of companies by size is presented in Figure 3.

Most respondents wished to address Textiles as a source of microplastic emissions (21%), followed by Pellets (19%) and Detergent Capsules (17%). Paints and Tyres were addressed by 15% of the respondents while Geotextiles by 11%.



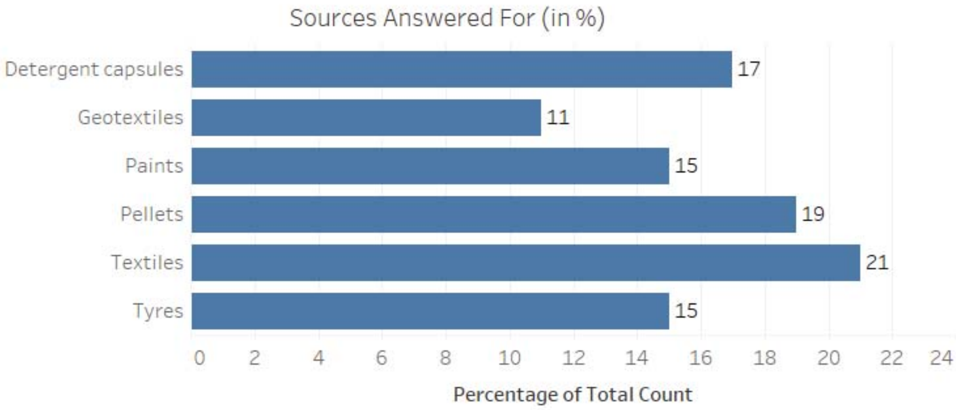


Figure 1: Composition of Responses by Country and Sources Answered

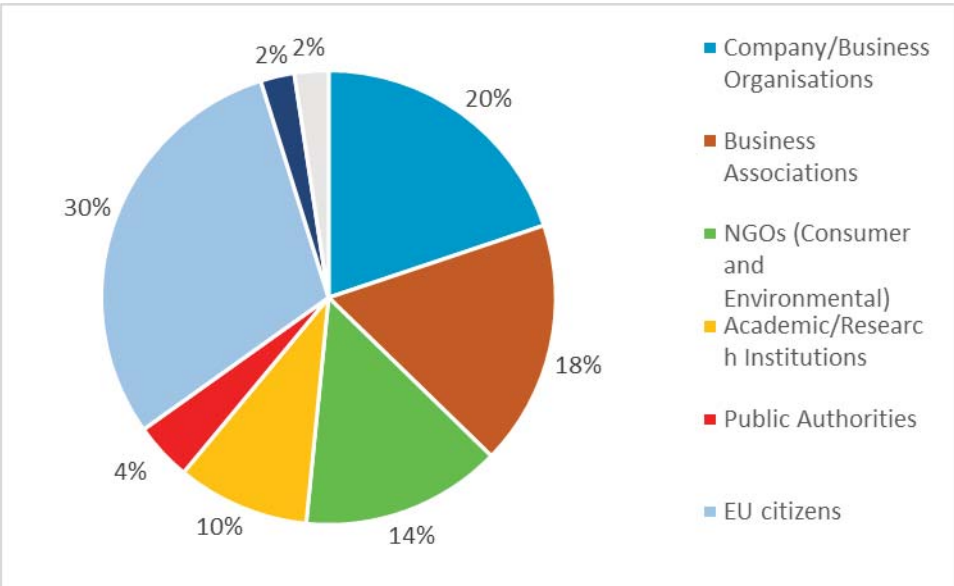


Figure 2: Distribution of Responses, Total

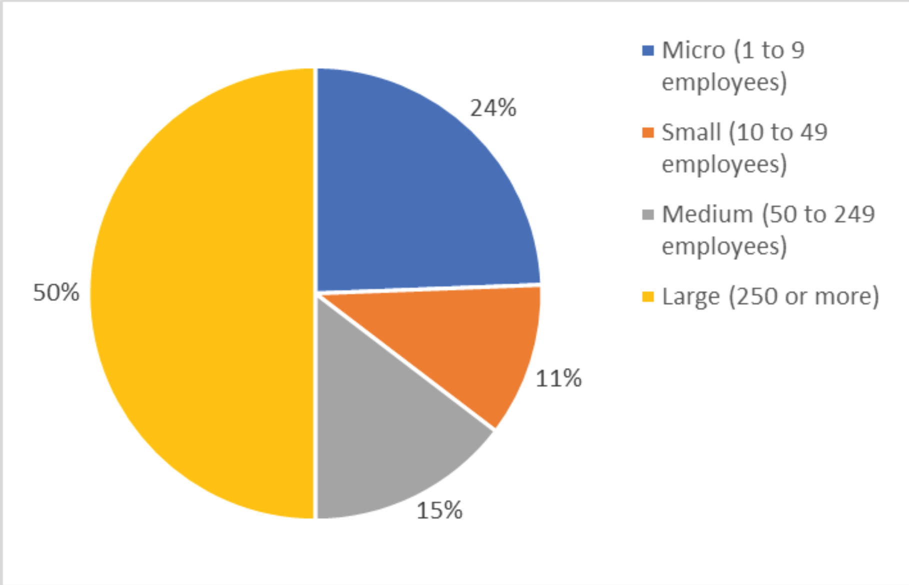


Figure 3: Size of Organisations

4.7 OPC Results

The following section details visuals and summarizes the responses received within each section of the questionnaire. The highlighted tables are populated and aggregated by stakeholder composition. The summary following each table briefly explains general attitudes for each aspect of microplastics by country of origin with the highest responses. Creating visuals for attitudes by country has been omitted due to low response shares and the lack of a representative sample.

4.7.1 Part II. General Public

1. *Please indicate to which extent you agree with the following concerns as to microplastic pollution (N=410)*
   a) Overall, 76% of EU citizens agree with the **hazardous nature of microplastic** emissions, while about 16% somewhat agree. About 91% of NGOs, 67% of research institutions and 56% of business organisations completely recognise the hazards of microplastics. EU citizens (67%) completely agree with the **harmful effects of microplastics on humans via ingestion and inhalation**, whereas about 19% somewhat agree. About 41% and 20% of business organisations completely and somewhat agree on the same. More details on health concerns are shown in Figure 4.
   b) NGOs (88%), research institutions (77%), public authorities (69%), EU citizens (70%) and non-EU citizens (90%) completely agree with the **long-distance transmission of microplastics**, while 58% of business organisations and 24% of business associations completely agree to the same.
   c) Among EU citizens 75% and NGOs 88% completely agree with the **persistence of microplastics**. About 48% of business organisations and about 31% of business associations agree completely with the same. More details on the accumulations and persistence of microplastics are shown in Figure 5.
   d) Regarding the **harmful economic effects of microplastics**, EU citizens overall were spread out across the scale, where about 43% completely agree, 15% somewhat agree, and 29%

maintain a neutral stance. Business associations showed a similar pattern, and around 50% of business organisations agreed or somewhat agreed, while 65% of NGOs completely agreed with the statement.

e) Around 25% of Company/Business Organisations and Public Authorities completely agree with **plant assimilation of microplastics** while 68% of NGOs and 43% or EU Citizens are in the same scale.

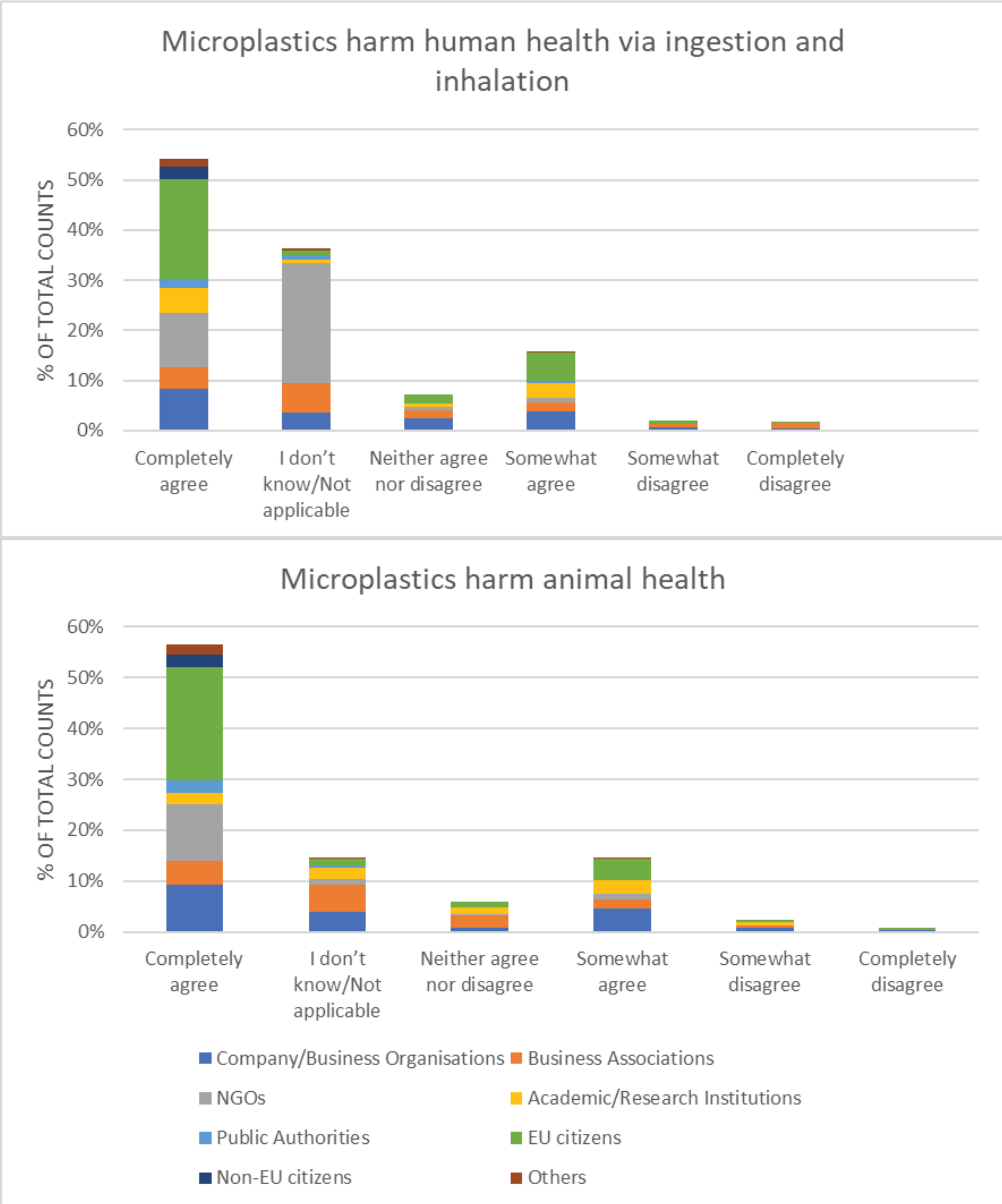


Figure 4: Microplastic Pollution: Health Concerns

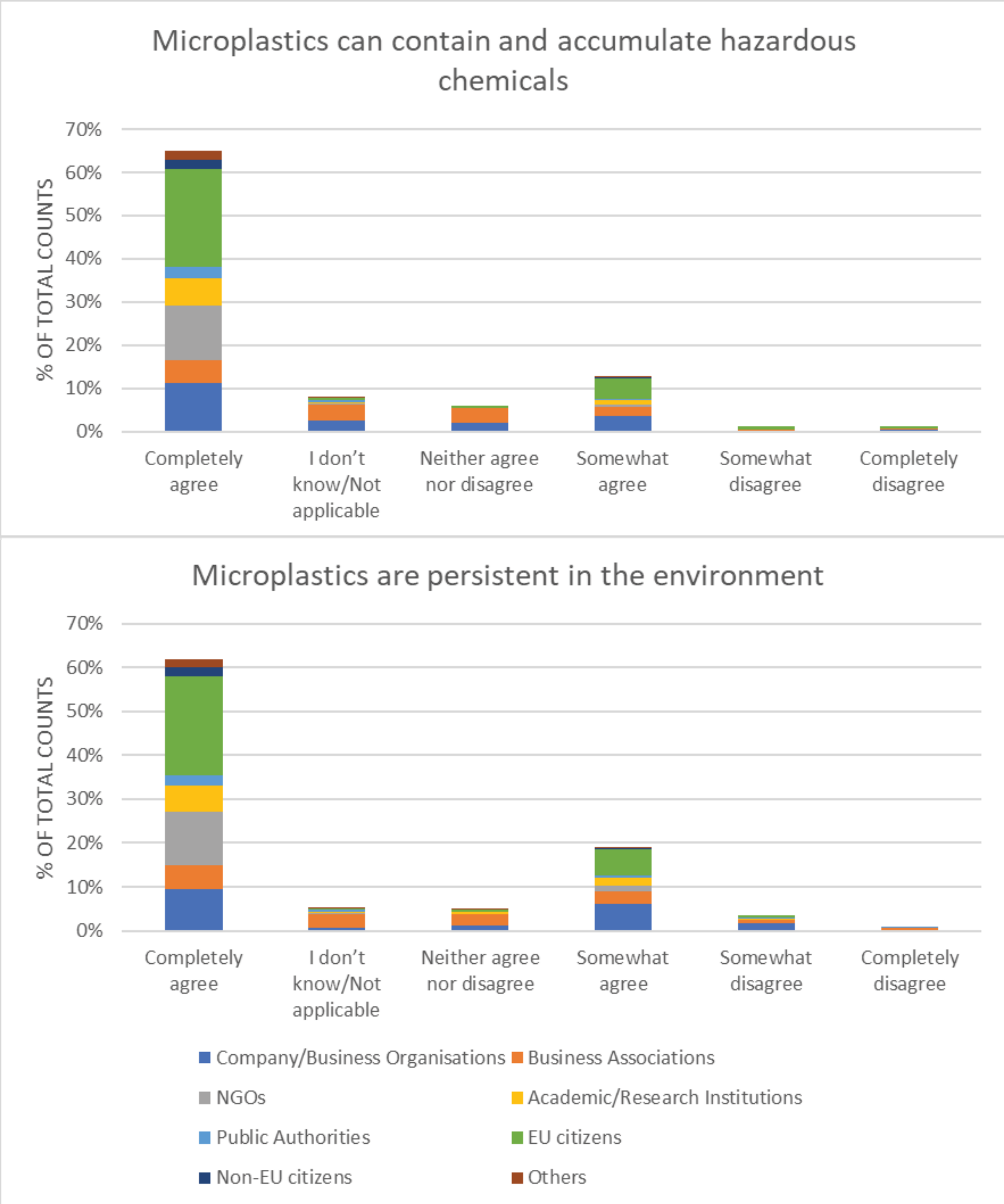


Figure 5: Microplastic Pollution: Accumulation and Persistence

Table 4: Microplastic Pollution: Other Concerns – Plants Assimilate Microplastics and Microplastics Harm the Economy

Plants Assimilate Microplastics						
Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	24%	6%	42%	14%	10%	
Business associations	13%	6%	43%	11%	5%	4%
NGOs	68%		17%	2%	12%	
Academic/Research Institutions	17%	2%	12%	18%	38%	5%
Public Authorities	25%		31%	6%	19%	
EU citizens	43%	5%	22%	8%	16%	4%
Non-EU citizens	90%		10%			
Others	50%		20%	10%	20%	

Microplastics Harm the Economy						
Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	29%	4%	20%	11%	21%	11%
Business associations	15%	7%	29%	14%	8%	13%
NGOs	65%	2%	14%	4%	12%	4%
Academic/Research Institutions	21%		23%	3%		
Public Authorities	31%		31%	13%	6%	
EU citizens	43%	5%	10%	19%	15%	5%
Non-EU citizens	80%				10%	10%
Others	50%		10%		30%	10%

2. To reduce microplastics pollution, how and at what level should the action be (N=410)

There is an overwhelming agreement among all stakeholders to undertake action at all levels of authority. Almost all respondents agree with voluntary measures (64%), regulatory measures (87%) and international action (95%).

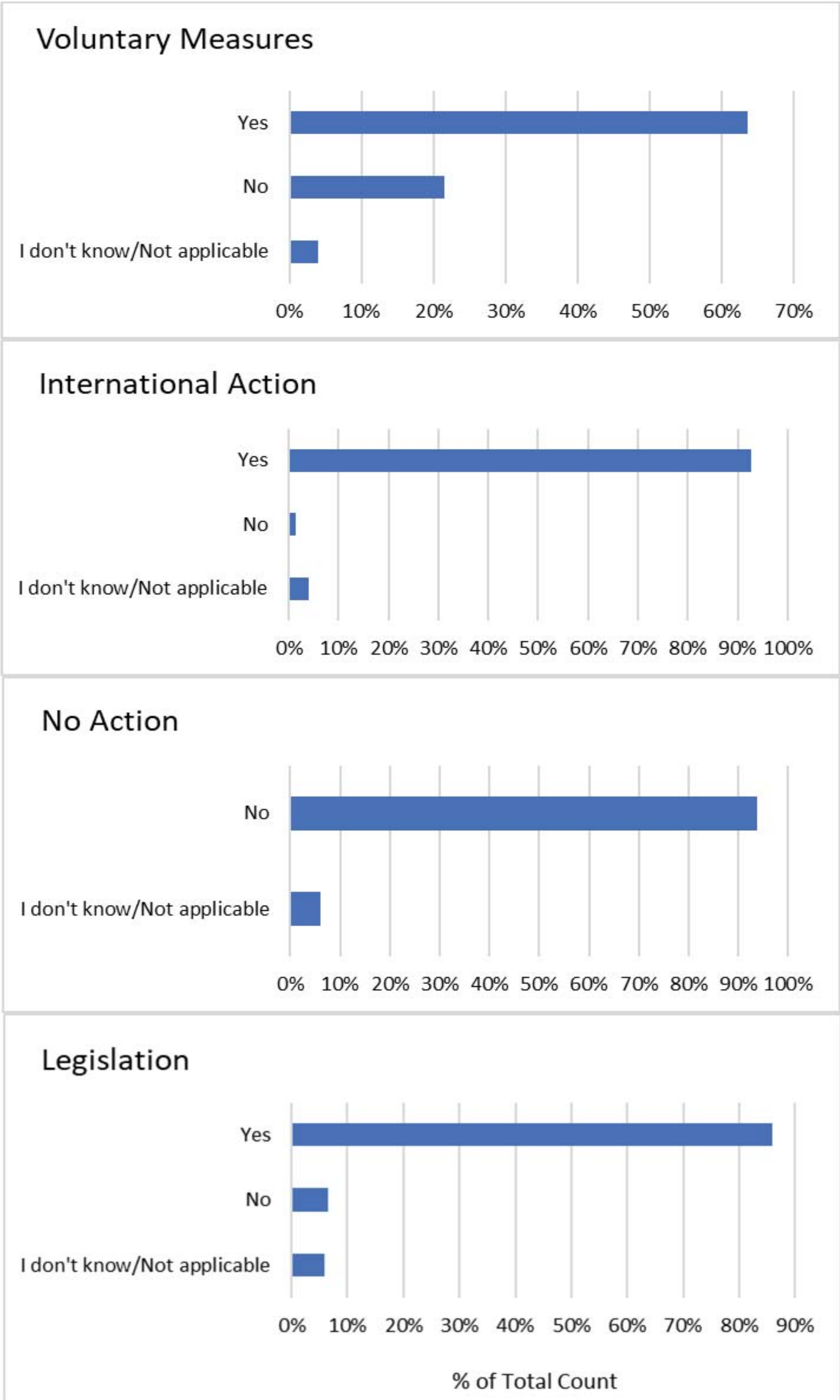


Figure 6: Agreement on the Level of Measures

3. *To what extent would you agree to buy a product that releases less microplastics, even if it costs more? (N=357)*

   a) There is general agreement on buying a variety of products if they're made to be sustainable but expensive, except Business Association where more than 50% remained neutral.
   b) Academic/Research Institutions (75%) completely agree to buy sustainable clothing and around 70% of EU citizens and NGOs and 47% of Company/Business Organisations are on the same opinion.
   c) Most of all stakeholders completely or somewhat agree to buy sustainable furniture, sustainable detergent capsules, sustainable painted products, sustainable paints and sustainable tyres at higher prices while Business associations remain rather neutral. More details are show in Table 5 and Table 6.

Table 5: Sustainable Choices for Households (1-3): Would you buy sustainable clothing at higher prices? – Would you buy sustainable furniture at higher prices? – Would you buy sustainable detergent capsules at higher prices?

Would you buy sustainable clothing at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	47%		27%	3%	19%	3%
Business associations	32%		56%	2%	9%	
NGOs	69%	2%	17%	3%	7%	
Academic/Research Institutions	76%		8%	3%	14%	
Public Authorities	67%		25%		8%	
EU citizens	72%	2%		6%	18%	2%
Non-EU citizens	80%				20%	
Others	50%		20%	10%	20%	

Would you buy sustainable furniture at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	38%	3%	27%	8%	18%	5%
Business associations	30%		56%	5%	5%	2%
NGOs	68%	2%	17%	3%	8%	
Academic/Research Institutions	62%		8%	8%	14%	5%
Public Authorities	50%		25%	8%	17%	
EU citizens	67%	3%	2%	7%	17%	3%
Non-EU citizens	80%				20%	
Others	60%		20%		20%	

Would you buy sustainable detergent capsules at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	49%		27%	5%	17%	
Business associations	28%		60%	4%	5%	
NGOs	68%	2%	20%	3%	5%	
Academic/Research Institutions	73%		8%	5%	8%	
Public Authorities	67%		25%		8%	
EU citizens	72%	2%	6%	5%	14%	2%
Non-EU citizens	80%				20%	
Others	60%		20%		20%	

Table 6: Sustainable Choices for Other Durables (1-3): Would you buy sustainable painted products at higher prices? – Would you buy sustainable paints at higher prices? – Would you buy sustainable tyres at higher prices?

Would you buy sustainable painted products at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	38%	6%	27%	8%	17%	3%
Business associations	23%	5%	56%	2%	9%	2%
NGOs	47%	2%	19%	20%	8%	2%
Academic/Research Institutions	62%		8%	5%	19%	
Public Authorities	50%		25%	8%	8%	
EU citizens	63%	2%	4%	11%	19%	2%
Non-EU citizens	80%				20%	
Others	60%		20%		20%	

Would you buy sustainable paints at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	42%	3%	26%	8%	14%	6%
Business associations	26%	2%	56%	2%	7%	4%
NGOs	63%	2%	19%	7%	8%	
Academic/Research Institutions	65%		8%	3%	19%	
Public Authorities	50%		25%	8%	8%	
EU citizens	63%	3%	4%	7%	21%	1%
Non-EU citizens	90%				10%	
Others	50%		20%	10%	20%	

Would you buy sustainable tyres at higher prices?

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	43%	1%	30%	5%	16%	5%
Business associations	28%	2%	58%	2%	5%	4%
NGOs	69%		17%	3%	8%	2%
Academic/Research Institutions	73%		5%		14%	3%
Public Authorities	67%		25%		8%	
EU citizens	69%	2%	4%	7%	16%	2%
Non-EU citizens	80%		10%		10%	
Others	50%		20%		30%	

4.7.2 Part III. Expert Section

Part III contains questions for which expert knowledge is required, but all types of respondents are welcome to respond. It includes questions on the sources of microplastics pollution being assessed by the European Commission (pre-production pellets, tyre wear particles, synthetic textiles, paints, geotextiles, and detergent capsules) and on the policy measures reducing unintentional release of microplastics.

Note: Based on the pattern of responses, it appears from preliminary analysis that all Business Associations (n=12) tend to skew responses using neutral or moderate scales. While open text comments cannot throw conclusive light on the issue, this can appear as a campaign and must be examined and further discounted.

4.7.2.1 Pre-Production Pellets (N=164)

1. *To what extent would you agree with the following weaknesses on how current systems deal with pellets?*
   - *a)* Most of Public Authorities (75%), NGOs (76%), Academic/Research Institutions (67%) and EU Citizens (64%) and half of the Company/Business Organisations *completely or somewhat agree* on the **lack of risk assessment of pellet handling activities by companies**, however, Business Associations are more widespread on the scale and maintain a rather neutral stance. (See Table 7)
   - *b)* Most NGOs (74%), Company/Business Organisations (52%), Academic/Research Institutions (75%) and EU Citizens (51%), *completely or somewhat agree* on the **lack of independent audit policies**, but Business Associations and Public Authorities remain neutral. (See Table 7Table 7)

c) NGOs, Business Associations and Company/Business Organisations stay rather neutral on the **lack of economic incentives** while half of Academic/Research Institutions and EU citizens *completely agree*. (See Table 7)

d) NGOs (64%) *completely agree* with the **improper handling of pellet-related activities** and with the **improper transferring protocols** while other stakeholders remain rather neutral. (See Table 8)

e) NGOs (68%), Public Authorities (54%) and Company/Business Organisations (41%) *completely or somewhat agree* on **improper worker training** while Business Associations remain neutral. (See Table 8)

f) NGOs (65%) *completely agree* on **improper sealing of packages** and on **improper handling of pellets**, while Business Associations, Company/Business Organisations and Public Authorities maintain a neutral position. (See Table 8)

g) NGOs (68%) *completely disagree* while other stakeholders remain rather neutral on **the expensive cost of prevention equipment**. (See Table 9)

h) There is general agreement among almost all stakeholders for **the lack of accounting for pellet discharge.** Business Associations mostly however *completely or somewhat disagree* with the statement. (See Table 9)

Table 7: Specific Shortfalls (1-3): Lack of Risk Assessment of Pellet Handling Activities by Companies; Lack of Independent Auditing and Lack of Economic Incentives

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Lack of Risk Assessment of Pellet Handling Activities by Companies						
Company/Business Organisations	34.48%	20.69%	3.45%	10.34%	17.24%	13.79%
Business associations		36.36%	9.09%	13.64%	22.73%	18.18%
NGOs	69.49%	1.69%	16.95%	3.39%	6.78%	
Academic/Research Institutions	33.33%		16.67%		33.33%	8.33%
Public Authorities	67%		25.00%		8.33%	
EU citizens	47.17%	5.66%	13.21%	3.77%	16.98%	5.66%
Non-EU citizens	100%					
Others			66.67%		33%	
Lack of Independent Auditing						
Company/Business Organisations	34.48%	20.69%	17.24%	6.90%	17.24%	3.45%
Business associations	18.18%	22.73%	13.64%	22.73%	9.09%	13.64%
NGOs	67.80%		25.81%		6.45%	
Academic/Research Institutions	50.00%		25.00%		25.00%	
Public Authorities	36.36%		36.36%	27.27%		
EU citizens	39.62%	5.66%	18.87%	13.21%	11.32%	
Non-EU citizens	67%		33.33%			
Others	33.33%		67%			
Lack of Economic Incentices						
Company/Business Organisations	31.03%	17.24%	10.34%	24.14%	17.24%	
Business associations	13.64%	27.27%	9.09%	22.73%	13.64%	9.09%
NGOs	19.35%	9.68%	25.81%	29.03%	12.90%	
Academic/Research Institutions	50.00%	8.33%	8.33%	25.00%	8.33%	
Public Authorities	45.45%	9.09%	18.18%		18.18%	
EU citizens	56.60%	9.43%	3.77%	9.43%	11.32%	1.89%
Non-EU citizens	100%					
Others			67%		33.33%	

Table 8: Operational Issues (1-5): Improper Transferring Protocols; Improper Worker Training; Improper Storage Protocols; Improper Sealing of Packages and Improper Handling

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
			Improper Transferring Protocols			
Company/Business Organisations	20.69%	17.24%	24.14%	3.45%	24.14%	10.34%
Business associations		27.27%	18.18%	13.64%	22.73%	13.64%
NGOs	64.52%		25.81%	3.23%	6.45%	
emic/Research Institutions	16.67%		33.33%	8.33%	41.67%	
Public Authorities	27.27%		36.36%	9.09%	18.18%	
EU citizens	24.53%	7.55%	26.42%	13.21%	11.32%	9.43%
Non-EU citizens	67%				33.33%	
Others			100%			
			Improper Worker Training			
Company/Business Organisations	20.69%	17.24%	13.79%	6.90%	20.69%	17.24%
Business associations	9.09%	31.82%	13.64%	9.09%	18.18%	18.18%
NGOs	61.29%		25.81%	6.45%	6.45%	
emic/Research Institutions	25.00%		33.33%	16.67%	25.00%	
Public Authorities	45.45%		27.27%	18.18%	9.09%	
EU citizens	33.96%	5.66%	20.75%	9.43%	18.87%	5.66%
Non-EU citizens	67%		33.33%			
Others			100%			
			Improper Storage Protocols			
Company/Business Organisations	17.24%	20.69%	24.14%	3.45%	20.69%	13.79%
Business associations		36.36%	13.64%	13.64%	4.55%	27.27%
NGOs	64.52%		25.81%	3.23%	6.45%	
emic/Research Institutions	16.67%		33.33%	25.00%	16.67%	8.33%
Public Authorities	18.18%		45.45%	18.18%	18.18%	
EU citizens	20.75%	11.32%	24.53%	13.21%	16.98%	7.55%
Non-EU citizens	67%		33.33%			
Others			100%			

Improper Sealing of Packages						
Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	13.79%	17.24%	20.69%	10.34%	17.24%	20.69%
Business associations	4.55%	31.82%	22.73%	13.64%	9.09%	18.18%
NGOs	64.52%		25.81%	3.23%	6.45%	
demic/Research Institutions	25.00%		25.00%	25.00%	25.00%	
Public Authorities	27.27%		36.36%	18.18%	18.18%	
EU citizens	32.08%	5.66%	13.21%	15.09%	15.09%	13.21%
Non-EU citizens	67%		33.33%			
Others	33.33%		67%			
Improper Handling						
Company/Business Organisations	31.03%	31.03%	13.79%	6.90%	6.90%	10.34%
Business associations		31.82%	18.18%	13.64%	4.55%	27.27%
NGOs	64.52%		25.81%	3.23%	6.45%	
demic/Research Institutions	25.00%		25.00%	16.67%	25.00%	8.33%
Public Authorities	36.36%	9.09%	27.27%	18.18%	9.09%	
EU citizens	26.42%	7.55%	24.53%	7.55%	20.75%	5.66%
Non-EU citizens	100%					
Others			100%			

Table 9: Miscellaneous Operational Issues (1-2): Expensive Prevention Equipment and Not Accounting for Pellet Discharge

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
			Expensive Prevention Equipment			
Company/Business Organisations	13.79%	20.69%	24.14%	13.79%	10.34%	13.79%
Business associations		4.55%	22.73%	31.82%	18.18%	22.73%
NGOs	3.23%	67.74%	22.58%	3.23%	3.23%	
Academic/Research Institutions		16.67%	33.33%	25.00%	16.67%	8.33%
Public Authorities	9.09%	9.09%	36.36%	36.36%	9.09%	
EU citizens	11.32%	9.43%	39.62%	15.09%	11.32%	5.66%
Non-EU citizens	33.33%		67%			
Others			100%			
			Not Accounting for Pellet Discharge			
Company/Business Organisations	37.93%	13.79%	3.45%	10.34%	20.69%	10.34%
Business associations	18.18%	13.64%	13.64%		13.64%	36.36%
NGOs	70.97%		22.58%		6.45%	
Academic/Research Institutions	83.33%				16.67%	
Public Authorities	54.55%		9.09%	18.18%	18.18%	
EU citizens	62.26%	7.55%	7.55%	1.89%	11.32%	3.77%
Non-EU citizens	100%					
Others	33.33%		67%			

2. *To what extent would you agree with the following non-regulatory measures improving voluntary schemes?*

   a) There is general agreement with all stakeholders that the **industry should prioritize preventive measures**. Most of the NGOs (63.16%), Academic/Research Institutions (100%), EU citizens (67.92%), Non–EU citizens (100%), and Public Authorities (63.64%) *completely agree* that clearer **public reporting,** transparency and tracking of progress measures improve voluntary schemes. (See Table 10)

   b) Most of the Academic/Research Institutions (58%), EU citizens (49.6%) and Non–EU citizens (100%) *completed agree*, while Businesses Associations (40%) *completely disagree* with an initiative on the **industry to create a remediation fund**. (See Table 10)

   c) All stakeholders *completely or somewhat agree* on **independent auditing**. (See Table 11)

   d) Academic/Research Institutions (92%), Company/Business Organisations (59%), Business Associations (59%) and EU citizens (61%) *completely or somewhat* agree on the importance of **multi stakeholders' governance**, while 42% EU Citizens *completely agree* on the same. (See Table 11)

Table 10: Industry Measures (1-3): Industry to Prioritise Preventive Measures; Industry to Create Remediation fund and Public Reporting

Industry to Prioritise Preventive Measures

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	59%			7%	31%	3%
Business associations	55%			14%	32%	
NGOs	65%		26%	3%	6%	
Academic/Research Institutions	67%	8%	8%		17%	
Public Authorities	64%		18%		18%	
EU citizens	72%	2%	2%	4%	13%	4%
Non-EU citizens	67%			33%		
Others	33%		67%			

Industry to Create Remediation fund

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	31%	24%	21%	10%	7%	7%
Business associations	14%	41%	18%	9%	14%	5%
NGOs	26%		19%	3%	6%	6%
Academic/Research Institutions	58%			17%	25%	
Public Authorities	36%		9%	36%	9%	
EU citizens	49%	11%	8%	11%	15%	2%
Non-EU citizens	100%					
Others	33%		67%			

Public Reporting

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	32%	7%	11%	18%	29%	4%
Business associations	32%	5%	9%	23%	32%	
NGOs	63%		21%	5%	5%	5%
Academic/Research Institutions	100%					
Public Authorities	64%	9%	18%		9%	
EU citizens	68%			6%	19%	4%
Non-EU citizens	100%					
Others			67%		33%	

Table 11: Miscellaneous Measures (1-2): Independent Auditing and Multi Stakeholders' Governance

Independent Auditing

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	38%	7%	3%	14%	28%	7%
Business associations	45%	5%		23%	23%	5%
NGOs	68%		26%		6%	
Academic/Research Institutions	83%		8%		8%	
Public Authorities	64%		18%	9%	9%	
EU citizens	64%	2%	9%	4%	13%	2%
Non-EU citizens	100%					
Others	33%		67%			

Multi Staleholders' Governance

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	38%	3%	21%	14%	21%	
Business associations	36%	5%	5%	32%	23%	
NGOs	44%	6%	28%		17%	6%
Academic/Research Institutions	50%			8%	42%	
Public Authorities	27%		36%		27%	
EU citizens	42%	4%	11%	15%	19%	2%
Non-EU citizens	67%		33%			
Others			100%			

3. *To what extent would you agree with the following regulatory measures for pellet loss prevention?*
   a) Business Associations and Company/Business Organisations are widespread on the agreement scale while for other stakeholders there is general agreement on the need for **EU legislation to set up a comprehensive system for pellet handling companies**. (See Table 12)
   b) There is a general agreement (*completely or somewhat agree*) among all stakeholders for **international measures**. The same inference applies to **extended producer responsibility** where only Business Associations (50%) remain rather neutral**.** (See Table 12)

Table 12: Regulatory Measures (1-3): International Approaches; Extended Producer Responsibility and EU Legislation for Pellet Handling

International Approaches

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	48%	3%	21%		24%	3%
Business associations	32%		27%	23%	18%	
NGOs	87%		10%		3%	
Academic/Research Institutions	67%			8%	25%	
Public Authorities	73%		9%		18%	
EU citizens	79%	2%		2%	13%	2%
Non-EU citizens	100%					
Others	33%		67%			

Extended Producer Responsibility

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	41%	10%	7%	10%	14%	17%
Business associations	23%	27%	14%	9%	14%	9%
NGOs	90%		10%			
Academic/Research Institutions	75%				25%	
Public Authorities	64%	9%	9%		9%	9%
EU citizens	75%	2%	2%	4%	9%	4%
Non-EU citizens	100%					
Others	33%		67%			

EU Legislation for Pellet Handling

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	38%	21%	7%	3%	17%	14%
Business associations	23%	36%	14%		18%	9%
NGOs	81%		10%		10%	
Academic/Research Institutions	50%			8%	42%	
Public Authorities	91%		9%			
EU citizens	66%	6%		8%	17%	2%
Non-EU citizens	100%					
Others			67%		33%	

4. Open Text Comments

a) Respondents (n=1) maintain that the main issue is **awareness of pellets as hazardous substances**. As an application, they consult on using **International Maritime Dangerous Goods (IMDG) Codes on pellet transportation** with contingency plans for safe transport along with emergency policies among companies to manage pellet spills.

b) Another respondent (n=2) agrees on **improper management at the plant and transportation network.** Apart from **legislative penalties**, they consult **on tracers for pellets** to pinpoint producer responsibility during transport. There also exists awareness that the **level of measures undertaken are voluntary at the industry level**, which needs more control to ensure compliance.

c) There is another suggestion (n=1) on **balancing legislative compliance between consumers and producers**, where the respondent observes the incidence of excessive burden on EU producers.

d) There is disagreement (n=1) on **the extent of knowledge among public authorities of the modus operandi** of the industry as well as the concepts of **extended producer responsibility.**

4.7.2.2 Tyre Wear Particles (N=154)

1. To what extent would you agree with the following measures to reduce microplastic emissions from tyres?

a) All stakeholders *completely or somewhat agree* to have **tyres designed to reduce abrasion**. (See Table 13)

b) There is support among most stakeholders to propose **labelling of tyres in terms of abrasion**, whereas Business Associations (42%) remain neutral. (See Table 13)

c) All stakeholders *completely or somewhat agree* on **legal limits on tyre abrasion** (see Table 14)

d) Businesses associations (52%), Company/Business organisations (55%) and EU citizens (52%) *completely agree* on **requirements on road infrastructure** while Academic/Researchers Institutions (46%) and Public Authorities (55%) *somewhat agree*. (See Table 14)

e) All stakeholders *completely or somewhat agree* on the **capture and treatment of road run-off water** where NGOs are split between agreement (44%) and disagreement (40%). All stakeholders *completely or somewhat agree* for **improvements in road cleaning in high-emission spots.** (See Table 15)

f) Businesses Associations, NGOs and EU citizens *somewhat or completely agree* with implementing **AI and advanced assisted driving technologies**, whereas Academic/Researchers Institutions and Public Authorities are neutral or somewhat agree. (See Table 15)

Table 13: Design Parameters (1-2): Tyres Designed to Reduce Abrasion and Labelling of Tyres in terms of Abrasion

Tyres Designed to Reduce Abrasion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree
Company/Business Organisations	72%				28%
Business associations	42%	37%			21%
NGOs	95%				3%
Academic/Research Institutions	54%			8%	38%
Public Authorities	67%		22%		11%
EU citizens	70%	4%	7%	7%	13%
Non-EU citizens	100%				
Others	100%				

Labelling of Tyres in terms of Abrasion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree
Company/Business Organisations	50%			6%	44%
Business associations	37%			42%	21%
NGOs	85%		3%	3%	10%
Academic/Research Institutions	62%				38%
Public Authorities	56%		11%	11%	22%
EU citizens	59%	4%	9%	7%	20%
Non-EU citizens	100%				
Others	100%				

Table 14: Regulations (1-3): Legal Limits on Tyre Abrasion; Requirements on Road Infrastructure and Higher Fees in Extended Producer Responsibility

Legal Limits on Tyre Abrasion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	53%		12%	12%	24%	
Business associations	68%			16%	16%	
NGOs	95%		3%		3%	
Academic/Research Institutions	54%			31%	15%	
Public Authorities	44%		11%	11%	33%	
EU citizens	59%	4%	9%	4%	20%	4%
Non-EU citizens	100%					
Others	100%					

Requirements on Road Infrastructure

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	56%			6%	33%	
Business associations	53%		11%	11%	16%	11%
NGOs	25%		8%	43%	15%	10%
Academic/Research Institutions	23%			23%	46%	8%
Public Authorities	11%		22%		56%	11%
EU citizens	52%	2%	4%	11%	22%	9%
Non-EU citizens	100%					
Others	25%		25%		25%	25%

Higher Fees in Extendedd Producer Responsibility

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	50%		22%	11%	11%	6%
Business associations	37%	42%	5%		16%	
NGOs	80%	3%			13%	5%
Academic/Research Institutions	38%	8%		23%	31%	
Public Authorities	33%				67%	
EU citizens	65%	7%	2%	11%	15%	
Non-EU citizens	100%					
Others	50%				50%	

Table 15: Tech Improvements (1-3): Improve Road Cleaning in High Emission Spots; Artificial Intelligence and Advanced Driver Technology and Capture and Treat Road Run-Off Water

Improve Road Cleaning in High Emission Spots

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	44%		11%	11%	28%	
Business associations	53%			11%	21%	11%
NGOs	23%		3%	13%	55%	5%
Academic/Research Institutions	54%			23%	23%	
Public Authorities	44%		22%	11%	22%	
EU citizens	65%	2%	9%	11%	13%	
Non-EU citizens	100%					
Others				25%	75%	

Artificial Intelligence and Advanced Driver Technology

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	39%		17%	22%	6%	11%
Business associations	11%		5%	21%	58%	5%
NGOs	13%	5%	8%	15%	55%	5%
Academic/Research Institutions	15%	15%	15%	31%	15%	8%
Public Authorities	11%		44%		44%	
EU citizens	30%	13%	11%	17%	24%	4%
Non-EU citizens	100%					
Others			50%		50%	

Capture and Treat Road Run-Off Water

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	50%		6%	22%	17%	
Business associations	21%			11%	58%	11%
NGOs	33%		3%	13%	13%	40%
Academic/Research Institutions	54%			8%	38%	
Public Authorities	44%		11%	11%	33%	
EU citizens	67%	2%	4%	9%	17%	
Non-EU citizens	100%					
Others	50%				50%	

1. *Open Text Comments*
   a) Responses (n=2) include an emphasis on **improving public transport** to reduce traffic congestion and regulate demand for private vehicles, along with better **management of freight transport.**
   b) Another respondent points **out potential emission issues with the measures listed** on the survey – the intentional and inevitable nature of tyre production vis-à-vis microplastic emissions, AI as a redundant solution, and further contamination from cleaning roads with brushes**.**

4.7.2.3 Synthetic Textiles (N=154)

1. *During which phase of the life cycle, microplastics emissions from textiles are the most significant?*
   a) Most stakeholders believe that emissions from **manufacturing of synthetic fibres, thread, yarn, and other raw material for garment production** are very significant while the response of Business Associations is spread across the significance chart. (See Table 16)
   b) All stakeholders believe that **emissions from garment production** are very significant while the responses of Business Associations and EU citizens' responses are spread across the significance scale**.** (See Table 16)
   c) **Emissions from pre-wash cycles after production** are very significant for all the stakeholders. (See Table 16)
   d) On the consumer end, **garment wear** contributes significantly to emissions for most EU Citizens (62%), while Business Associations (40.6%), and Public Authorities (44.4%) find it very little significant. (See Table 17)
   e) All stakeholders overwhelmingly attribute **use-phase washing cycles** as a very significant contributor to microplastic emissions while **use-phase drying cycles** as a source is more distributed in scale of significance – 70.8% of Academic/Researchers Institutions find it very significant and 44% of Public Authorities find it little significant. (See Table 17)
   f) A garment's **end of life** holds high significance for the stakeholders in terms of emissions. Here, only Public Authorities (44%) believe it is completely insignificant. (See Table 17)

Table 16: Production and Consumer Usage I (1-3): Manufacturing of Synthetic Fibres, Thread, Yarn, other Raw Materials for Garment Production; Emission from Garment Production and Emission from Pre-Wash Cycles after Production

Manufacturing of Synthetic Fibres, Thread, Yarn, other Raw Materials for Garment Production

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations	3%	10%	23%	50%	15%
Business associations		31%	28%	22%	19%
NGOs		4%	10%	67%	18%
Academic/Research Institutions		8%	29%	50%	13%
Public Authorities		30%	20%	40%	10%
EU citizens	3%	12%	22%	41%	22%
Non-EU citizens		10%	10%	70%	10%
Others			33%	50%	17%

Emission from Garment Production

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations	3%	8%	30%	40%	20%
Business associations		34%	25%	25%	16%
NGOs		2%	18%	57%	22%
Academic/Research Institutions			26%	52%	22%
Public Authorities		11%	33%	44%	11%
EU citizens	1%	15%	27%	33%	24%
Non-EU citizens			20%	70%	10%
Others			33%	50%	17%

Emission from Pre-Wash Cycles after Production

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations	2%	2%	17%	63%	15%
Business associations		6%	31%	50%	13%
NGOs		2%	8%	76%	14%
Academic/Research Institutions		4%	25%	58%	13%
Public Authorities			20%	70%	10%
EU citizens		6%	27%	76%	19%
Non-EU citizens			30%	70%	
Others			17%	83%	

Table 17: Production and Consumer Usage II (1-4): Emission from Garment Wear; Emission from Use-Phase Washing Cycles; Emission from Use-Phase Drying Cycles and Emission from Garment End of Life

Emission from Garment Wear

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations	5%	15%	25%	43%	13%
Business associations	3%	41%	28%	19%	9%
NGOs		2%	55%	24%	18%
Academic/Research Institutions		22%	35%	39%	4%
Public Authorities		44%	44%		11%
EU citizens	6%	17%	20%	36%	21%
Non-EU citizens		10%	20%	60%	10%
Others			17%	67%	17%

Emission from Use-Phase Washing Cycles

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations		5%	24%	61%	10%
Business associations		25%	44%	28%	3%
NGOs			18%	71%	10%
Academic/Research Institutions			25%	75%	
Public Authorities			20%	70%	10%
EU citizens	1%	4%	25%	53%	16%
Non-EU citizens			10%	90%	
Others				100%	

Emission from Use-Phase Drying Cycles

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations		15%	24%	44%	17%
Business associations		19%	41%	31%	9%
NGOs	2%	2%	41%	35%	20%
Academic/Research Institutions		4%	25%	71%	
Public Authorities		11%	44%	33%	11%
EU citizens	6%	13%	21%	41%	19%
Non-EU citizens			40%	50%	10%
Others		17%	17%	50%	17%

Emission from Garment End of Life

Contribution As	Completely insignificant	Very little significant	Somewhat significant	Very significant	I don't know/Not applicable
Company/Business Organisations	5%	5%	21%	46%	23%
Business associations	3%	6%	19%	38%	34%
NGOs	2%		10%	67%	20%
Academic/Research Institutions		4%	38%	42%	17%
Public Authorities	44%		11%	11%	33%
EU citizens	3%	9%	20%	46%	22%
Non-EU citizens		10%		90%	
Others		17%	33%	33%	17%

2. *To what extent would you agree with the following measures to reduce microplastic emissions specifically from clothing, carp fabrics for furniture and similar?*

   a) *During Design or Production Phase* –
   Business Associations and Public Authorities *somewhat agree* to a **restriction of all synthetic fibres for certain applications** and **those with high microplastic content** while 63% and 85% EU Citizens are respectively of the same opinion. (See Table 18)

   Among all stakeholders there is *complete agreement* on **product design requirements** and **specific waste-water treatment in production plants.** (See Table 19)

   Business Associations are spread across agreement scale on **mandatory pre-washing before market placement** while 45% Academic/Researchers Institutions and 56% EU Citizens *completely agree*. (See Table 19)

   There is majority agreement among stakeholders on **emissions limit during production** and **emissions limit on textiles on the EU Market.** (See Table 20)

   b) During Use-Phase –
   Most stakeholders *completely or somewhat agree* on **consumer awareness**, **washing machine filters**, and **laundry emission limits.** (See Table 21)

   c) *Transversal Policies –*

There is overwhelming agreement among all stakeholders for **all measures listed** in the questionnaire. (See Table 21)

Table 18: During design and production phase I (1-2): Restriction of all Synthetic Fibers for Certain Applications and Restriction on Synthetic Fibers with High Microplastic Content

Restriction of all Synthetic Fibers for Certain Applications

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	30%	28%	3%	10%	23%	8%
Business associations	15%	45%	9%	12%	12%	6%
NGOs	61%	6%	6%	8%	12%	6%
Academic/Research Institutions	33%	17%		17%	13%	21%
Public Authorities	30%	10%	10%		30%	20%
EU citizens	63%	4%	1%	4%	24%	3%
Non-EU citizens	80%				20%	
Others	67%				17%	17%

Restriction on Synthetic Fibers with High Microplastic Content

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	51%	7%	5%	5%	22%	10%
Business associations	27%	12%	9%	9%	24%	18%
NGOs	82%		8%		10%	
Academic/Research Institutions	63%				29%	8%
Public Authorities	60%	10%			30%	
EU citizens	86%	1%		1%	12%	
Non-EU citizens	100%					
Others	83%				17%	

Table 19: During design and production phase II (1-3): Product Design Requirements; Specific Waste Water Treatment in Production Plants and Mandatory Pre-Washing before Placing on the Market

Product Design Requirements

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	66%	2%		2%	27%	2%
Business associations	48%		9%	12%	27%	3%
NGOs	90%		2%		8%	
Academic/Research Institutions	75%			8%	13%	4%
Public Authorities	70%			10%	20%	
EU citizens	80%		1%	4%	13%	1%
Non-EU citizens	60%				40%	
Others	50%				50%	

Specific Waste Water Treatment in Production Plants

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	65%	3%		5%	25%	3%
Business associations	39%	3%	9%		42%	6%
NGOs	90%		2%		8%	
Academic/Research Institutions	83%			4%	8%	4%
Public Authorities	89%				11%	
EU citizens	77%		3%		16%	4%
Non-EU citizens	70%				30%	
Others	83%				17%	

Mandatory Pre-Washing before Placing on the Market

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	48%	15%	3%	10%	25%	
Business associations	24%	9%	15%	15%	21%	15%
NGOs	71%	4%	6%	2%	14%	2%
Academic/Research Institutions	46%	4%		13%	25%	13%
Public Authorities	40%			10%	50%	
EU citizens	57%	3%	9%	10%	20%	1%
Non-EU citizens	30%		10%	10%	50%	
Others	50%		17%	17%	17%	

Table 20: During design and production phase III (1-2): Emission Limit During Production and Emission Limit on Textiles in the EU Market

Emission Limit During Production

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	58%	5%	5%	10%	20%	3%
Business associations	21%	9%	18%	15%	21%	15%
NGOs	57%		4%		37%	2%
Academic/Research Institutions	54%			8%	33%	4%
Public Authorities	40%			10%	50%	
EU citizens	70%		1%	7%	22%	
Non-EU citizens	70%				30%	
Others	33%				67%	

Emission Limit on Textiles in the EU Market

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	65%	5%	5%	10%	13%	3%
Business associations	24%	9%	15%	18%	18%	15%
NGOs	86%		6%		8%	
Academic/Research Institutions	50%		4%	13%	29%	4%
Public Authorities	30%			30%	40%	
EU citizens	77%	1%	1%	6%	13%	1%
Non-EU citizens	80%			10%	10%	
Others	50%			17%	33%	

Table 21: Use phase and transversal policies (1-3): Consumer Awareness; Filters in Washing Machines and Regulate Emissions from Laundries

Consumer Awareness

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	80%		2%	2%	15%	
Business associations	47%		6%	6%	41%	
NGOs	49%			4%	45%	2%
Academic/Research Institutions	67%			4%	25%	4%
Public Authorities	20%			10%	60%	10%
EU citizens	87%	3%		3%	6%	1%
Non-EU citizens	70%				30%	
Others	100%					

Filters in Washing Machines

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	63%		2%	17%	17%	
Business associations	36%	3%		21%	33%	6%
NGOs	41%			31%	27%	2%
Academic/Research Institutions	42%	4%		25%	25%	4%
Public Authorities	40%			10%	40%	10%
EU citizens	75%	6%	3%	1%	12%	3%
Non-EU citizens	70%			10%	20%	
Others	33%				67%	

Regulate Emissions from Laundries

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	56%	2%	5%	5%	32%	
Business associations	27%	3%	24%	12%	30%	3%
NGOs	43%		4%	2%	51%	
Academic/Research Institutions	50%			13%	33%	4%
Public Authorities	50%		10%		30%	10%
EU citizens	79%	6%	1%	4%	10%	
Non-EU citizens	90%				10%	
Others	67%			17%	17%	

3. Open Text Comments

a) Responses emphasize the **incontrollable release of microplastics** and the **intentional spill over of emissions from microplastics** during production. Improvements include **sustainable materials such as polyester.**

b) Apropos washing cycles of textiles, one respondent proposes **incineration methods for microplastics** that end up in waste-water treatment plants because filters in washing machines are insufficient for full treatment.

c) Other measures include **taxation on polluting textiles** and emphasis on **eco-conception** and **regulations on fast fashion.**

d) Among design related regulations, suggested measures include **recycling modifications for single type textiles** and **strict limits/possible phase out of elastane in fabrics.**

e) One respondent claimed that **pre-use washing of fabrics before market placement** reduces microplastic emissions more significantly than use-phase washing and hence, they emphasize this measure over others. This highlights the **need to include microplastics as an important step of Life-Cycle Assessment** for textiles.

4.7.2.4 Paints (N=98-105)

a. During which phase of the life cycle, microplastics emissions from paints are the most significant?

Initial spray painting and **end of life** hold high significance for the stakeholders in terms of microplastic emissions. However, for spray painting, Academic/Researcher Institutions are split between believing it to be very little significant (42%) and very significant (42%) and 59% of NGOs believe that it is somewhat significant. (See Table 22)

b. Wear and tear of paints from –

Wear and Tear from **Infrastructure, Cars, and Buildings** hold very high significance among many stakeholders. NGOs, Academic/Research Institutions, Public Authorities, EU citizens believe that wear and tear from Cars, Infrastructure are significant while Business Associations do not find it to be significant. (See Table 23)

Almost all stakeholders believe **that roads, ships, and boats** are significant for wear and tear while the opinion of Business Associations and Company/Business Organisations is spread across the significance scale**.** (See Table 24)

c. Emissions from the maintenance of –

Maintenance emissions from ships and boats are very significant for most stakeholders except Business Associations and Companies/Business Organisations. (See Table 25)

NGOs, Business Associations and Companies/Business Organisations are split between significance and insignificance for **maintenance emissions from cars**. NGOs (59%) and Academic/Research Institutions (57%) find **maintenance emissions from infrastructure** to be somewhat significant while Public Authorities (57%) and EU citizens (43%) gave a neutral response. (See Table 26)

Almost all stakeholders find **maintenance emissions from roads and buildings** to be significant. However, Business Associations (50%) and Companies/Business Organisations (42%) gave a neutral response on the significance scale for the **maintenance emissions from roads**. (See Table 26)

Table 22: Life cycle emissions (1-2): Initial Spray Painting and Paint End of Life

Initial Spray Painting

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	4%	26%	9%	43%	17%
Business associations	6%	28%	6%	44%	17%
NGOs		19%	59%	4%	19%
Academic/Research Institutions			14%	43%	43%
Public Authorities		43%	43%		14%
EU citizens	3%	38%	26%	10%	23%
Non-EU citizens					100%
Others			50%		50%

Paint End of Life

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	22%	26%	13%	4%	35%
Business associations	17%	28%	11%	33%	11%
NGOs		11%	11%		78%
Academic/Research Institutions				14%	86%
Public Authorities		43%	43%		14%
EU citizens	3%	33%	8%	3%	54%
Non-EU citizens	70%				100%
Others			50%		50%

Table 23: Wear and tear I (1-3): Wear and Tear from Cars; Wear and Tear from Infrastructure and Wear and Tear from Buildings

Wear and Tear from Cars

Contribution As	Completely insignificant	I don’t know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	26%	17%	17%	22%	17%
Business associations	50%	25%		13%	13%
NGOs		7%	67%	11%	15%
Academic/Research Institutions	14%		57%	29%	
Public Authorities		57%		43%	
EU citizens	5%	35%	19%	14%	27%
Non-EU citizens					100%
Others				100%	

Wear and Tear from Infrastructure

Contribution As	Completely insignificant	I don’t know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	9%	22%	26%	30%	13%
Business associations	13%	25%	19%	38%	6%
NGOs		15%	56%		30%
Academic/Research Institutions			29%	29%	43%
Public Authorities		57%	14%	14%	14%
EU citizens		41%	16%	5%	38%
Non-EU citizens		75%	50%		100%
Others					

Wear and Tear from Buildings

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	4%	26%	22%	30%	17%
Business associations	18%	29%	18%	29%	6%
NGOs		7%	7%	4%	81%
Academic/Research Institutions			29%	43%	29%
Public Authorities		43%	29%		29%
EU citizens	3%	42%	16%	8%	32%
Non-EU citizens					100%
Others			50%		50%

Table 24: Wear and tear II (1-2): Wear and Tear from Roads and Wear and Tear from Ships and Boats

Wear and Tear from Roads

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations		17%	17%	35%	30%
Business associations		25%	25%	38%	13%
NGOs		11%	7%		81%
Academic/Research Institutions			14%	29%	57%
Public Authorities		29%	14%	14%	43%
EU citizens	3%	35%	16%		46%
Non-EU citizens					100%
Others					100%

Wear and Tear from Ships and Boats

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations		22%	17%	26%	35%
Business associations	6%	25%		50%	19%
NGOs		7%			93%
Academic/Research Institutions			14%		86%
Public Authorities		25%	25%	13%	38%
EU citizens	3%	32%	16%	3%	46%
Non-EU citizens					100%
Others					100%

Table 25: Maintenance emissions I (1-3): Maintenance Emission from Ships and Boats; Maintenance Emission from Cars and Maintenance Emission from Infrastructure

Maintenance Emission from Ships and Boats

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	27%	23%	14%	9%	27%
Business associations	25%	25%		31%	19%
NGOs	49%			4%	45%
Academic/Research Institutions			14%		86%
Public Authorities		25%	25%		50%
EU citizens		38%	16%	5%	41%
Non-EU citizens		7%	7%		85%
Others			50%		50%

Maintenance Emission from Cars

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	36%	23%	14%	23%	5%
Business associations	44%	25%		19%	13%
NGOs	41%			31%	27%
Academic/Research Institutions			29%	57%	14%
Public Authorities		57%		43%	
EU citizens	8%	38%	16%	16%	22%
Non-EU citizens					100%
Others	50%			50%	

Maintenance Emission from Infrastructure

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	27%	23%	18%	14%	18%
Business associations	19%	25%	31%	13%	13%
NGOs		15%	59%		26%
Academic/Research Institutions			57%	29%	14%
Public Authorities		57%	14%	14%	14%
EU citizens		43%	22%	5%	30%
Non-EU citizens					100%
Others		50%	50%		

Table 26: Maintenance Emissions II (1-2): Maintenance Emission from Buildings and Maintenance Emission from Roads

Maintenance Emission from Buildings

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	24%	19%	14%	19%	24%
Business associations	18%	24%	18%	35%	6%
NGOs		7%	11%	4%	78%
Academic/Research Institutions			29%	29%	43%
Public Authorities		29%	43%	14%	14%
EU citizens	3%	39%	18%	11%	29%
Non-EU citizens					100%
Others			50%		50%

Maintenance Emission from Roads

Contribution As	Completely insignificant	I don't know/Not applicable	Somewhat significant	Very little significant	Very significant
Company/Business Organisations	10%	43%	5%	24%	19%
Business associations	6%	50%	19%	19%	6%
NGOs		7%	19%		74%
Academic/Research Institutions			43%	29%	29%
Public Authorities		29%	43%	14%	14%
EU citizens	3%	38%	11%	8%	41%
Non-EU citizens					100%
Others			50%		50%

d. How much do you agree with the following measures to reduce microplastic pollution due to paints, depending on the application?

a) Among most stakeholders, there is *complete agreement* on the **Promotion of alternative solutions without paint** to reduce microplastic pollution. However, Business Associations (52%) and Companies/Business Organisations (40%) *completely disagree*. (See Table 27)

b) Most of the stakeholders agree with the measure of **Including aspects of microplastics in EU ecolabel and Green Public Procurement** to reduce microplastic pollution. (See Table 27)

c) Almost all stakeholders agree on the measures of **Regulated Dust Protection and Capture for key industries** and **Regulation of plastic shares in paints** to reduce microplastic pollution while Business Associations (47%) *completely disagree* with the measure of **Regulation of plastic shares in paints**. (See Table 28)

d) Business Associations (42%) completely *or somewhat disagree,* and Companies/Business Organisations (56%) *completely or somewhat agree* for **Increasing the share of biodegradable plastics in paint** as a measure to reduce microplastic pollution. While Academic/Research Institutions (42%) *completely disagree* and the rest of stakeholders *completely or somewhat agree* with the measure. (See Table 29)

e) Most of the stakeholders agree with the measure of **Increasing Application yield** and **Improving Lifetime of paints** while NGOs (55%) are neutral about the measure to reduce microplastic pollution. (See Table 29)

f) Most of the stakeholders agree with the measures of **Dust cover improvements** and **Capture scrap road markings** to reduce microplastic pollution. (See Table 30)

g) Most of the stakeholders agree on the measure of **Gypsum waste management in construction and demolition waste** while NGOs (55%) and Public Authorities (50%) take a neutral stance**.** (See Table 31)

h) EU Citizens are broadly in agreement over all measures listed in the question.

Table 27: Paint Emission Measures: Promotion and Awareness (1-3): Promotion of Alternative Solutions without Paints; Awareness of Unused Purchases and Include Aspects of Microplastics in EU Ecolabel and Green Public Procurement

Promotion of Alternative Solutions without Paints

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	32%	41%	9%		14%	5%
Business associations	21%	53%	16%		5%	5%
NGOs	30%		4%	4%	63%	
Academic/Research Institutions	29%		14%	14%	14%	29%
Public Authorities	63%		13%		25%	
EU citizens	67%	8%	3%	15%	5%	3%
Non-EU citizens	100%					
Others				50%	50%	

Awareness of Unused Purchases

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	27%	14%		18%	41%	
Business associations	39%	6%	11%	6%	33%	6%
NGOs	15%		4%	19%	15%	48%
Academic/Research Institutions	14%		14%	14%	43%	14%
Public Authorities	38%	13%	13%	13%	25%	
EU citizens	59%	13%	5%	8%	13%	3%
Non-EU citizens	100%					
Others				50%	50%	

Include Aspects of Microplastics in EU Ecolabel and Green Public Procurement

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	41%	27%	5%	5%	14%	9%
Business associations	26%	32%	5%	16%	11%	11%
NGOs	89%		4%	7%		
Academic/Research Institutions	29%			14%	43%	14%
Public Authorities	50%		13%	13%	25%	
EU citizens	77%	5%	3%	5%	8%	3%
Non-EU citizens	100%					
Others	50%			50%		

Table 28: Paint Emission Measures: Regulation and Operational Improvements (1-2): Regulate the Share of Plastic in Paints and Regulate Dust Protection and Capture for Key Industries

Regulate the Share of Plastic in Paints

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	27%	23%	14%	14%	14%	9%
Business associations	21%	47%	16%		11%	5%
NGOs	85%				15%	
Academic/Research Institutions	14%	14%			57%	14%
Public Authorities	50%	13%	13%	13%	13%	
EU citizens	68%	3%	8%	5%	13%	5%
Non-EU citizens	100%					
Others	50%				50%	

Regulate Dust Protection and Capture for Key Industries

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	43%		4%		30%	22%
Business associations	33%	6%	11%		33%	17%
NGOs	85%		12%	4%		
Academic/Research Institutions	43%				57%	
Public Authorities	63%		25%	13%		
EU citizens	70%	3%	8%	8%	11%	
Non-EU citizens	100%					
Others	50%		50%			

Table 29: Paint Emission Measures: Regulation and Operational Improvements (contd., 1-4): Increase Biodegradable Paint Content; Increase Application Yield; Increase Lifetime of Paint and Localised Preventive Maintenance

Increase Biodegradable Paint Content

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	26%	4%		4%	30%	35%
Business associations	21%	21%	11%	26%		21%
NGOs	15%	11%	59%		15%	
Academic/Research Institutions	14%	43%		14%	14%	14%
Public Authorities	38%				38%	25%
EU citizens	65%	5%	3%	5%	18%	5%
Non-EU citizens	100%				30%	
Others	50%				50%	

Increase Application Yield

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	18%	5%	9%	18%	36%	14%
Business associations	26%	16%	11%	16%	32%	
NGOs	15%		19%	56%	11%	
Academic/Research Institutions	29%		14%	14%	14%	29%
Public Authorities	50%		25%	25%		
EU citizens	56%	8%	3%	10%	21%	3%
Non-EU citizens	100%					
Others			50%		50%	

Increase Lifetime of Paint

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	27%		14%	32%	27%	
Business associations	37%		5%	42%	16%	
NGOs	67%		7%	11%	15%	
Academic/Research Institutions	43%		14%	14%	29%	
Public Authorities	75%				25%	
EU citizens	58%		8%	10%	20%	5%
Non-EU citizens	100%					
Others				50%	50%	

Localised Preventive Maintenance

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	36%		23%		36%	5%
Business associations	32%		26%	5%	32%	5%
NGOs	81%		7%	7%	4%	
Academic/Research Institutions	29%		14%	14%	43%	
Public Authorities	38%		38%	13%	13%	
EU citizens	56%		8%	10%	23%	3%
Non-EU citizens	100%					
Others			50%	50%		

Table 30: Paint Emission Measures: Operational Improvements (1-3): Use Technologies Increasing Dust Cover; Capture Scrapped Road Markings and Capture and Treat Road Run-Off Water

Use Technologies Increasing Dust Cover

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	45%		9%		45%	
Business associations	32%		11%	21%	37%	
NGOs	81%		15%		4%	
Academic/Research Institutions	57%		14%		29%	
Public Authorities				25%	75%	
EU citizens	58%		5%	8%	26%	3%
Non-EU citizens	100%					
Others			50%		50%	

Capture Scrapped Road Markings

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	52%		26%	4%	17%	
Business associations	26%		47%	5%	21%	
NGOs	81%		7%		11%	
Academic/Research Institutions	57%				29%	14%
Public Authorities	50%		25%	13%	13%	
EU citizens	54%		10%	10%	23%	3%
Non-EU citizens	100%					
Others					100%	

Capture and Treat Road Run-Off Water

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	41%		41%	9%	9%	
Business associations	16%	5%	37%		32%	11%
NGOs	19%		4%	11%	63%	4%
Academic/Research Institutions	86%				14%	
Public Authorities	50%		25%	13%	13%	
EU citizens	67%		8%	10%	15%	
Non-EU citizens	100%					
Others					100%	

Table 31: Paint Emission Measures: Operational Improvements (contd., 1-2): Cleaning Shipyards Prior to Refloating of Ships and Boats and Gypsum Waste Management in Construction and Demolition Waste

Cleaning Shipyards Prior to Refloating of Ships and Boats

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	45%		18%	27%	9%	
Business associations	37%		26%	16%	21%	
NGOs	81%		19%			
Academic/Research Institutions	57%			14%	29%	
Public Authorities	50%		25%	13%	13%	
EU citizens	72%		8%	3%	18%	
Non-EU citizens	100%					
Others			100%			

Gypsum Waste Management in Construction and Demolition Waste

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	36%		23%	23%	18%	
Business associations	32%	5%	26%	16%	21%	
NGOs	15%		22%	56%	7%	
Academic/Research Institutions	43%	14%	14%		29%	
Public Authorities	25%		50%	13%	13%	
EU citizens	64%		8%	5%	15%	8%
Non-EU citizens	100%					
Others			100%			

4.7.2.5 Detergent Laundry and Automatic Dishwasher Capsules (N=35-42)

Some of these capsules have a plastic shell around the detergent that consists of polyvinyl alcohol (PVA), a synthetic polymer, intended to dissolve in water, but that may not fully biodegrade, leaving microplastics in the environment. The Detergents Regulation, currently under revision, already regulates certain aspects of biodegradability of these capsules

a. *Please provide any information regarding this shell and its biodegradability in wastewater and its treatment, including possible releases of microplastics. (Open Text Comments)*
   i. While responses recognize the extant use of PVA in capsule shells, one response highlights **recent advances in using Casein**, a milk protein, **as a polymeric film** which is water-soluble and biodegradable. The comment encourages the recognition and further examination of other alternatives apart from PVA shells.
   ii. Another response highlights examining proper definitions of biodegradability in legislation and regulation of microplastic emissions that include a temporal and location-based degradation limit.

b. *If there would be sufficient evidence about the microplastics emissions of detergent capsules, to which extent would you agree with the following measures?*
   i. Almost all the stakeholders *completely or somewhat agree* of **all the measures listed** in the

      Table 32.
   ii. However, Business Associations were neutral on the measures of **Incentivise Eco-friendly Alternatives** and **Improve Waste-Water Treatment Plants**. Public Authorities were neutral

on the measures of **Improve Waste-Water Treatment Plants** and **Monitoring of PVA in Waste-Water Treatment Plants.** (See Table 32)

iii. All stakeholders *completely or somewhat agree* with the measures of **restriction of non-biodegradable water-soluble capsule shells, protocol to address the biodegradability of dissolvable capsule shells in real life conditions** and **extended producer responsibility.** Business Associations are neutral with the measure of **restriction of non-biodegradable water-soluble capsule shells.** (See Table 33)

Table 32: Emissions of detergent capsules I (1-4): Consumer Awareness; Incentivise Eco-Friendly Alternatives; Monitoring of PVA in Waste-Water Treatment Plants and Improve Waste-Water Treatment Plants

Consumer Awareness

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	47%			13%	40%	
Business associations	71%			7%	21%	
NGOs	29%		4%	7%	61%	
Academic/Research Institutions	67%				33%	
Public Authorities	33%	11%		33%	22%	
EU citizens	79%			2%	19%	
Non-EU citizens	100%					
Others	50%				50%	

Incestivise Eco-Friendly Alternatives

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	60%			13%	27%	
Business associations	29%		7%	43%	21%	
NGOs	25%	43%	7%	11%	14%	
Academic/Research Institutions	50%	17%			17%	17%
Public Authorities	78%			11%	11%	
EU citizens	89%	2%			9%	
Non-EU citizens	100%					
Others	50%				50%	

Monitoring of PVA in Waste-Water Treatment Plants

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	43%			21%	29%	7%
Business associations	7%		21%	7%	57%	7%
NGOs	11%		11%	7%	68%	4%
Academic/Research Institutions	50%			17%	17%	17%
Public Authorities	22%	22%	22%		22%	11%
EU citizens	77%		2%		17%	4%
Non-EU citizens	100%					
Others	50%				50%	

Improve Waste-Water Treatment Plants

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	40%	7%	7%	13%	20%	
Business associations	21%		7%	43%	14%	14%
NGOs	14%	7%	11%	14%	50%	4%
Academic/Research Institutions	50%	17%		17%	17%	
Public Authorities	11%		33%	33%	22%	
EU citizens	77%			4%	17%	2%
Non-EU citizens	100%					
Others	50%				50%	

Table 33: Emissions of detergent capsules II (1-3): Protocol to Address the Biodegradability of Dissolvable Capsule Shells in Real Life Conditions; Extended Producer Responsibility and Restrict Non-Biodegradable Water Soluble Shells for Capsules

Protocol to Address the Biodegradibility of Dissolvable Capsule Shells in Real Life Conditions

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	64%	7%		7%	21%	
Business associations	71%		7%	7%	14%	
NGOs	36%		7%	7%	50%	
Academic/Research Institutions	67%				17%	17%
Public Authorities	67%		22%		11%	
EU citizens	89%	2%			4%	4%
Non-EU citizens	100%					
Others	50%				50%	

Extended Producer Responsibility

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	50%	14%	7%	7%	21%	
Business associations	50%	21%	14%		7%	7%
NGOs	43%		4%	4%	50%	
Academic/Research Institutions	67%				33%	
Public Authorities	44%	22%	11%		22%	
EU citizens	83%	2%			13%	2%
Non-EU citizens	100%					
Others	50%				50%	

Restrict Non-Biodegradable Water Soluble Shells for Capsules

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	73%		7%		20%	
Business associations	43%		14%	36%	7%	
NGOs	89%			7%	4%	
Academic/Research Institutions	50%			17%	33%	
Public Authorities	89%				11%	
EU citizens	91%				9%	
Non-EU citizens	100%					
Others	100%					

c. Open Text Comments

All unique responses received agree on **regulating use by households**, where suggestions include **promotion of manual dish washing** and **prohibition of plastic pot cleaners**. Comments also mention **regulation of detergent discharge** into water bodies.

4.7.2.6 Geotextiles (N=49-112)

1. *How much do you agree with the following measures to reduce microplastic pollution from geotextiles?*

   1.1. Most stakeholders *completely agree* with the following measures, **Regulate the type of fibre or polymer used** and **Promote alternatives and eco-friendly materials**, to reduce microplastic pollution while Business Associations are split on the agreement scale (40% agreement; 45% disagreement). (See Table 34)

   1.2. Business Associations *completely or somewhat disagree* (50%) with the measure to **regulate the range of applications** while the rest of the stakeholders agree. (See Table 34)

   1.3. Business Associations and Public Authorities take a neutral stance with the measure of **regulating emission limits** while the rest of the stakeholders *completely or somewhat agree***.** (See Table 35)

Table 34: Emissions from Geotextiles I (1-3): Regulate the Types of Polymers and Fibers Used; Regulate the Range of Applications for Geotextiles and Promote Alternatives

Regulate the Types of Polymers and Fibers Used

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	47%	7%		13%	27%	7%
Business associations	30%	40%		15%	10%	5%
NGOs	87%	4%		9%		
Academic/Research Institutions	43%			14%	43%	
Public Authorities	33%		11%	11%	44%	
EU citizens	83%	3%		3%	7%	3%
Non-EU citizens	75%				25%	
Others	67%			33%		

Regulate the Range of Applications ofr Geotextiles

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	60%		13%	13%	13%	
Business associations	15%	30%		15%	20%	20%
NGOs	83%	4%	4%	9%		
Academic/Research Institutions	43%				29%	29%
Public Authorities	33%		11%	11%	44%	
EU citizens	71%	3%		3%	16%	6%
Non-EU citizens	75%				25%	
Others	33%			67%		

Promote Alternatives

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	56%	25%		6%	6%	6%
Business associations	25%	50%		5%	15%	5%
NGOs	96%	4%				
Academic/Research Institutions	57%					43%
Public Authorities	44%		11%	11%	33%	
EU citizens	77%	3%		6%	10%	3%
Non-EU citizens	100%					
Others	67%	33%				

Table 35: Emissions from Geotextiles II (1-2): Promote Eco-Friendly Materials and Regulate Emission Limits

Promote Eco-Friendly Materials

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	69%				25%	6%
Business associations	45%		5%		45%	5%
NGOs	96%				4%	
Academic/Research Institutions	57%			14%	14%	14%
Public Authorities	67%		11%	11%	11%	
EU citizens	81%			6%	13%	
Non-EU citizens	100%					
Others	100%					

Regulate Emission Limits

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	53%		7%	27%	13%	
Business associations	21%	26%	5%	26%	16%	5%
NGOs	78%	4%		9%	9%	
Academic/Research Institutions	43%			29%	14%	14%
Public Authorities	11%		11%	33%	33%	11%
EU citizens	83%		3%		13%	
Non-EU citizens	75%				25%	
Others	67%			33%		

a. How much do you agree with the following statements related to the applications of geotextiles?

i. *Geotextiles for Coasts*

Almost all Public Authorities and EU citizens take a neutral stance when it comes to the **types of geotextiles** that can protect the coast – **either woven, non-woven, or made with natural fibres**. (See Table 36)

Businesses Associations, on the other hand, are in complete agreement of the efficacy of geotextiles of all types. NGOs completely agree (70%) for **geotextiles made with natural fibres** to protect the coast from erosion. They mostly disagree with non-woven geotextiles (60%) and woven geotextiles (60%). (See Table 36)

Table 36: Coastal Erosion (1-3): Non-Woven Geotextiles can Protect Coasts from Erosion; Woven Geotextiles can Protect Coasts from Erosion and Geotextiles from Natural Fibres can Protect Coasts from Erosion

Non-Woven Geotextiles can Protect Coasts from Erosion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	53%	7%	27%	7%	7%	
Business associations	56%		17%	17%	11%	
NGOs	4%	61%	17%		17%	
Academic/Research Institutions	14%	29%	14%	29%	14%	
Public Authorities	13%	13%	50%		25%	
EU citizens	13%	17%	50%	7%	7%	7%
Non-EU citizens	67%				33%	
Others	33%		33%		33%	

Woven Geotextiles can Protect Coasts from Erosion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	47%	7%	27%	13%	7%	
Business associations	59%		18%	24%		
NGOs	4%	61%	17%		17%	
Academic/Research Institutions	29%		14%	29%	29%	
Public Authorities	13%	13%	50%		25%	
EU citizens	21%	17%	48%	7%	7%	
Non-EU citizens			67%		33%	
Others	33%		33%		33%	

Geotextiles from Natural Fibers can Protect Coasts from Erosion

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	50%		25%	6%	6%	13%
Business associations	6%	11%	28%	11%		44%
NGOs	70%		17%		9%	4%
Academic/Research Institutions	14%		14%	14%	43%	14%
Public Authorities	38%	13%	50%			
EU citizens	42%		35%	6%	10%	6%
Non-EU citizens	25%		25%	25%	25%	
Others	33%		33%		33%	

ii. <u>*Geotextiles for Roads*</u>

All Academic/Researchers Institutions and Public Authorities remain neutral when it comes to the **types of geotextiles** that can be used to build roads – either **woven, non-woven, or made with natural fibres**. (See Table 37)

Businesses Associations on the other hand, are in *complete agreement* of the efficacy of geotextiles of all types except natural fibres where they weakly agree (43%). (See Table 37)

EU Citizens (45%) largely prefer **geotextiles made with natural fibres** as material to build roads. While they are mostly neutral on woven and non-woven geotextiles. NGOs *completely disagree* on woven (60%) and non-woven (60%) geotextiles while *completely agree* on natural fibres. (69.5%) (See Table 37)

Table 37: Road Construction I (1-3): Woven Geotextiles can be Used to Build Roads; Non-Woven Geotextiles can be Used to Build Roads and Geotextiles from Natural Fibres can be Used to Construct Roads

Woven Geotextiles can be Used to Build Roads

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	53%	7%	20%	7%	7%	7%
Business associations	58%		16%	21%	5%	
NGOs	4%	61%	17%		17%	
Academic/Research Institutions	14%		14%	29%	29%	14%
Public Authorities	25%	13%	63%			
EU citizens	20%	10%	50%	7%	10%	3%
Non-EU citizens	33%		33%		33%	
Others	33%		33%		33%	

Non-Woven Geotextiles can be Used to Build Roads

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	60%	7%	20%	7%	7%	
Business associations	53%		16%	16%	16%	
NGOs	4%	61%	17%		17%	
Academic/Research Institutions	14%	14%	14%	43%	14%	
Public Authorities	25%	13%	63%			
EU citizens	17%	10%	50%	3%	7%	13%
Non-EU citizens	33%		33%		33%	
Others	33%		33%		33%	

Geotextiles from Natural Fibers can be Used to Construct Roads

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	57%	7%	21%	14%		
Business associations	39%		28%	11%	6%	17%
NGOs	70%		17%		9%	4%
Academic/Research Institutions	14%		14%	14%	29%	29%
Public Authorities	13%	13%	75%			
EU citizens	45%		39%	6%	6%	3%
Non-EU citizens	50%		25%	25%		
Others	33%		33%		33%	

iii. All Public Authorities and EU citizens are neutral for the **non-existence of alternatives to geotextiles for drainage** while NGOs (82%) and Academic/Research Institutions (57%) *completely or somewhat agree* with the statement. (See Table 38)

Table 38: Road Construction II

There are no Alternatives to Geotextiles for Drainage

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	6%	13%	31%	25%	19%	6%
Business associations	17%		17%	39%	28%	
NGOs	74%		17%		9%	
Academic/Research Institutions	43%		14%	29%	14%	
Public Authorities	25%		50%	13%	13%	
EU citizens	13%	13%	50%	13%	7%	3%
Non-EU citizens	33%		33%			33%
Others			33%	33%	33%	

4.7.3 *Part IV. All Addressed Sources: Pellets, Synthetic Textiles, Tyres, Geotextiles, Detergent Capsules and Paints*

1. *How much do you agree with the following measures to reduce microplastic pollution in general? (N=357)*
   a) Apart from Business Associations who are neutral, all other stakeholders at large completely agree with a common system to monitor and report microplastic release throughout the lifecycle of the source. All stakeholders completely or somewhat agree on the measure on specific waste-water treatment in urban wastewater plants to reduce microplastic pollution. (See Table 39)
   b) There is an overwhelming support for international agreements across all stakeholders. Business Associations are neutral and almost all other stakeholder groups completely or somewhat agree on specific wastewater treatment in recycling plants to reduce the microplastic pollution. (See Table 40)

Table 39: General Emissions I (1-2): Common System to Monitor and Report Microplastic Releases throughout Life-Cycle and Specific Waste Water Treatment in Urban Waste Water Plants

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
	Common System to Monitor and Report Microplastic Releases throughout Life-Cycle					
Company/Business Organisations	43.04%	11.39%	11.39%	2.53%	30.38%	1.27%
Business associations	25.00%	22.06%	11.76%	10.29%	26.47%	4.41%
NGOs	77.97%		3.39%		18.64%	
Academic/Research Institutions	70.27%			8.11%	21.62%	
Public Authorities	43.75%		12.50%	12.50%	18.75%	12.50%
EU citizens	66.67%	1.71%	1.71%	5.98%	22.22%	1.71%
Non-EU citizens	80.00%				20.00%	
Others	60.00%		10.00%		30.00%	
	Specific Waste Water Treatment in Urban Waste Water Plants					
Company/Business Organisations	46.91%	2.47%	18.52%	2.47%	28.40%	1.23%
Business associations	32.84%	2.99%	20.90%	11.94%	23.88%	7.46%
NGOs	42.37%	5.08%		11.86%	11.86%	28.81%
Academic/Research Institutions	56.76%			8.11%	24.32%	10.81%
Public Authorities	25.00%		18.75%	6.25%	31.25%	18.75%
EU citizens	69.75%	0.84%	2.52%	5.88%	19.33%	1.68%
Non-EU citizens	100%					
Others	40.00%	10.00%	10.00%	10.00%	30.00%	

Table 40: General Emissions II (1-2): Specific Waste Water Treatment in Recycling Plants and International Agreements

Specific Waste Water Treatment in Recycling Plants

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	43%	1%	19%	6%	29%	1%
Business associations	25%	1%	39%	10%	22%	1%
NGOs	47%	2%	3%	8%	14%	25%
Academic/Research Institutions	57%		6%	6%	31%	
Public Authorities	44%		19%	13%	25%	
EU citizens	76%		2%	3%	19%	
Non-EU citizens	90%		10%			
Others	40%		20%	10%	30%	

International Agreements

Contribution As	Completely agree	Completely disagree	I don't know/Not applicable	Neither agree nor disagree	Somewhat agree	Somewhat disagree
Company/Business Organisations	56%		5%	7%	32%	
Business associations	42%		10%	15%	31%	1%
NGOs	54%		2%	5%	24%	15%
Academic/Research Institutions	84%		5%		11%	
Public Authorities	63%		6%		25%	6%
EU citizens	80%		1%	6%	13%	1%
Non-EU citizens	90%				10%	
Others	70%		10%		20%	

2. *Please provide any additional information regarding microplastics and the reduction of emissions, in particular for paints, geotextiles, and detergent capsules. (Open Text Comments)*

   While responses in this section are along the lines of those described in Section 6.1.2.1 (d.), one comment further accentuated the monitoring of and recognition of microplastic emissions at the industrial site level, while also suggesting the development of up-to-date databases on sustainable and eco-friendly alternative raw material. There is also a mention of studying fishing nets in agriculture as a major emitter of microplastics.

3. *Please provide any information if a significant fraction of the release might be in form of very fine particles (smaller than 1 micron, also called nano plastics), either in general, either for one of the specific sources, and the consequences that might have on possible measures. (Open Text Comments)*

   In general, valid responses mention a lack of research for nano plastics, especially in terms of their rate of degradability (or lack thereof) vis-à-vis microplastics and their rate of accumulation over time.

   One response claims that paints and tyres contribute the most to the emission of nano plastics. There is also a need to examine forest ecosystems and micro-organisms where a lot of emissions are bioaccumulated over time, especially for nano plastics.

5 Stakeholder Workshops

To complement the OPC, several online stakeholder workshops were organised to inform and engage stakeholders.

5.1 First stakeholder workshop: 16 September 2021

This first workshop had over 150 attendees from the industry, including SMEs, NGOs, Member States, and researchers. It presented the overall context of the European Strategy for Plastics in a Circular Economy as a part of Circular Economy Action Plan (CEAP) as well as the series of initiatives to tackle all types of plastics in general and microplastics in particular.

The presentation of the study was made along with the problem definition specific to the three sources (pellets, tyres, and textiles). The discussion also focused on additional sources of microplastics on which the study could focus.

5.2 Second series of thematic stakeholder workshops: 22, 24, 25 November 2021

This workshop was of three half-day dedicated sessions, each dealing with a specific source. The goal of this workshop was to update the participants on the state of the analysis and to identify possible measures to reduce the unintentional release of microplastics, including pellets, into the environment. A background note was sent out in advance to all participants to enable a useful discussion.

The participants were split into 4 groups to increase participation and discussion. The groups performed two activities:

1. Identification of measures and classification into different categories and vote from the participants on which were their preferred measures to reduce emissions to the environment.

2. Analysis of the 20 measures which received the most votes using a matrix of effectiveness against technical feasibility. The scale was from 0 to 5, with 0 being an ineffective measure or a non-feasible measure and 5 being an extremely effective measure to tackle emissions or a measure that could be easily implemented.

- 22 November 2021 – Textiles

Overall, 155 measures (including duplicates and measures that could be grouped together) were identified by 44 participants (actively involved in the activities) out of more than 152 participants in total to the workshop.

- 24 November 2021 – Tyres

Overall, 205 measures (including duplicates and measures that could be grouped together) were identified by 49 participants (actively involved in the activities) out of more than 80 participants in total to the workshop.

- 25 November 2021 – Pellets

Overall, 173 measures (including duplicates and measures that could be grouped together) were identified by 41 participants (actively involved in the activities) out of more than 70 participants in total to the workshop.

After the breakout sessions, a plenary session was organised where the measures were presented and discussed with stakeholders.

5.3 Third stakeholder workshop: 17 February 2022

This workshop focused on the new sources (paints, detergent capsules and geotextiles) as the scope of the analysis was expanded to these sources. It was attended by more than 100 participants. The presentation of the analysis was made along with the problem definition specific to the new sources. The methodological approach was explained to stakeholders and inputs were requested.

5.4 Fourth stakeholder workshop: 17 March 2022

The goal of this workshop was to update the participants on the state of the analysis and to identify possible measures to reduce unintentional release of microplastics, including pellets, into the environment. A background note was sent out in advance to all participants to enable a useful discussion. It was organised in 3 breakout sessions, one each on paints, detergent capsules and geotextiles.

The paint session was attended by 42 participants and 61 ideas about potential measures were collected.

The geotextiles session was attended by 28 participants and 58 ideas about potential measures were collected.

The detergent capsules session was attended by 25 participants and 9 ideas about potential measures were collected.

After the breakout sessions, a plenary session was organised where the measures were presented and discussed with stakeholders.

5.5 Fifth stakeholder workshop: 21 March 2022

This workshop presented the progress on tyres, pellets and textiles, in particular the screening of measures and initial analysis of impacts of these measures. The workshop was attended by more than 200 participants.

5.6 Sixth stakeholder workshop dedicated to Member States representatives: 23 March 2022

This dedicated workshop presented the progress on all six sources and feedback was collected from MS representatives. The meeting was attended by 27 participants including participants from the Commission.

5.7 Seventh stakeholder workshop on pellets: 12 December 2022

This dedicated workshop engaged in an in-depth discussion on baseline and policy options related to pellets. The meeting was attended by 53 participants covering NGOs, industry, and some Member States.

6 SME CONSULTATION

As an important part of the pellets volume is handled by SMEs, a dedicated SME consultation was carried out. The results can be found in Annex 12.

7 BILATERAL CONSULTATIONS

Extensive consultations were made with stakeholders (in particular, industry representatives relevant for the six sources, NGOs, as well various Commission services and other EU organisations such as EEA). An online tracker was maintained on the status and outcome of these meetings, which was regularly shared with DG ENV.

The objective of these meetings was to collect feedback on different steps of the analysis and seek additional data and evidence. The excel file indicating these consultations was made available through Teams.

Annex 3:
Who is affected and how?

1 Practical implications of the initiative on pellets

This annex sets out the practical implications of the preferred option for the various types of stakeholders concerned. The table below summarises such implications. This is followed by a summary per impact (economic, environmental, social), and overview tables for the preferred option.

Stakeholders	
Businesses and the economy at large	Businesses will benefit from the reduction of pellet losses and, therefore, from the reduction of adverse impacts linked to pellet losses. Reducing pellet losses will have positive knock-on economic effects on pellet businesses including reduced waste, less legacy pellet pollution, modernised equipment, improved staff awareness, reduced fire risk and improved reputation. On reduced waste, the analysis has demonstrated that for businesses owning the pellets, there would be an economic gain of EUR 25-141 million, thanks to the 25-141 thousand tonnes of pellets that would not be lost anymore (1000 EUR/t). It will also save annually 98 000 – 551 000 tonnes of GHG emissions. It is also expected that the playing field will be levelled, thus reinforcing the position of companies applying measures vis-à-vis companies that do not apply such measures, which would be beneficial for the sector as a whole. In areas that are particularly affected by pellet losses, reducing such losses will also have positive knock-on economic effects on commercial fishing and agriculture as well as recreation and tourism. At the same time, Option 1 “Mandatory standardised methodology” will have one-off costs for developing and testing the methodology that would have a higher impact on SMEs. Option 2b “Mandatory requirements” will entail direct compliance costs for every pellet handling company. In particular, the option will entail both adjustment (e.g. investing in equipment) and administrative (e.g. notifying certification) costs, as well as charges (i.e. auditing and certification by independent private bodies). The pellet industry will bear these costs. As it is already moving towards both the application of measures and a system of external auditing and certification, the direct economic costs will only be higher than those envisaged in the baseline for those firms that will not take actions in the meanwhile. In addition, this option foresees a series of mitigation measures (Option 2b) to alleviate the direct economic costs on the micro and small companies present in the pellet supply chain to mitigate concerns from SMEs (e.g. lack of staff/time, lack of information on risks and solutions and lack of financial resources). These measures will prevent these actors, who only represent a minor share of pellet losses, to make these costly investments which would have limited environmental benefits. It can thus be recommended. There would be cost savings thanks to the single harmonised measurement methodology to assemble the loss data and lower verification costs (option 1). The subsequent implementation costs of this methodology will be for industry, but they are already fully covered by their reporting obligation under the new REACH restriction. Therefore, the additional reporting under Option 2b (compliance) would result only in a very minor cost. The analysis undertaken shows that the market benefits of reducing pellet losses outweigh the costs of the measures needed to meet mandatory requirements.

Public authorities/administrations	Under Option 1, there will be costs for developing the harmonised measurement methodology, which could be borne by industry and/or public authorities. There could be cost for public authorities to assemble the loss data. Under option 2, increasing the stringency of requirements and of implementation can be expected to lead to an increase in direct administrative and enforcement costs on public authorities (e.g. public register, data collection, verification, correction and in the case of non-compliance, corrective measures and, where relevant, penalties).
End Users	Citizens, consumers and the society in general will benefit from better understanding of pellet losses under Option 1. Option 2b "Mandatory requirements" will result in a reduction of pellet losses to a level consistent with the Commission's overall microplastic releases reduction target of 30% by 2030, thus bringing overall benefits for citizens, consumers and the society in general.

Economic impacts on businesses - summary

Impact categories	Qualitative scoring of impact	Affected stakeholders	Description of impact
Adjustment costs and conduct of business	-	Pellet manufacturers (virgin pellets), plastics recyclers (recycled pellets), pellet convertors, pellet transporters and storage operators	There will be additional costs to put in place measures to prevent and contain pellet spills and losses. However, as the industry is already moving towards an OCS certification scheme, a part of industry will have anticipated these additional costs. Operators (including SMEs) will also benefit economically thanks to modernised equipment, improved reputation, reduced waste and a level playing field.
Administrative burdens on businesses	-	Same as above	The administrative burden will increase because of reporting requirements for the certification scheme, beyond the existing voluntary scheme.
Operation / conduct of SMEs	- /0	SMEs represent a significant share of the pellet supply chain, especially converters and logistics, and will be affected	The impact will be in terms of measures needed to prevent and contain pellet spills and losses and reporting requirements for the certification scheme. Option 2b sets lighter requirements for micro- and small enterprises.
Functioning of the internal market and competition	0	All actors in the pellet supply chain	If action is taken at EU level, the functioning of the internal market can be improved (same obligations on every operator, level playing field among them). The additional estimated cost of option 2b would represent about 0.13% of the EU plastics sector turnover, which would have a minor impact on its competitive advantage.

Impact categories	Qualitative scoring of impact	Affected stakeholders	Description of impact
Public authorities: Change in costs to authorities for compliance and enforcement activities	0/-	Member State competent authorities	The impact would be low or negative. Depending on their pellet responsibilities (data collection, verification, correction and enforcement), they will need to manage the monitoring, enforcement and receive the data from companies, so there might be additional human resources needed.
Public authorities: Change in costs to the Commission	-	European Commission / and EU institutions	There might be costs involved with the development of a measurement standard, but there are cost savings in the existing reporting obligations towards ECHA.
Innovation and research	-/+	Researchers	The development of a measurement standard (under option 1) will improve knowledge on plastic pellet losses.
Third countries and international relations	+/-	Third countries	No direct effects expected. As with other legislation, third countries could set up similar measures as a consequence of this initiative.
Consumers and household (end users)	0/-	Households	Measures could lead to a very slight increase in the price of plastic pellets, and therefore plastic products. However, industry might choose to absorb this increase, meaning consumers would not be impacted.

Environmental impacts - summary

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Quality of natural resources	+++	General public	Reduced pellets loss to the environment will results in a better quality of natural resources, improved eco-systems, improved biodiversity and improved services for the economy and society (e.g. fisheries), with the general public being the affected group.
Efficient use of raw materials	+	Plastic industry	Less pellet losses leads directly to the more efficient use of pellets
International environmental impacts	++	General public, sea food industry	Pollution caused by pellet loss affects both cross-border river basins and the seas and is, therefore, an important international impact. Reduced pellet loss will therefore lead to improved ecosystems and biodiversity globally.
Waste production, generation and recycling and its impact on land use	+	Wastewater treatment companies Potentially tourism and agricultural sectors	The accumulation of pellets may impact wastewater treatment infrastructure. If not properly managed, pellets can pile up in certain areas (such as coastal areas) and negatively impact other activities (tourism). As well as agriculture as around half of the sludge from wastewater is applied on agricultural land.
Climate change	+	No specific group is impacted	Reducing pellet loss will lead to less GHG emissions, as less plastics will be needed. There could be indirect effects on plankton growth.

Social impacts - summary

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Public health and safety	+	Public & pellet value chain employees	There are potential health impacts caused by microplastics, thus a reduction in pellet loss will reduce risks to human health. Fewer pellet spills will also increase safety at work.
Affected populations	+	Populations in affected areas	Reducing pellet losses will alleviate negative effects on affected populations, for example, by improving tourism, recreation, agriculture, and fishing.
Employment	+	Plastics industry & public authorities	The measures will create more job opportunities in the plastic sector, and more widely in public authorities if additional resources are required for the compliance checks.

2 SUMMARY OF COSTS AND BENEFITS

The following table outlines the benefits, both direct and indirect, of the preferred option.

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
Reduction in pellet losses	Measures under the preferred option could potentially result in the reduction of pellet losses to the environment in the range of 25 142 to 140 621 tonnes by 2030, which will reduce adverse impacts on water resources (both marine and freshwater and management wastewater).	As the reduction potential of all measures under the preferred option cannot be calculated, this estimation is conservative. All stakeholders will benefit because this will result in better environmental quality.
Improved understanding of pellet loss pathways and mechanisms in reaching the environment	The measurement standard and reporting will improve the availability of data on pellet losses.	This benefit will be mostly for the industry and public authorities. This will be of much use in designing better products, monitoring the effectiveness of reduction measures.
Creation of a level-playing field	Option 2b will create a level playing field among different actors within the plastic value chain. It will also bring a competitive advantage to the EU industry by improving its global reputation around environmental protection and moving towards a circular economy. Better pellet management will increase the image of the EU industry.	It could also negatively affect the competitiveness of the EU industry if a downstream actor in the value chain imports pellets from outside the EU, which could be cheaper in the absence of regulatory requirements.
Indirect benefits		
Safer work environment	The measure will reduce the amount of pellet spills and benefit the safety of employees working throughout the pellet chain by reducing their chances of falling. As a result, there will be fewer work accidents contributing to a safer work environment.	
Healthier soil	The measure will reduce the quantities of pellets in soil due to less losses through direct spills or through the use of sewage sludge as a fertiliser.	

Benefits to ecosystem services	The measure will reduce the quantities of pellets in affected areas, having knock-on effects on sectors such as tourism and recreation (increased attractivity of the region), fisheries (less pellets being absorbed by marine animals) and agriculture (less pellets being released on soils).	
Reduced costs for affected populations	The measure will reduce the need for local populations to finance clean-up operations following a spill.	

(1) Estimates are gross values relative to the baseline for the preferred option as a whole (i.e. the impact of individual actions/obligations of the preferred option are aggregated together); (2) Please indicate which stakeholder group is the main recipient of the benefit in the comment section;(3) For reductions in regulatory costs, please describe details as to how the saving arises (e.g. reductions in adjustment costs, administrative costs, regulatory charges, enforcement costs, etc.;).

The following table provides an overview of the costs of the preferred option.

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	**Recurrent**	**One-off**	**Recurrent**	**One-off**	**Recurrent**
Action (a)	Direct adjustment costs	No one-off cost	A possible minor increase in the price of pellets could be passed on to the downstream users and, ultimately citizens because of an increase in the price of plastic products.	The businesses need to adapt their operations and administrative procedures to the new requirements by the preferred option. Developing the measurement standard (option 1) will entail adjustment costs between EUR 1.3 – 3.2 million, however compensated by recurrent savings in using a single method and in reporting.	Costs for applying the methodology developed under option 1 for monitoring however compensated by recurrent savings on reporting. Actions for implementing pellet loss reduction measures (EUR 332 to 447 million of pellets handled during production, processing or logistics operations). Businesses could choose to absorb these or pass them on to consumers.	Administrations would potentially directly support the investments needed to develop new methodologies and standards (option 1).	Administrations will need to ensure the enforcement of EU law on pellets and review the reports submitted.
	Direct administrative costs	None	None	Setting up systems in businesses for administrative procedures to report pellet	EUR 43.9 million from the costs for internal assessment (EUR 30.8 million), external audit and/or certification and	Setting up systems in Member States for administrative procedures (EUR 36	Costs (EUR 125 000) for enforcement and analysis of the reported data.

				losses (EUR 0.1 million [5]).	notification (EUR 12.9 million), and minor costs (EUR 0.2 million) for data collection, verification, correction and enforcement, but more cost savings expected in the existing reporting.	700 [6]), including setting up a register of certified companies.	
	Direct regulatory fees and charges	None	None	None	Only if public authorities decide to put fees in place.	None	None
	Direct enforcement costs	None	None	Putting in place administrative procedures.	Minor costs for notification.	Putting in place administrative procedures, including measures for ensuring compliance.	Costs for enforcement and analysis of the reported data.

(1) Estimates (gross values) to be provided with respect to the baseline; (2) costs are provided for each identifiable action/obligation of the preferred option otherwise for all retained options when no preferred option is specified; (3) If relevant and available, please present information on costs according to the standard typology of costs (adjustment costs, administrative costs, regulatory charges, enforcement costs, indirect costs;).

[5] Total initial cost are EUR 0.5 million for businesses, which have been annualised over a 5 year period using a discount rate of 3% (0.5 hour for medium and large businesses and 0.25 hour for small and micro businesses and using EU average wages (29 €/hour)). It is estimated that the internal assessment is already covering most of the related cost.

[6] Total initial cost are EUR 313 000 million for public authorities, which have been annualised over a 10 year period using a discount rate of 3% (50 person days in average for each Member State using EU average wages (29 €/hour)).

III. Application of the 'one in, one out' approach – Preferred option			
[44 M€]	**One-off** (annualised total net present value over the relevant period)	**Recurrent** (nominal values per year)	**Total**
Businesses			
New administrative burdens (INs)	Setting up systems in businesses for administrative procedures to report pellet losses (EUR 0.1 million[7]).	Costs for internal assessments, external auditing and certification of about EUR 43.9 million: - internal assessment – EUR 30.8 million - external audit and/or certificate – EUR 12.9 million - filling forms and tables – EUR 0.2 million (for notifying public authorities of the certification).	EUR 44 mln €
Removed administrative burdens (OUTs)	None	None	None
Net administrative burdens*	EUR 0.1 mln €	EUR 43.9 mln €	EUR 44 mln €
Adjustment costs**	The businesses need to adapt their operations and administrative procedures to the new requirements by the preferred option. Developing the measurement standard (option 1) will entail adjustment costs between EUR 1.3 – 3.2 million, however compensated by recurrent savings in using a single method and in reporting.	Costs for applying the methodology developed under option 1 for monitoring however compensated by recurrent savings on reporting. Actions for implementing pellet loss reduction measures (EUR 332 to 447 million of pellets handled during production, processing or logistics operations). Businesses could choose to absorb these or pass them on to consumers.	
Citizens			
New administrative burdens (INs)	None	None	None
Removed administrative burdens (OUTs)	None	None	None
Net administrative burdens*	None	None	None
Adjustment costs**	None	A possible minor increase in the price of pellets could be passed on to the downstream users and, ultimately citizens because of an increase in the price of plastic products.	

[7] Total initial cost are EUR 0.5 million for businesses, which have been annualised over a 5 year period using a discount rate of 3% (0.5 hour for medium and large businesses and 0.25 hour for small and micro businesses and using EU average wages (29 €/hour)). It is estimated that the internal assessment is already covering most of the related cost.

Total administrative burdens****	EUR 0.1 mln €	EUR 43.9 mln €	EUR 44 mln €

(*) Net administrative burdens = INs – OUTs;
(**) Adjustment costs falling under the scope of the OIOO approach are the same as reported in Table 2 above. Non-annualised values;
(***) Total administrative burdens = Net administrative burdens for businesses + net administrative burdens for citizens.

3 RELEVANT SUSTAINABLE DEVELOPMENT GOALS

The following table sets out the Sustainable Development Goals which are of relevance to the preferred option.

III. Overview of relevant Sustainable Development Goals – Preferred Option		
Relevant SDG	**Expected progress towards the Goal**	**Comments**
SDG 14 – Conserve and sustainably use the oceans, seas and marine resources for sustainable development	A reduction in the amount of pellet losses to the marine environment.	
SDG 2 – Ensure healthy lives and promote well-being for all at all ages	Reduced microparticles from degradation and fragmentation of pellets also contribute to air pollution that is one of the causes for respiratory diseases. Similarly, reducing pellets losses into water will also ensure a less polluted food chain.	
SDG 12 - Ensure sustainable consumption and production patterns	Reducing pellet losses leads to a more efficient use of resources (here, pellets) and thus more sustainable production patterns.	

Annex 4:
Analytical methods

1 METHODOLOGY USED FOR THE INITIATIVE ON PELLETS

The methodology to develop this initiative follows the Commission Better Regulation Guidelines. These guidelines place an emphasis on the need for analysis to rely on evidence-based knowledge and scientifically robust methods.

There are significant knowledge gaps in the field of pellet losses, but it is an active field of research, and new evidence is appearing every day in scientific journals, national policy and international initiatives from multilateral organisations (e.g. OECD, UN), industry-led voluntary initiatives and civil society organisations. Main assumptions used in this impact assessment are presented below. Stakeholders were consulted to ensure the plausibility of these assumptions.

All calculations were done for a base year, 2030.

Assumptions for pellet production in the EU

The data sources and assumptions used to estimate the total quantity of pellet production volumes and projections until 2030 are the following:

- 2019 is taken as the base year, as 2020 is an outlier because of COVID, and we are seeing positive growth trends again from 2021;
- For virgin pellets, the projections are made from 2019 figures[8]; a growth rate of 0.9% per year is assumed till 2030[9];
- The source for recycled pellets production data (2019-2021) is Plastic Recyclers Europe; a growth rate of 5.6% per year is assumed[10];
- The source for bio-based pellets production data (2019-2021) is Plastics Europe; for a growth rate CAGR of 14% for 2022-2027[11], and the same trend is assumed to continue till 2030;
- Pellets imports and exports figures for virgin pellets are from Eurostat; a growth rate of 0.9% is assumed till 2030.

Assumptions for quantifying chronic pellet losses

There is no harmonised methodology for measuring pellet losses. Neither pellet loss measurements have been made at different steps of the value chain, nor are any systemic monitoring and reporting data available within the Member States or the industry to calculate the pellet losses. Hence, it is impossible to establish exact figures on pellet losses at each step because it depends on the installation size, actors involved, management practices, etc., and all these aspects are very heterogeneous in the

[8] Plastics Europe changed the calculation method in 2021, excluding adhesives, paints and coatings, thus not used to be coherent with previous year estimates and also with import/export figures

[9] Plastics Europe and SystemIQ

[10] K 2022 - Trend Report Europe https://www.k-online.com/en/Media_News/Press/Technical_article/K_2022_-_Trend_Report_Europe

[11] Nova Institute (2023) Bio-based Building Blocks and Polymers Global Capacities, Production and Trends 2022–2027 https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2022-2027-short-version-pdf/

EU. Approaches to quantifying the amount of pellets entering the environment typically apply a 'loss rate' to the pellet volume handled. Robust empirical evidence is scarce to inform a 'loss rate' at different steps. However, the greater the number of steps at which pellets are handled, the greater the opportunities for loss.

The following loss rates were assumed for calculating the losses occurring at four major steps: production, processing, recycling and logistics. It is estimated that losses happen at a higher rate at processing and recycling installations because of relatively small installations and a large number of steps than at production ones, and at an even higher rate during logistics operations.

- Production: 0.01% - 0.03%
- Processing: 0.02%-0.06%
- Recycling: 0.02%-0.06%
- Logistics: 0.03%-0.12%

These rates account for the major handling steps in production, processing, recycling and logistics phases and do not take account of other handling steps occurring in other phases (e.g. distribution), for which no information is available. These figures are, therefore, at the same time uncertain due to the lack of a standardised methodology to measure pellet losses and scarce data.

Pellet loss calculations were made using these ranges of pellet loss ratios (lower and higher figures) for the four types of operations, namely virgin pellet production, recycling, pellet processing and logistics. These pellet loss ratios are applied to the volume of pellets handled during different steps of the plastic value chain.

Table 41: Pellet losses (tonnes per year) per sector and per size of the companies in 2030

	Micro	Small	Medium	Large	Total
Production	0	0	0	8051 – 24 153	8051 – 24 153
Waste management, including recycling	0	0	0	2743 – 8228	2743 – 8228
Conversion	727 – 2182	2909 – 8727	6644 – 19 930	8284 – 24 852	18 564 – 55 691
Logistics	2801 – 11 203	5334 – 21 334	8372 – 33 488	16 314 – 65 258	32 821 – 131 283
Total	3528 – 13 385	8243 – 30 061	15 015 – 53 418	35 392 – 122 491	62 178 – 219 355

Impact of existing initiatives in reducing pellet losses

The assumptions used for estimating the impact of the voluntary initiatives (OCS certification and RecyClass) and legislation in Member States (France) in terms of reduction of pellet losses in 2030 are the following.

- Production: 90% of the total virgin pellet volume produced (by the members of Plastics Europe) and 5% for the non-Plastics Europe members will be certified compliant against OCS new rules and will be effectively implementing such rules with a success rate ranging from 60% to 80%;
- Recycling: 20% of the total recycled pellet volume will be certified compliant against RecyClass pellet provisions and will be effectively implementing the new provisions with a success rate ranging from 40% to 60%;
- Processing: 30% of the total volume processed will be certified compliant against OCS' new rules and will be effectively implementing such rules with a success rate ranging from 40% to 60%;
- Logistics: 40% of the total volume handled by logistics companies will be SQAS assessed and will be effectively implementing such a scheme with a success rate ranging from 40% to 60%.
- French legislation: It will cover about 85% of the French pellet volume (about 10% of the EU volume), leading to a 60-80% pellet loss reduction in 2030.

Assumptions taken in the calculation of the impacts of certain options

The assumptions used for estimating the costs of the measures for the relevant industry were based on data from the industry and Eurostat and are the following:

- Converters: The average costs for a small, medium and large converting enterprise, were calculated based from the converting industry data. They were based on Belgium and West-European figures. A correction factor (based on the relation between a Belgium and EU average salary) was used. The costs for the micro-enterprises were extrapolated from the three other categories.
- Producers: Large enterprise costs for converters were applied to plastic producers (including virgin and recycled plastics, export and import) as they are generally large companies.
- Logistics: It was also assumed that the structure of the whole transport sector (goods) could be applied on the subsector of transport dealing with pellets. The same assumption was made to the storage providers. The costs for the logistics operators (transport and storage providers, cleaning stations) were based on the basic assumption that the measures needed to be taken by a logistics enterprise are largely similar to a plastic converter enterprise. As an important part of the cost are related to personnel, it was assumed that an enterprise with the same number of persons would occur the same cost structure, and this for the main types: micro-, small, medium and large enterprises. Assumptions per industry (for each enterprise type):
  - storage providers, the same cost as for converters;
  - transport providers, no costs related to equipment and investments, only to personnel, external auditing and miscellaneous. It was assumed that 50% of the micro-enterprises in the transport sector will be subject to additional costs.
  - no additional costs for tank cleaning stations as those dealing with pellets are already complying with SQAS which has similar requirements.

As the industry has already started implementing some of the proposed measures through their voluntary programs, such as OCS CS and RecyClass, some of these costs will already be incurred in the business-as-usual scenario, i.e. under the baseline. For this, the average of the assumptions used under "*Impact of existing initiatives in reducing pellet losses*" were used.

The total cost for enterprises was then calculated based on the volume (tonnes) of pellets handled by enterprise type. For the plastic converters and producers, it was calculated on a per tonne basis, using cost figures for a typical plant for each enterprise type. For the transport and storage providers, it was calculated per enterprise within each enterprise type. The cost calculation was made using ranges (lower and higher figures). Therefore, lower figure of the cost scenario is linked with lower figure of the pellet reduction scenario and higher costs are linked to higher pellet reduction. Therefor one should compare lower figure of a range of one option with the lower figure of a range of another option, (or the higher figure of a range over the different options).

Uncertainties and data gaps

The principal uncertainty comes from the loss rates used for production, recycling, processing, and logistics. There are uncertainties regarding the potential success of existing and upcoming measures on the reduction of pellet loss.

There are data gaps on the structure of the sector (except for converters and producers), as well as on the exact costs and benefits that should be attributed under the different options, leading to some uncertainties. However, this could be solved using the assumptions as explained before.

There are very few data available on the packaging used within the sector, and the impact packaging has on pellet losses.

2 OVERVIEW OF METHODOLOGICAL STEPS

1. The first step was to define the problem for which extensive desk research was conducted, as well as workshops with stakeholders and experts. The objective was to identify the main sources of microplastics and their relative contribution to microplastics present in the environment. While three main sources (pellets production and use, tyre abrasion, and synthetic textiles) were evident from the existing knowledge, more research and consultation led to the addition of three sources in the scope of this initiative: paints, detergent capsules, and geotextiles. These six sources were chosen due to the magnitude of their contribution to microplastic releases in the environment. Overall, these six sources cover up around 90% of the total microplastic emissions in the EU.
2. While this initiative in the end only focusses on pellets, analytical work was first undertaken for all the sources identified. The analytical work on the other sources (paints, tyres, geotextiles, textiles and detergent capsules) is presented in Annex 15 and shows that there is potential to reduce and prevent unintentional microplastic releases from these 5 sources. In line with Better Regulation guidelines, they were not pursued here as the preliminary analysis demonstrated that existing or forthcoming instruments were better suited to targeting those sources, and/or that additional data needs to be collected on cost-effectiveness and on the impacts of alternatives. A major conclusion of this preliminary analysis is the lack of established methodology to estimate the amount of microplastics released of these six product groups.
3. The information collected on pellets was, however, deemed sufficient for action to be taken. Especially, as there is currently no existing EU legislation specifically addressing plastic pellets as a form of pollution occurring along the entire supply chain.
4. While analysing pellets' contribution to microplastic releases, a major problem was identified: current practices for handling pellets lead to losses at each stage in the supply chain, causing adverse environmental and (potential) human health impacts.
5. Deriving from this problem, several problem drivers were identified, namely market failure due to prices not reflecting negative externalities, market failure in the shape of imperfect information, and regulatory failure as existing EU legislation does not address pellets sufficiently.

6. The problem and its drivers led to the overall objective to prevent and reduce pellet losses to the environment that are due to current handling pellet practices at all stages of the supply chain. Three more specific objectives were also set out: reduce pellet losses to a level consistent with the 30% reduction target for microplastic releases by 2030 set out by the EU Zero Pollution Action Plan, improve information on pellet losses, and ensure appropriate mitigation of impacts for SMEs.
7. To achieve these objectives, it was essential to identify policy options that could reduce pellet losses. These options were selected based on available literature and input from stakeholders, either bilateral or in stakeholder workshops, including a workshop organised in December 2022 to specifically address pellets, the related baseline and preferred option. Information provided in response to the Inception Impact Assessment and the Public Consultation was also taken into account along with the findings of a survey carried out between January and February 2023 targeting only SMEs active in the pellet supply chain.
8. The measures within these policy options had previously been selected been selected from a first long list of measures, according to the screening criteria of the Better Regulation Guidelines and in coordination with stakeholders and the Inter-Service Consultation group.
9. Following the assessment of the different options in terms of their environmental, economic and social impacts on different stakeholders and society, these options were compared, and a preferred option was constructed.
10. To calculate the impact for the enterprises, who are dealing with the plastics pellets in the supply chain, data from industry and Eurostat was taken into account.

Annex 5: Competitiveness Check

1 Overview of impacts on competitiveness

Aspect of competitiveness	*Magnitude (++, +, 0,, -, -- or n.a.)*	*Reference to description in main IA report or annex*
Costs and prices	-	Sections 6 and 8.2 Annexes 3 and 11
Capacity to innovate	N/A	N/A
International competitiveness	-	Sections 6 and 8.2 Annexes 3 and 11
SME competitiveness	-	Section 8.2.3 Annex 12

2 Assessment and explanation

The turnover of the plastics sector in the EU27 in 2021 was EUR 405 billion. Therefore, the additional estimated **costs** of the preferred option would represent about 0.13% of the EU plastics sector turnover and are considered to be limited. The costs are expected to be greater in the short term but lower in the longer term once the appropriate systems and processes are in place and training undertaken. There will be some cost savings as a result of reduced losses to the environment (as pellets are a raw material). The proposal will encompass all actors in the pellet supply chain creating a level playing field in the EU. Some sectors currently impacted by pellet losses will benefit from the proposal e.g. agriculture, tourism.

The additional costs are likely to have a very minor negative impact on the **international competitiveness** of the EU pellet producers, as their competitors outside the EU will not be subject to the requirements (although logistical operators importing pellets will have to comply within the EU). However, the EU companies will have a first mover advantage if/when other countries adopt similar requirements, e.g. through an international agreement such as the Global Plastic Treaty.

The proposal will make a positive impact on the **capacity to innovate** as different actors of the value chain will develop solutions to minimise pellet spills in order to optimise their costs for controlling pellet losses.

A targeted SME consultation was undertaken to understand the potential impacts of different options for **SMEs including on their competitiveness**. Feedback indicated that the direct economic impacts of all the requirements would be too high to be sustainable for micro and small companies, as well as companies with capacities below 1000t. As a result, the proposal includes lighter requirements for SMEs to mitigate potential impacts by setting less obligations (e.g. no internal assessment) for micro- and small companies and a longer implementation period for medium companies. There is a balance to be sought between the magnitude of cost effects on SMEs, and reducing pellet losses. We believe that the preferred option reaches the appropriate balance, but should the college want to go further, additional lighter requirements (not foreseen in sub-option 2b) are assessed and outlined in Box 4 and Box 5. These might help reduce administrative costs for micro-, small and medium companies, along with carriers transporting pellets, but will increase pellet losses.

Annex 6:
Legislation and actions relevant to reducing pellet losses to the EU environment

1 EU Policies

1.1 The REACH restriction on intentionally added microplastics

A REACH restriction dossier has been in preparation since 2018 on intentionally added microplastics, covering also some aspects related to pellets. The Commission published a proposal for a restriction under Annex XVII of REACH. It was adopted on 25 September 2023[12]. The EU-wide restriction covers intentionally added microplastics in multiple applications including agriculture, horticulture, cosmetic products, paints, coatings, detergents, maintenance products, medical and pharmaceutical applications, and rubber infill in artificial sport surfaces. It is estimated that the proposed restriction could result in a reduction in microplastics emissions of about half a million tonnes including infill material over 20 years, at an estimated total cost of up to 19 billion euros.

Pellets are very partially covered by the REACH restriction on microplastics intentionally added to products[13]. The restriction does not prevent the placing on the market of pellets but does foresee lighter measures for so-called 'derogated' uses, meaning uses of microplastics at industrial sites, including plastic pellet sites, where releases can be prevented through risk management measures. These lighter measures are namely an 'instructions for use and disposal' requirement along the supply chain, and a 'reporting' requirement. The latter applies to pellets manufacturers and downstream users[14] and aims to gather information on three aspects:

a) the uses of such microplastics;

b) the generic identity of the polymers used; and

c) an estimate of the quantity of microplastics released to the environment on an annual basis, via a prescribed electronic format.

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12 Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

13 European Chemicals Agency, Opinion of the Committee for Risk Assessment and Opinion of the Committee for Socio-economic Analysis on an Annex XV dossier proposing restrictions on intentionally-added microplastics, ECHA/RAC/RES-O-0000006790-71-01/F and ECHA/SEAC/RES-O-0000006901-74-01/F, 2020, p.49 (https://echa.europa.eu/documents/10162/a513b793-dd84-d83a-9c06-e7a11580f366).

14 In REACH, 'downstream users' are defined as "any natural or legal person established within the Community, other than the manufacturer or the importer, who uses a substance, either on its own or in a mixture, in the course of his industrial or professional activities. A distributor or a consumer is not a downstream user. A re-importer exempted pursuant to Article 2(7)(c) shall be regarded as a downstream user". Concretely, pellet converters, recyclers as well as storing operators who own the pellets would be considered as downstream users under REACH. Transporters are not all downstream users but emissions during transport would also need to be reported by the relevant downstream user. Instead, would not be covered by the reporting obligation: distributors, storing operators who store the pellets for third parties, retailers and consumers. A transitional period of 24 months is set for the entry into force of the reporting requirement.

The reported information on all ‘derogated’ uses would help identify high releases and prioritise them for further regulatory risk management. However, as they apply to all ‘derogated’ uses, these lighter measures are generally defined and not specific to each single ‘derogated’ use. Also, they do not help as such to effectively reduce pellet losses or prevent them (e.g. they are not a requirement on their handling), and the reporting requirement is not based on a methodology to measure pellet losses (it was left to the industry to develop a methodology).

Moreover, where ‘instructions for use and disposal’ and ‘reporting’ requirements are proposed, a largely qualitative analysis of expected incremental costs to industry was presented based on the arguments that the effort needed to fulfil these requirements is expected to be limited and that sufficient time is given to the industry to established the efforts needed. In its conclusions, the Committee for Socio-economic Analysis (SEAC) agrees that the costs incurred to provide ‘instructions for use and disposal’ is likely to be moderate as cost effective communication tools are available, the extent of information required is limited and the transition period give actors sufficient time to smoothly implement the requirements. Instead, for the reporting requirement, the total costs of reporting could be substantial as the number of companies affected is likely to be large. SEAC considers that there are different options to reduce such costs, e.g. by excluding certain actors (small or micro-sized companies) from the requirement or by setting a threshold for microplastics volumes used or released to be reported. However, SEAC cannot draw a firm conclusion on how these different options would compromise the value of information obtained and hence the benefits of reporting in terms of facilitating better risk management. Moreover, SEAC considers that for certain actors in the supply chain, e.g. manufacturers of microplastics, a shorter transition period, i.e. 12 months, seems to be justified.

The Commission received the final ECHA opinion on the restriction proposal on 23 February 2021[15]. Following discussions with Member States, the Commission published its restriction proposal on 30 August 2022, and it was voted in the REACH Committee on 26 April 2023. The proposal was adopted on 25 September by the Commission.

1.2 The Marine Strategy Framework Directive (MSFD)

The Marine Strategy Framework Directive (MSFD) addresses the monitoring and assessment of the impacts of microlitter, including microplastics, in coastal and marine environments in a way that they can be linked to sources[16]. Currently, an update of the first MSFD guidance on monitoring marine litter guidance document is under development in view of harmonised methodologies, including to the monitoring of the presence and distribution of plastic pellets along the coastline. However, this work does not include specific requirements concerning the prevention or reduction of pellet losses at the source.

[15] European Chemicals Agency, Opinion of the Committee for Risk Assessment and Opinion of the Committee for Socio-economic Analysis on an Annex XV dossier proposing restrictions on intentionally-added microplastics, ECHA/RAC/RES-O-0000006790-71-01/F and ECHA/SEAC/RES-O-0000006901-74-01/F, 2020, p.49 (https://echa.europa.eu/documents/10162/a513b793-dd84-d83a-9c06-e7a11580f366).

[16] “…micro-litter shall be monitored in the surface layer of the water column and in the seabed sediment and may additionally be monitored on the coastline. Micro-litter shall be monitored in a manner that can be related to point-sources for inputs (such as harbours, marinas, waste-water treatment plants, storm-water effluents), where feasible.”

1.3 The Urban Wastewater Treatment Directive and its revision

The Urban Wastewater Treatment Directive (UWWT Directive) aims to protect the water environment from the adverse effects of discharges of urban wastewater and from certain industrial discharges.

In October 2022, the Commission adopted a proposal for a revised UWWT Directive which contains provisions on microplastics (including pellets). The revised Directive proposes to monitor microplastics in UWWT plants (including in sludge). It also contains new requirements on storm water and urban runoff management (see Article 5 and Annex 15), which will have an impact on microplastics.

Microplastics found in domestic wastewaters originate from the washing of textile, tyre abrasion on the roads, detergent capsules, and also from the bad handling of plastic pellets during transport when spilled pellets can reach urban wastewater through urban runoff entering combined sewer systems.[17] Heavy rains may lead to overflows which bypass the treatment facilities and result in releases of pellets and other (micro)plastics to the environment. If properly implemented, the revised UWWTD is expected to cut microplastics emissions by 9% from stormwater overflows by 2040. However, this estimate excludes the amount of microplastics coming back to environment with the sewage sludge.

Most large pellet producers are connected to industrial wastewater treatment plants but some small recyclers and processors are connected to UWWT plants[18]. If a spill happens within these connected facilities, they may enter the urban wastewater collecting system and reach Urban Wastewater Treatment plants.

Microplastics, including pellets, would appear to be relatively well captured in urban wastewater treatment plants,[19] where it is retained in sludge. The UWWTD revision also includes additional treatment requirements for larger facilities[20] meaning more microplastics, including pellets, will be captured in sludge in the future. The most common use of sludge is to spread it on agriculture so about half of microplastics captured in urban wastewater treatment facilities will be released into the environment. Sludge, however, also contains valuable nutrients which are beneficial for agriculture, so the revised UWWTD will seek to avoid the pollution of sludge, notably by proposing to track and trace industry wastewater that is not easily treatable in conventional treatment plants (Art. 14 and Art. 20).

Although we do not have exact estimates, only a minor part of plastic pellets would seem to be captured by the urban sewage system and only when connected to urban wastewater treatment. This revision would therefore have a limited impact on the overall reduction pellet losses to the environment.

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[17] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

[18] As informed by recyclers

[19] According to the UWWTD impact assessment, 80.5% of microplastics are captured after primary treatment, 97.5% after secondary treatment and 99.2% after tertiary treatment.

[20] The revision of the UWWTD introduces mandatory tertiary treatments for all larger facilities treating a load equal to or greater than 100 000 p.e. (population equivalent). All agglomerations with a p.e. of 1.000 or more (compared to 2.000 p.e. and more in the existing Directive), are obliged to proceed to two treatments.

1.4 The Sewage Sludge Directive

The Sewage Sludge Directive (SSD) covers the use of sewage sludge in agriculture, while preventing harmful effects on soil, waters, vegetation, animals, and humans. The Directive prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. It also requires that sludge is used in such a way that plants' nutrient requirements are satisfied and that the soil and surface and groundwater quality is not impaired. Microplastics are not addressed in the current Directive.

Recent research from the Norwegian Water Institute estimated that "between 110 000 and 730 000 tonnes of microplastics are transferred every year to agricultural soils in Europe and North America".[21,22]

The Sewage Sludge Directive is currently under evaluation. During this evaluation, the concept of source control, i.e. targeting substances such as microplastics and micropollutants at source, was widely supported by stakeholders to improve circularity in the wastewater treatment sector. Indeed, if sludge and/or water is reused, stakeholders highlighted that pollution must be tracked and prevented at source. It is not yet clear however which measures will be proposed in its future revision, and whether these would target microplastic pollution.

Other water legislation

The recast of the Drinking Water Directive (DWD), the update of the Groundwater Directive (GWD) and the Environmental Quality Standards Directive (EQSD) all include provisions related to downstream microplastics monitoring. Methodologies to monitor microplastics under the DWD will be further developed, to the extent possible, for use in groundwater, surface waters and coastal waters. Once a harmonised monitoring methodology is in place, microplastics may be included in the surface and groundwater watch lists and may be monitored. Subsequently, harmonised monitoring data on microplastics will be collected during a period of at least 2 years resulting in quality standards for microplastics in surface and groundwater. As for the drinking water, the Commission should adopt (by delegated acts) a methodology to measure microplastics by 12 January 2024 with a view to including them on the watch list. In addition, the Commission will submit, no later than 12 January 2029, a report on the potential threat to sources of water intended for human consumption from microplastics, pharmaceuticals and, if necessary, other contaminants of emerging concern. The report will also address the potential associated health risks.

1.5 The Industrial Emissions Directive

The Industrial Emissions Directive (IED)[23] regulating prevention and control of pollution arising from industrial activities in large industrial installations is only partially suited to address pellet losses as a form of pollution occurring along the entire supply chain. While activities like the production of polymeric materials on an industrial scale fall under the scope of the IED, other activities like the conversion, storage or transport of pellets, usually operated by small and medium enterprises, are not covered. Moreover, the BAT Reference Document (BREF) for the production of polymers was adopted in 2007 and does not address the specific issue of pellet losses.

[21] Hurley, R., & Nizzetto, L., 'Fate and occurrence of micro(nano)plastics in soils: Knowledge gaps and possible risks', *Current Opinion in Environmental Science & Health*, Vol. 1, 2018, pp. 6-11, Elsevier BV.

[22] Water Briefing. (2016, November 7). Sewage sludge: new research warns over microplastics in soil.

[23] Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (recast)

1.6 The Waste Framework Directive

The Waste Framework Directive (WFD)[24] lays down basic waste management principles and imposes general obligations to Member States to take measures to prevent waste generation. As for industrial production and manufacturing those measures shall, at least, contribute to reducing waste generation, considering the best available techniques adopted under the IED. Pellets may become waste as a substance or object which the holder discards intentionally or unintentionally.

Member States shall establish waste prevention programmes setting out waste prevention measures. Examples of possible measures to be adopted by Member States addressing industrial production and distribution are listed in the Directive and include the provision of information on waste prevention techniques intending to facilitate the implementation of best available techniques by industry, the organisation of training of competent authorities as regards the insertion of waste prevention requirements in permits under the WFD and the IED, the inclusion of measures to prevent waste production at installations not falling under the IED, awareness campaigns or the provision of financial, decision making or other support to businesses, especially small and medium-sized enterprises, the use of voluntary agreements, or sectoral negotiations in order that the relevant businesses or industrial sectors set their waste prevention plans and the promotion of creditable environmental management systems.

According to Article 29 (5) of the WFD, the Commission shall adopt guidelines to assist Member States in preparing their programmes and preventive measures.

The generic provisions mentioned above have not resulted in any significant reduction of pellet losses and there is however no specific action or measure included in the WFD focussing on pellets.

2 Actions in Member States

Several EU27 member states have been conducting research on microplastic (including pellets) emissions and some of them have even implemented measures to tackle pellet loss as presented in Table 42.

For example, France and Austria have taken legislative measures to curb this pollution.

The French legislation[25] covers businesses making and handling pellets in quantities higher than 5 tonnes including logistic platforms but not transporters. The threshold has been reduced from what initially proposed i.e. 10 tonnes following public consultation. Businesses are subject to equipment and procedural obligations to prevent the loss and leakage of pellets, and are required to be regularly audited by independent and accredited certification bodies[26]. Obligations remain of a relatively generic nature. For instance, a business must identify areas where pellets are more likely to spill, check that the packaging used is designed to minimise the risk of spills and train and raise awareness

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[24] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705).

[25] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official "Lois et Décrets" no. 0092 du 18 avril 2021 [JORF] [Official journal "Laws and Decrees" no. 0092 of 18 April 2021], 18 April 2021, Fr.

[26] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official "Lois et Décrets" no. 0092 du 18 avril 2021 [JORF] [Official journal "Laws and Decrees" no. 0092 of 18 April 2021], 18 April 2021, Fr.

among staff. As a unique transparency measure, the company must make the summary of the auditing report available on its website. The Decree entered into force on January 1, 2022 for new sites, while for existing sites, it will enter into force in 2023, at the same time as equipment obligations.

The Austrian government has set a threshold for the emissions of filterable substances (pellets are considered filterable substances) to the environment. [27] However, the emission level (30mg/L) allowed is significant since companies can release up to 94.5 tonnes of pellets annually into the environment.[28] This legislation does not address pellets directly but rather "filterable substances", to which pellets belong. In light of the high volume of pellets losses allowed, it seems that the current Austrian legislation on wastewater emissions is not sufficient to reduce pellet loss.

In 2021, in response to a clear call for sufficiently reliable and comparable data on pellets at the European level from OSPAR and the European Task Group for Marine Litter, the Netherlands carried out a pilot monitoring project[29] showing that significant amounts of pellets and mesoplastics are present on Dutch beaches[30]. In view of these encouraging first results, they will continue the monitoring in coming years. Apart from this monitoring activity, there is no Dutch scheme or process to tackle pellet losses. Denmark launched a monitoring program, as a part of the Danish Marine Strategy (2018-2024), including monitoring of marine litter, analyses of microplastic in sediments, as well as analyses of macro and microplastics in the stomachs of two fish species[31].

In 2022, the Flemish Authorities consulted with stakeholders on techniques and measures to prevent and reduce plastic losses and which Best Available Techniques (BAT) to select. On the basis of this consultation, they hope to produce recommendations for Flemish environmental legislation (general binding rules and specific environmental permit conditions). In a recent meeting with the Commission, an OVAM representative reported that "there are pellet losses around the Port of Antwerp". In recognition of this, the Port of Antwerp has been running the Antwerp Zero Pellet Loss Platform since 2017, to optimize the implementation of the European plastic industry voluntary programme called 'OCS' (see under industry initiatives), in the port of Antwerp.

Spain's actions are limited to promoting the implementation of the recently launched European plastic industry's voluntary certification scheme called 'OCS certification scheme' (see under industry initiatives). Other countries are similarly relying on the industry efforts in this field.

In Sweden, the 2020 guidelines on measures to minimise microplastic emissions from manufacturing and management of plastics are still used. [32] In order to promote upcoming standards and certification schemes to reduce the loss of plastic pellets throughout the entire plastic supply chain, there are plans

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[27] Lechner, A. and Ramler, D., 'The Discharge Of Certain Amounts Of Industrial Microplastic From A Production Plant Into The River Danube Is Permitted By The Austrian Legislation', *Environmental Pollution*, Vol. 200, 2015, pp. 159-160. Elsevier BV.

[28] Lechner, Aaron, and David Ramler. "The Discharge Of Certain Amounts Of Industrial Microplastic From A Production Plant Into The River Danube Is Permitted By The Austrian Legislation". Environmental Pollution, vol 200, 2015, pp. 159-160. Elsevier BV, doi:10.1016/j.envpol.2015.02.019. Accessed 28 Mar 2022.

[29] Dutch Government, Policy Programme on (micro) plastics – European Marine Strategy Framework Directive, 2020 (https://g20mpl.org/partners/netherlands).

[30] Dutch Ministry of Infrastructure and Water Management, 'Monitoring of pellets and mesoplastic fragments on Dutch beaches in 2021: a pilot study', 2022 (https://puc.overheid.nl/rijkswaterstaat/doc/PUC_721767_31/1/)

[31] Ministry of Environment and Food of Denmark; Microplastics: Occurrence, effects and sources of releases to the environment in Denmark, Environmental project No. 1793, 2015

[32] Swedish Government, 'Microplastics', 2022 (https://www.naturvardsverket.se/amnesomraden/plast/om-plast/mikroplast/).

to revise the Swedish guidelines to make them more comprehensive and include more actors along the plastic pellet value chain.

Table 42: Selected actions in Member States

Countries	Measure
Austria	Threshold for the emissions of filterable substances (including pellets)
Belgium (Flanders)	Environmental permit system to be put in place/ Best Available Techniques Examining the option of an environmental management system with possible certification
Denmark	Monitoring Waiting for OCS certification scheme implementation and Commission's proposal
France	Law adopted providing minimum obligations to prevent pellet losses for all actors in the supply chain along with mandatory external auditing
Netherlands	Research program on mitigation measures to avoid microplastic emissions, including from pellets, and monitoring Waiting for OCS certification scheme implementation
Spain	Promoting OCS certification scheme implementation
Sweden	Revision of current guidelines to make them more comprehensive and include more actors across the supply chain.

3 International actions on pellets

Some countries, outside of the EU, have also started taking actions against pellet losses, as captured in Table 43.

In 2021, the British Standards Institution published the Publicly Available Specification (PAS) PAS 510:2021[33]. This PAS is for use by any organisation of any size in any part of the supply chain that handles pellets, including raw material manufacturers, distributors, storage facilities, recyclers, transporters, and plastics processors. It builds on the groundwork laid by the industry-led Operation Clean Sweep® (OCS) programme (see under industry initiatives) by creating a standardised and consistent approach to risk management and the containment of pellets in order to prevent losses to the environment throughout the plastic supply chain[34]. The PAS may be considered for further development as a British standard or constitute part of the UK input into the development of a European or International standard on pellets.

[33] Plastic pellets, flakes and powders. Handling and management throughout the supply chain to prevent their leakage to the environment. Specification - PAS 510:2021101

[34] The PAS provides requirements in the following areas: a) Organizational responsibilities; b) Leadership and commitment; c) Competence, training and awareness; d) Risk assessment of pellet loss to the environment; e) Operational controls, i.e. prevention, containment and clean-up, procurement and suppliers; f) Internal and external communication; g) Performance evaluation, i.e. monitoring and documentation, auditing and verification of conformity; h) Improvement, i.e. internal and external non-conformity and corrective action, and continual improvement.

The USA has enforced the "Break Free from Plastic Pollution Act of 2021",[35] prohibiting the emissions of pellets to wastewater, spills and runoff from plastics production facilities. Three years from when the senate passed the Bill (on 26 March 2021), Best Available Technology Economically Achievable (BAT) and New Source Performance Standards (NSPS) regarding pollution prevention will have to be available. Under the current regime, pellet manufacturers must obtain a National Pollutant Discharge Elimination System (NPDES) permit to produce pellets. The permit comes with a set of Best Management Practices (BMPs) that aim to prevent pellet losses to the environment.[36]

Prior to this national Bill, the Assembly Bill (AB) 258, which became effective in 2008, added Chapter 5.2 to Division 7 of the California Water Code, section 13367, entitled "Preproduction Plastic Debris Program."[37] It enables the Regional and State Water Board to perform compliance inspections on pellets production, transportation and handling, enforcing action, in particular, to improve storm water discharges. They also facilitate multi-stakeholders actions, such as meetings between pellets producers and environmental action groups.

Table 43: Selected international actions

Countries	Measure
UK	New PAS 510:2021 technical specifications provides requirements for the handling and managing of plastic pellets, flakes and powders throughout the supply chain to prevent spills, leaks and losses to the environment.
USA	The "Break Free from Plastic Pollution Act of 2021",[38] prohibiting the emissions of pellets to wastewater, spills and runoff from plastics production facilities. Any plastic sector company needs to get a National Pollutant Discharge Elimination System (NPDES) permit to produce pellets. The permit comes with a set of Best Management Practices (BMPs) that aim to prevent pellet losses to the environment.[39]
USA (California)	The California Water Code, section 13367, entitled "Preproduction Plastic Debris Program."[40] enables the Regional and State Water Board to perform compliance inspections on pellets production sites, transportation vehicles and during handling operations.

4 Multilateral Actions

Multilateral action targeting pellets is so far limited to the **OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic**. This Convention is an international legal instrument bringing together 16 signatories to coordinate the protection of the North-East Atlantic

35 US Congress, Break Free from Plastic Pollution Act of 2021, H.R. 2238, 2021 (https://www.congress.gov/bill/117th-congress/house-bill/2238/text).
36 US Environmental Protection Agency, 'Industrial Stormwater fact sheet: Sector Y: Rubber, Miscellaneous Plastic Products, and Miscellaneous Manufacturing Industries', 2006 (https://www3.epa.gov/npdes/pubs/sector_y_rubberplastic.pdf).
37 California Environmental Protection Agency, 'Preproduction Plastic Debris Program', 2008 (https://www.waterboards.ca.gov/water_issues/programs/stormwater/plasticdebris.shtml).
38 US Congress, Break Free from Plastic Pollution Act of 2021, H.R. 2238, 2021 (https://www.congress.gov/bill/117th-congress/house-bill/2238/text).
39 US Environmental Protection Agency, 'Industrial Stormwater fact sheet: Sector Y: Rubber, Miscellaneous Plastic Products, and Miscellaneous Manufacturing Industries', 2006 (https://www3.epa.gov/npdes/pubs/sector_y_rubberplastic.pdf).
40 California Environmental Protection Agency, 'Preproduction Plastic Debris Program', 2008 (https://www.waterboards.ca.gov/water_issues/programs/stormwater/plasticdebris.shtml).

marine environment. In 2021, signatories adopted the non-binding Recommendation 2021/06[41] to reduce the loss of plastic pellets in the marine environment. The recommendation invites contracting parties to promote pellet loss prevention standards and certification schemes according to a specific hierarchy of measures i.e. prevention, mitigation, cleaning and reporting. It provides minimum requirements for certification schemes to de developed. Detailed guidelines were also approved. This impact assessment builds on this non-binding recommendation, as explained in the relevant parts.

In particular, the Recommendation contains the following guidance:

Pellet handling standards:

- Documentation of an Organisation's Responsibilities identifying which are the operations during which spills can and cannot occur;
- Management should demonstrate leadership to prevent pellet losses;
- Training and awareness-raising of employees;
- Risk assessment of pellet losses to be done by all members of the supply chain;
- Operational controls are to be established by the business to prevent spills (by avoiding unnecessary handling and having best handling practices in place), mitigate and contain spills whenever they occur, and clean up spills after they have occurred;
- Businesses should implement procurement policies relating to pellet handling;
- Implemented measures should be communicated by businesses;
- Businesses' performances regarding pellet loss prevention measures should be evaluated regularly; and
- Businesses should improve their practices whenever they are non-conform.

A pellet certification scheme:

- It should be international to ensure a level playing field for all businesses;
- A database should be created to form a public Register storing all data related to the scheme;
- The management and governance of the scheme should be developed and managed by an independent organisation;
- To be certified, any site must have been audited first and passed an appropriate standard;
- Joining the scheme should be simple;
- The auditing should be regular and performed by an independent accredited auditor;
- The certification body should be independent and well trained in the standard they are auditing; and
- The scheme should acknowledge that a company has been accepted or that an update has occurred.

The first full implementation report is due in January 2025. However, an interim report on the progress made will be published in 2024. OSPAR shared a preliminary interim report in February

[41] www.ospar.org/convention/strategy

2023 and the actions reported by the Member States that are parties to the OSPAR Convention are presented in Table 42.

In March 2022, the second session of the 5th **United National Environment Assembly** unanimously adopted resolution 14: End Plastic Pollution: towards an international legally binding instrument42 (hereafter referred to as the resolution). The preamble to the resolution highlights that "*plastic pollution includes microplastics*". This inclusion indicates that that intergovernmental negotiating committee (INC) will have to consider how to address microplastics in a forthcoming global agreement.

In May 2019, the Conference of the Parties to the **Basel Convention** adopted a decision by which it amended Annexes II, VIII and IX of the Convention in relation to plastic waste. A Plastic Waste Partnership was created with the aim, among other things, to significantly reduce and eliminate waste discharge of plastics and microplastics in the environment.

The **OECD** Council Recommendation on Water calls for Adherents to prevent, reduce and manage water pollution from all sources, while paying attention to pollutants of emerging concern, such as microplastics.

In the **International Maritime Organization** (IMO), a Correspondence Group on Marine Plastic Litter from Ships looked at measures that could be relevant in reducing the environmental risks associated with the maritime transport of plastic pellets. While three primary measures including packaging were identified as particularly relevant (and a voluntary circular to this effect was drafted as a guidance document), the Group was not in a position to conclude on the most appropriate instrument for mandatory measures[43]. The Group noted that experience gained from the implementation of the voluntary measures could be useful in the further consideration of the most appropriate instrument for mandatory measures.

A similar international initiative is ongoing on containers lost at sea, and discussions are held on the possibility of making the information on containers lost at sea available publicly (to date, sufficient information is reported only to insurance companies). If retained, this measure would allow for a better understanding of the scale and magnitude of pellets lost at sea and would facilitate liability identification and compensation arrangements in line with the polluter pays principle.

5 VOLUNTARY ACTIONS ON PELLETS

5.1 Industry actions

The problem of pellet losses has been known about since the 1980s with the US Environmental Protection Agency (EPA) and the Center for Marine Conservation (now known as the Ocean

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[42] United Nations Environment Assembly, Resolution – End plastic pollution: towards an international legally binding instrument, UNEP/EA.5/Res.14, 02.03.2022.

[43] The three primary measures identified as relevant are: Packaging provisions for plastic pellets carried at sea; Provisions for notifying the carrier so that containers containing plastic pellets can be identified; Stowage provisions for freight containers containing plastic pellets. Among the options for mandatory measures, the Group considered the three following options/instruments: Assignment of an individual UN Number (class 9) for plastic pellets transported at sea in freight containers (UN Number); Amendment to Appendix I of MARPOL Annex III that would recognize plastic pellets as a "harmful substance" (Harmful substance); A new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

Conservancy) “detecting plastic pellets in US waterways from the Atlantic to the Pacific”[44]. In 1986, SPI (the US Plastics Industry Trade Association, now known as the Plastics Industry Association) established the Resin Pellet Task Force to “educate the plastics industry [….] about the negative consequences of plastic pellets in the marine environment”. In 1991 the industry-led Operation Clean Sweep (OCS) initiative was created by SPI, with companies voluntarily signing a pledge to work towards zero plastic pellet losses.

Since 2015, the European plastics manufacturing industry has also progressively adopted the international Operation Clean Sweep® (OCS) programme as a voluntary free pledge.[45] Under this programme, each company making or handling pellets recognises the importance of making zero pellet losses and 1) improves worksite set-up to prevent and address spills; 2) creates and publish internal procedures to achieve zero pellet loss; 3) provides employee training and accountability for spill prevention, containment, clean-up and disposal; 4) audits performance regularly; 5) complies with all applicable local and national regulations governing industrial pellet containment; 6) encourages partners to pursue the same objectives. Recommendations on how to deliver on each of these six actions are given in the form of a manual. The Operation Clean Sweep® (OCS) manual contains in particular the following guidelines to help plastics industry operations managers reduce the loss of pellets to the environment:

Under ‘Work site set-up’:

- Pave loading/unloading areas where unavoidable spills occur to facilitate clean-up
- For clean-up in gravel yards, consider fitting vacuums with screen or mesh on intake hoses to collect pellets without disturbing gravel
- Provide catch trays for use at all car/truck unloading valves
- Use bulk-handling equipment that is designed to minimise pellet leakage
- Install central vacuum systems where practical
- Install connecting hoses equipped with valves that will close automatically when the connection is broken
- Properly empty and seal bulk containers (rail or truck) after unloading
- Assure proper handling when storing and removing waste pellets
- Seal expansion joints in concrete floors with flexible material to avoid pellet accumulation in hard to clean spaces
- Conduct routine inspections and maintenance of equipment used to capture and contain pellets
- Install zero loss containment systems wherever necessary to prevent pellets from escaping plant boundaries
- Place screening in all storm drains
- Install baffles, skirts and booms in containment ditches or ponds
- Finally, ensure that employees have ready access to: Brooms, dustpans, rakes, etc., Heavy-duty shop vacuums for inside use, Portable shop vacuums for outside use, Catch trays or traps, Wide-mouth sample collection jars or poly-bags, Tape for repairing bag or box damage, Scrap pellet containers, Procedures you expect them to undertake and checklists to assist in follow-through, Forklift clean-up kit.

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[44] Document Display | NEPIS | US EPA; Plastics Industry Association (2016) Operation Clean Sweep Celebrates 25 Years, available at https://www.plasticsindustry.org/article/operation-clean-sweep-celebrates-25-years

[45] https://www.opcleansweep.eu/

Then, under ‘Prevention, Containment & Clean-up Procedures’, best practices are provided for each handling step, namely: Cleaning Empty Tank Railcars and Trucks; Top Loading; Sealing Loading Railcars/Trucks; Storing at Intermediate Sites; Valve Opening; Completing Unloading; Sampling; Sealing Valves; Sampling from unloading tubes; Sampling from top hatches; Selecting Packaging Materials; Bags: Filling and Handling; Bags: Emptying and Disposal; Octabins.

According to the industry, preventive measures taken separately have estimated pellet loss prevention efficiency ranging from 59% to 97%[46], while mitigation measures taken separately have estimated pellet loss prevention efficiency ranging from 81% to 95%. These measures must not be used alone but in unison to achieve a satisfactory reduction of losses to the environment.

While best practices measures are generally well understood, they have not been comprehensively implemented. As of April 2023, 2548 companies have committed to OCS[47]. This figure includes all PlasticsEurope’s members (adherence to OCS is mandatory for the members of this association) but only a very small number of converters and transporters. Regarding converters, only 2% of all EuPC’s members have committed to OCS (1,000 converters out of a total of close to 50,000). Regarding transporters, some 500 transport companies are OCS signatories. As no precise reporting has been made available within OCS, it is not possible to say whether those who have committed have also effectively or fully implemented the programme, with some evidence showing the opposite. Both acute and chronic pellet incidents have been reported to continue over the last years, including at sites that are OCS signatories[48].

Recognising the low take-up of OCS by the industry and the increasing rate of pellet losses, European plastic manufacturers (PlasticsEurope) and converters (EuPC) announced plans in 2019 to go beyond the OCS programme and develop a voluntary certification scheme building on OCS, including requirements, third-party, independent auditing, certification and some level of transparency (all aspects not foreseen under the current OCS programme). In January 2023, the new scheme was officially launched by its promoters based on the preparatory work carried out by a Supervisory Board gathering producers, converters, representatives of some Member States (Scotland, Germany and Spain), one NGO (Fauna & Flora International), some certification bodies (Aenor and Tuv-Nord) as well as one European Institution (the European Parliament). Representatives of the European Commission, the European Chemical Transport Association (ECTA) and Cefic took part in the discussions as observers.

According to the scheme owners, OCS CS is aimed at “controlling and documenting compliance of companies throughout the entire supply chain with requirements aiming for a minimisation of pellet losses across the entire plastic supply chain. It will also support the effective, harmonized and quantifiable implementation of the OCS programme”. Companies will be invited to comply with requirements from the following categories:

- Commit to making zero loss of pellets, flakes, and powder a priority;
- Improve worksite set to prevent and address spills, meaning site risk assessments;

[46] Confidential data provided by EUPC from their documents used to setup the OCS certification scheme.le
[47] Idem
[48] Regarding chronic pellet losses in the Netherlands, Belgium and Spain, see https://www.plasticsoupfoundation.org/wp-content/uploads/2022/03/Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf; https://surfrider.eu/en/learn/news/ecaussinnes-belgium-surfrider-foundation-tackles-industrial-plastic-granules-1211028228325.html; https://goodkarmaprojects.org/2020/11/20/new-report-out-exposes-alarming-impacts-of-plastic-pellets-across-europe/?lang=en.

- Create and publish internal procedures to achieve zero pellet loss goals meaning documented procedures, including, for instance, description of roles and responsibilities, but also recording, investigation and follow-up of incidents and effectiveness of procedures, equipment and instructions in place;
- Provide employee training, including theory and practical hands-on exercises and accountability for spill prevention, containment, clean-up and disposal;
- Audit performance regularly, meaning internal audits;
- Comply with all applicable local and national regulations governing pellet containment; and
- Encourage partners to pursue the same objectives to be monitored, for instance, via the % of contracts containing an OCS clause.

Compliance will be verified at site level by third-party, independent auditors. Once successfully audited, companies will be certified compliant and will have the name of the company and the site location listed in a public register. The certification will be valid for 3 years after the date of the first audit, subject to an annual control audit. First audits were foreseen as of April 2023.

5.2 NGO activities

Several environmental non-governmental organisations (NGOs), such as Fidra, Fauna and Flora International (FFI), SOS Mal de Seine, are also working to reduce pellet losses. These organisations have implemented monitoring programs and engaged with authorities and the industry to promote good practices when handling pellets. Fidra has been working with the plastics industry since 2012 to raise awareness and collaborates with trade associations, decision-makers and regulators to identify solutions that will build upon Operation Clean Sweep® (OCS). FFI has engaged with the plastics industry and with regulators in the UK and across Europe to promote wider uptake and implementation of OCS since 2012 and has encouraged the introduction of annual compliance audits and open reporting that feed into yearly OCS membership renewal (rather than automatic membership for life) to enable all stakeholders to see which companies have fully implemented best management practices for preventing pellet loss at their sites. SOS Mal de Seine is in contact with the French Ministry of Environment and participates in raising awareness around plastic pellet losses. Several other NGOs are also actively involved in promoting awareness and regulatory action at the European level. Since 2018, NGO As You Sow has challenged seven of the largest pellets manufacturers to report any pellet spills happening in their facilities[49]. The companies agreed to do so; however, public reporting has not been done yet[50].

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49 As You Sow, 'Plastic Pellet Pollution', 2021 (https://www.asyousow.org/our-work/waste/plastic-pellets).

50 Evidence gathered by the NGOs include:
Dutch Ministry of Infrastructure and Water Management, 'Monitoring of pellets and mesoplastic fragments on Dutch beaches in 2021: a pilot study', 2022 (https://puc.overheid.nl/rijkswaterstaat/doc/PUC_721767_31/1/);
Rethink Plastic Alliance, Surfrider Foundation Europe, & Break Free from Plastic, 'Plastic Giants polluting through the backdoor', 2020 (https://rethinkplasticalliance.eu/wp-content/uploads/2020/12/bffp_rpa_pellets_polluting_through_the_backdoor.pdf);
Greenpeace, 'Inquinamento Silenzioso – Chi contamina le coste pugliesi con i granuli di plastica?' [Silent Pollution – Who is contaminating Puglia's coastline with plastic pellets?], 2022 (https://www.greenpeace.org/static/planet4-italy-stateless/2022/07/904ad868-inquinamento-silenzioso.pdf), It;
KIMO, 'Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines', 2020 (https://www.kimointernational.org/news/plastic-pellets-spill-pollutes-danish-norwegian-swedish-coastlines/);
Legambiente & Italian National Agency for New Technologies, Energy and Sustainable Economic Development, 'First preliminary study on microplastic within Italian lakes', 2016 (https://www.legambiente.it/sites/default/files/docs/microplastic_in_italian_lakes_legambiente_2016.pdf);

Table 44: Selected Voluntary initiatives (Industry and NGO)

Name	Details
Surfrider	Field actions on the presence of pellets on beaches, called "pellet hunt"
Rethink plastic alliance	Microplastics
Seas at Risk	Microplastics
Operation Clean Sweep (OCS)	Awareness raising, promoting best practices and providing guidance and tools to implement pellet loss prevention measures. https://www.opcleansweep.eu/. Since 2023, mandatory certification for members of EU trade association Plastics Europe.
SQAS	Alternative system to the OCS for transporters, the section on pellets is still under development (www.sqas.org)
RecyClass	Certification for recyclers, the section on pellets is still under development (www.recyclass.eu).

Italian National Agency for New Technologies, Energy and Sustainable Economic Development, 'Environment: ENEA in the field for the microplastics emergency in Italian lakes', 2022 (https://www.enea.it/en/news-enea/news/environment-enea-in-the-field-for-the-microplastics-emergency-in-italian-lakes);
SOS Mal de Seine, 'Granulés plastiques industriels sur le littoral français', 2011 (http://maldeseine.free.fr/documents%20granules/RAPPORT_version_WEB.htm);
Mani, T., et al., 'Repeated detection of polystyrene microbeads in the Lower Rhine River', Environmental Pollution, Vol. 245, 2019, pp. 634-641, Elsevier BV.

Annex 7:
Microplastics and pellets in the environment

The following section captures the current state of play of research regarding microplastics. It looks at the definition of microplastics, the impacts on health, the environment and climate, and the difficulties related to its monitoring. Most of these impacts are related to microplastics in general, and the impacts of pellets losses to the environment are largely similar. We would generally expect that the adverse impacts of pellets will be proportional to their part in the total microplastic emissions.

1 WHAT ARE MICROPLASTICS?

Plastics are materials prepared from (semi-)synthetic polymers such as polyethylene, polyvinylchloride (PVC), polyethylene terephthalate (PET), nylon, rayon and cellulose nitrate that are generally treated with chemical additives to transform them into plastic products.

Microplastics are plastic particles measuring less than 5 mm and include sub-micrometre particles called 'nanoplastics'.

While there is no legally binding definition of microplastics, there is a common understanding on their general characteristics:[51]

- synthetic materials with a high polymer content,
- solid particles,
- smaller than 5 mm, and
- not degradable.

The REACH restriction[52] for intentionally added microplastics, defines microplastics as "particles containing solid polymer, to which additives or other substances may have been added, and where ≥ 1% w/w of particles have (i) all dimensions 0.1µm ≤ x ≤ 5mm, or (ii) a length of 0.3µm ≤ x ≤ 15mm and length to diameter ratio of >3. " This definition excludes polymers with a solubility > 2 g/L. The size definition of microplastics was discussed at the first international research workshop on the occurrence, effects and fate of microplastic marine debris in 2008, hosted by NOAA.53 The participants adopted a pragmatic definition, suggesting an upper size limit of 5 mm. This was based on the premise that it would include a wide range of tiny particles that could readily be ingested by biota and such particles that might be expected to present a different kind of threat than larger plastic items such as entanglement. The minimum size of microplastics is most often defined as 1 µm as this can be verified by Raman microscopy, but due to methodological constraints of sampling or analysis limitations, different operational lower size limits, e.g., 10, 100, or 300 µm, are often used.

In Europe, approximately 80 % of all plastic raw materials produced are in the form of round to oval granules of approximately 2 mm to 5 mm in diameter.[54] A relevant part of the remaining 20% is even

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[51] Leslie, H.A., 'Review of microplastics in cosmetics: Scientific background on a potential source of plastic particulate marine litter to support decision-making', *V.U. Institute for Environmental Studies*, 2014.

[52] EUR-Lex - 32023R2055 - EN - EUR-Lex (europa.eu)

[53] Arthur, C., Baker, J. and Bamford, H. (eds), 'Proceedings of the International Research Workshop on the Occurrence, Effects, and Fate of Microplastics Marine Debris', NOAA Marine Debris Program, 2008 (https://marinedebris.noaa.gov/proceedings-international-research-workshop-microplastic-marine-debris).

[54] PlasticsEurope, 'PlasticsEurope Operation Clean Sweep® Report 2017', 2017 (https://www.opcleansweep.eu/application/files/8316/3456/6233/PlasticsEurope_OCS_progress_report-2017.pdf).

smaller than 2mm, such as powders, and a minor part can be slightly taller. It is common sense to tackle all these pellets together. This will equally avoid any action of the industry to make pellets slightly taller than 5mm in order to escape possible legislation. Figures from literature often refer to “pellets”, irrespective of their dimension and shape.

1.1 Methodological challenges: lack of standardisation and reliable data

Although the number of publications on microplastics has increased rapidly in recent years, a standardised procedure for identifying/quantifying microplastics is still lacking, even though a first standard describing “Principles for the analysis of microplastics present in the environment” (ISO 24187:2023)[55] was recently released. Investigations are generally conducted using different methods, differing particle size ranges and expressed in different units that cannot be easily converted, making it challenging to compare results across studies resulting in largely incomparable data between studies. In a 2019 article, 40 bulk sampling and analysis methods for microplastics were studied and compared. It presents the general process for microplastic sampling and analysis in four steps: collection, density separation, digestion, and identification. It observed that each research team used one out of 2 to 5 different procedures depending on the article and the step (two for collection and up to five for identification). Hence, the reported abundance of microplastics and respective sources in the environment have high variability and may differ by several orders of magnitude, making harmonising sampling and analysis methods one of the biggest challenges when assessing the evolution of unintended release of microplastics.

As it is a transboundary issue, a bottom-up solution is not possible. A top-down approach assessment will involve a large number of assumptions, which could further add to the uncertainty. An approach could be to use case studies to illustrate specific scenarios of the evolution of (unintentionally released) microplastic load.

In the study, “Rethinking Microplastics as a Diverse Contaminant Suite”[56], the authors strongly advocate changing the thinking from one contaminant, “microplastic”, to a diverse suite of contaminants, microplastics, as has been done for pesticides and flame retardants in the past.

1.2 Monitoring

Microplastics’ main pathways into the environment are runoff waters, treated or untreated wastewater, direct input to water compartments (rivers, lakes, ocean), soil and the air. Their adverse impacts also depends on the microplastic particles’ shape, size, on the polymer type and on the additives they contain, therefore gathering information on these microplastics’ characteristics with regards to their appearance is crucial to better understand the production, occurrence, distribution and degradation of microplastics. One of the main problems encountered in tackling microplastics is the insufficient data available on their release and presence in the environment. This information and knowledge failure is due to the lack of standardised protocols and common data bases. To observe and analyse microplastics particles in the environment, harmonised measurement protocols must be established and followed. The MSFD Technical Group on Marine Litter is currently updating the MSFD Guidance on Monitoring Marine Litter to improve harmonised monitoring of marine litter

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55 ISO 24187:2023

56 Rochman, C.M., Brookson, C., Bikker, J., Djuric, N., Earn, A., Bucci, K., Athey, S., Huntington, A., McIlwraith, H., Munno, K., De Frond, H., Kolomijeca, A., Erdle, L., Grbic, J., Bayoumi, M., Borrelle, S.B., Wu, T., Santoro, S., Werbowski, L.M., Zhu, X., Giles, R.K., Hamilton, B.M., Thaysen, C., Kaura, A., Klasios, N., Ead, L., Kim, J., Sherlock, C., Ho, A. and Hung, C. (2019), Rethinking microplastics as a diverse contaminant suite. Environ Toxicol Chem, 38: 703-711. https://doi.org/10.1002/etc.4371

(including microplastics) and to ensure consistency and comparability of monitoring data for the MSFD. These protocols have to be laid down after considering the steps and aspects detailed below.

1.2.1 Sampling

The sampling of microplastics can take place through direct sampling from water using sieving or through the collection of sediments. The distribution of microplastics is largely influenced by geographical, meteorological, and temporal factors thus the sampling time, sampling place, the sample volume, replications and field blanks are crucial for a uniform classification. The lower the available sample volume is, the more important replication become to minimise sampling error. Regarding the sampling method, it is important to specify where the samples were taken.[57]

1.2.2 Extraction

Various extraction procedures are available based on density separation, filtration, digestion, etc. Recovery and precision can vary depending on the properties and amount of microplastics present, the sample matrix and the protocol used. The utilisation of blanks is important to detect and control contamination by particles during sampling and the analytical procedure.

1.2.3 Analysis

The most common types of analysis are microscopic techniques using Raman or FTIR spectoscropy and thermo-analytical techniques based on gas chromatography/mass spectroscopy of decomposition (pyrolysis) products. Prior to measurement, sample preparation is required depending on the sample and the measurement technique. The limit of an instrument's detection capacities must also be taken into account. Polymer libraries provide a means of identifying the polymers present in samples.

2 What are the impacts of microplastics and pellets?

Four types of adverse impacts can be observed from microplastics, such as pellets, finding their way into the environment: 1) on the environment; 2) on climate; 3) on human health; and 4) on the economy.

Some of these impacts are related to microplastics in general, including pellets, while others are specific to pellets. It is to be noted that pellets can also be in the form of powder, thus very small and thus airborne, as well as slightly bigger than 5 mm in diameter.

2.1 Impacts on the environment

The significant adverse impacts of microplastics on the environment were highlighted in a recent publication[58] that revealed that the 5th planetary boundary of novel entities had been exceeded. Chemicals at large, including plastics, have been identified as fulfilling the characteristics of a novel entity. The planetary boundaries (9 in total) were defined in a 2009 article as the "boundaries within which we expect that humanity can operate safely"[59].

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[57] J. C. Prata et al., Methods for sampling and detection of microplastics in water and sediment: A critical review, TrAC Trends in Analytical Chemistry, 2019, 110: 150-159.

[58] https://pubs.acs.org/doi/10.1021/acs.est.1c04158Persson, L., Carney Almroth, B., Collins, C. et al., 'Outside the safe operating space of the planetary boundary for novel entities', *Environmental Science and Technology,* Vol. 56, No 3, 2022, pp. 1510–1521, American Chemical Society.

[59] Rockström, J., Steffen, W., Noone, K. et al., 'Planetary boundaries: exploring the safe operating space for humanity', *Ecology and Society*, Vol. 14, No 2, Article 32.

The presence of microplastics in soil may have effects on soil physicochemical properties. It might also trigger alterations in physical soil properties including soil bulk density, water holding capacity, and soil structures and in the soil biota negatively impacting the growth of some plants[60].

Detrimental effects have also been observed on marine biodiversity[61,62]. Once in the aquatic environment, microplastics can impact marine biodiversity in a number of ways. An increasing number of studies report microplastic ingestion throughout the food chain[63,64]. International Pellet Watch, initiated in 2005 by Hideshige Takada[65] and The Great Nurdle Hunt[66], organised by UK charity FIDRA, both relied on pellet samples collected by citizens to demonstrate that pellet pollution is a global issue. Indeed, they are highly mobile and have been found thousands of kilometres from the nearest pellet production or conversion facility[67], including in important Natura 2000 areas[68]. They can carry a wide range of contaminants and microbes which can form a biofilm on their surface, thus promoting the invasion of alien species in the ocean.[69] When pellets are encrusted with tiny biotas or larvae, the risk of introducing invasive species is increased, putting local native species at risk[70].

Once released into the environment, pellets can be easily ingested by aquatic wildlife including marine fish, squid, and different seabirds.[71] While only a few studies have focused specifically on the physiological effects of pellets, numerous laboratory studies have shown how microplastics interact with aquatic organisms and animals. Many animal species ingest plastic and microplastic, mistaking it for food – from large mammals, birds and fish to tiny zooplanktons, affecting among others feeding behaviour, reproduction, and growth, and sometimes leading to death[72]. Microplastics can be taken up by to the organisms at the bottom of the food chain due to their size and ubiquitous distribution in the open seas and lowest levels of water bodies. Microplastics have been found inside the digestive tract of more than 100 different species[73].

The Risk Assessment Committee of the European Chemicals Agency (ECHA) also stated[74] that ingestion in laboratory studies has been linked to a diverse range of sub-lethal endpoints, including

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[60] Wang, W. et al., 'Environmental fate and impacts of microplastics in soil ecosystems: Progress and perspective', Science of the Total Environment, Vol. 708, 2020.

[61] P. L. Corcoran, Degradation of Microplastics in the Environment, Handbook of Microplastics in the Environment, 2022, 531–542.

[62] N. Kalogerakis et al., Microplastics Generation: Onset of Fragmentation of Polyethylene Films in Marine Environment Mesocosms, 2017, doi.org/10.3389/fmars.2017.00084

[63] Cole, M., Lindeque, P., Halsband, C. and Galloway, T. S., 'Microplastics as contaminants in the marine environment: A review', *Marine Pollution Bulletin*, Vol. 62, 2011, pp. 2588-2597.

[64] Koelmans, A. A. et al., Risk assessment of microplastic particles, *Nature Reviews Materials*, 7:138–152, 2022.

[65] http://www.pelletwatch.org/index.html

[66] https://www.nurdlehunt.org.uk

[67] Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, Science of the Total Environment, 747:141227, 2020.

[68] The unaccountability case of plastic pellet pollution - ScienceDirect

[69] Khalid, N. et al., Linking effects of microplastics to ecological impacts in marine environments, *Chemosphere*, 264: 128541, 2021.

[70] Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, *Science of the Total Environment*, 747:141227, 2020.

[71] Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, *Science of the Total Environment*, 747:141227, 2020.

[72] Group of Chief Scientific Advisors, 'Scientific opinion on the Environmental and Health risks of microplastics pollution', Aprile 2019.

[73] Secretariat of the Convention on Biological Diversity, 'Impacts of marine debris on biodiversity: Current status and potential solutions', *CBD Technical Series*, No 67, 2012.

[74] ECHA Committee for Risk Assessment (RAC) Committee for Socio-economic Analysis (SEAC), Background Document to the Opinion on the Annex XV report proposing restrictions on intentionally added microplastics, (https://echa.europa.eu/documents/10162/2ddaab18-76d6-49a2-ec46-8350dabf5dc6).

survival, feeding, growth, reproduction, moulting, malformation, behaviour, photosynthesis, oxidative stress, enzyme activity, inflammation, gene expression and nutrient cycling. Typical harmful effects are inner and outer lesions and blockage of the gastrointestinal tract, leading to false satiation. Concerning micro- and nanoparticles, there are potentially three types of adverse effects associated with ingestion:

- Physical effects related to consumption are similar to those found for macro plastics (but for smaller organisms);
- Toxic responses from the release of hazardous substances derived from the additives in plastics or the toxic contaminants adsorbed on microplastics; and
- The contamination of new media (the environment or animals) by the microorganisms which develop on the surface of the plastic particles.

There is an emerging concern that microplastics can act as a carrier for microorganisms, including pathogenic species of bacteria, resulting in an increase in the occurrence of non-indigenous species.[75] GESAMP (2015)[76] suggests evaluating the potential significance of plastics and microplastics as a carrier for pathogenic microorganisms[77]. Although microplastics do not pose acute fatal effects on living organisms, they can cause chronic toxicity over the longer term. Due to their physical and chemical properties, microplastics can absorb and transport numerous organic contaminants such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), endocrine disrupting compounds (EDCs), various pharmaceuticals and heavy metals. Also, microplastics can contain a complex mixture of chemicals, which may subsequently be released into the environment and constitute new routes of exposure for organisms.

Specific impacts on the environment from pellets

Pellets have been found in areas including important Natura 2000 areas[78]. First of all, the persistence of a pellet in the aquatic environment may be measured over decades or more, depending on the polymer type, the types and amounts of additives, and the polymers' and additives' reactions to environmental processes (e.g. weathering, sunlight, wave action)[79,80].

Once in the environment, pellets are known to be eaten by a range of organisms and animals, and cause harm to biodiversity and habitats. In areas that are badly affected, pellets have been seen smothering sensitive habitats. Concerning biodiversity, as pellets are mainly constituted of either polyethylene or polypropylene, once in the aquatic environment[81], they float unless they become heavily biofouled (the gradual accumulation of organisms such as algae, bacteria, etc, on the plastic) and then sink and accumulate in sediment. According to Werner et al. (2016), harm is caused by

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75 P.J. Landrigan et al., The Minderoo-Monaco Commission on Plastics and Human Health, *Annals of Global Health*, Vol. 89, no. 1, pp. 23.

76 Sources, fate and effects of Microplastics in the marine environment: a global assessement

77 Cole, M., Lindeque, P., Halsband, C. and Galloway, T. S., 'Microplastics as contaminants in the marine environment: A review', *Marine Pollution Bulletin*, Vol. 62, 2011, pp. 2588-2597.

78 The unaccountability case of plastic pellet pollution - ScienceDirect

79 P. L. Corcoran, Degradation of Microplastics in the Environment, Handbook of Microplastics in the Environment, 2022, 531–542.

80 N. Kalogerakis et al., Microplastics Generation: Onset of Fragmentation of Polyethylene Films in Marine Environment Mesocosms, 2017, doi.org/10.3389/fmars.2017.00084

81 The persistence of a pellet in the aquatic environment may be measured over decades or more, depending on the resin type, the types and amounts of additives, and the reactions of the resins and additives to environmental processes (e.g. weathering, sunlight, wave action). P. L. Corcoran, Degradation of Microplastics in the Environment, Handbook of Microplastics in the Environment, 2022, 531–542. N. Kalogerakis et al., Microplastics Generation: Onset of Fragmentation of Polyethylene Films in Marine Environment Mesocosms, 2017, doi.org/10.3389/fmars.2017.00084

pellets when they float or are in the water column, where they can be eaten by organisms and marine animals (e.g. seabirds, mammals, and fishes) either intentionally because they are mistaken for food or unintentionally when filter feeding animals take in seawater[82]. Several documented accounts describe pellet and other plastic ingestion by wildlife, most notably by seabirds and sea turtles[83,84,85]. Seabirds ingest pellets more frequently than any other animal, and approximately one-quarter of all seabird species are known to ingest pellets. Fulmars frequently ingest floating plastic debris, including pellets, as they capture prey from the sea surface[86].

Ingestion of pellets as any microplastic can cause physical harm such as internal injuries and impaired ability to breath, swallow, digest food properly, or immediate death[87]. In certain cases, plastic debris cannot pass through the digestive system, which can lead to malnutrition or starvation by creating a false feeling of fullness, known as pseudo-satiation[88].

Finally, it has been demonstrated in studies[89] as early as 2001 that pellets, unintentionally released from the plastic industry to the environment, contained measurable concentrations of hazardous substances used as additives. These hazardous substances can then enter the food chain, and be a potential risk for human health.

2.2 Climate impacts

When considering the possible impacts of microplastics (including pellets) on the climate, global trends suggest that microplastic emissions will continue to increase. Microplastics represent a non-climatic pressure on ecosystems as carbon and nutrient cycling processes in soil can be greatly affected by the presence of microplastics and their further decomposition[90] (and might therefore lead to a decreased capacity for GHG absorption). In addition, plastics and microplastics are a source of GHG emissions, putting additional pressure on the climate. GHGs are emitted throughout the plastic life cycle, because all related activities (extraction, refining, manufacturing and end of life management) are carbon intensive. Conventional plastics (based on fossil fuels) produced in 2015

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82 Werner S; Budziak A; Van Franeker J; Galgani F; Hanke G; Maes T; Matiddi M; Nilsson P; Oosterbaan L; Priestland E; Thompson R; Veiga J; Vlachogianni T. Harm caused by Marine Litter. EUR 28317 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC104308

83 Lacroix C. et Huvet A., 'Table ronde n°1 : Devenir et gestion dans les ports et les milieux littoraux – introduction scientifique : caractérisation de la pollution et risques associés' [Roundtable n°1 : Outlook and management in ports and coastal environmentas – scientific introduction : the characterisation of pollution and associated risks], Conférence Journée Plastiques et Environnement associés' [Conference : Day of plastics and associated environments], June 2019 (https://enviroplast2019.sciencesconf.org/data/TR1_1_PPT_journe_es_plastiques_et_environnement_Lacroix_Huvet.pdf).

84 Ryan, P. G., 'Seabirds indicate changes in the composition of plastic litter in the Atlantic and south-western Indian Oceans', *Marine Pollution Bulletin*, Vol. 56, no. 8, 2008, pp. 1406-1409.

85 Sheavly, S.B. and Register, K.M., 'Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions', *Journal of Polymers and the Environment*, Vol. 15, 2007, pp. 301-305.

86 Plastic particles in fulmars | OSPAR Commission

87 Group of Chief Scientific Advisors, 'Scientific opinion on the Environmental and Health risks of microplastics pollution', Aprile 2019.

88 The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission, OSPAR Background document on pre-production plastic pellets, 2018.

89 Mato Y. et al., 'Plastic resin pellets as a transport medium for toxic chemicals in the marine environment', *Environmental Science & Technology*, Vol. 34, No. 2, 2001, pp. 318-324.

90 Rilling M. C. et al., Microplastic effects on carbon cycling processes in soils, Plos Biology, 2021, https://doi.org/10.1371/journal.pbio.3001130

accounted for 3.8% of total global CO_2 emissions, and their share could reach 15% by 2050[91]. A more recent study estimates even higher CO_2 emissions from plastic production (1.96 Gt of CO_2e)[92].

Microplastics are widely found in aquatic environments.[93] Their presence may cause more greenhouse gas emissions as they can negatively affect multiple factors, such as phytoplankton photosynthesis, which contribute to carbon sequestration.[94] Microplastics are widely identified in aquatic environments.[95] The impact of marine plastics on ecosystem responsible for the gas exchange and circulation of marine CO2 may cause more greenhouse gas emissions. Marine microplastics can negatively affect phytoplankton photosynthesis and growth, zooplankton and their development and reproduction, marine biological pump andocean carbon stock. Phytoplankton and zooplankton are the most important producer and consumer of the ocean.[96]

Moreover, the climate change effects, e.g. more frequent heavy rainfall events, will exacerbate the problems linked with releases of those microplastics from urban runoff and stormwater overflows (SWO). Furthermore, the gradual degradation and fragmentation process of microplastics, when exposed to ambient solar radiation in ocean waters, may release methane, a potent greenhouse gas,[97] and ethylene into the atmosphere, depending on the type of microplastics, though the study also finds that this is likely to be an insignificant component of the global CH_4 budget.

2.3 Human health impacts

Despite more and more research being carried out to understand microplastics' impacts on human health, there is still no scientific consensus on these impacts. According to the Risk Assessment Committee of the European Chemical Agency (ECHA),[98] potential effects on terrestrial organisms in general, and on human health, have not been well studied but include infertility, genetic disruption, poisoning, reduced feeding and increased mortality in marine organisms and in humans if ingested in very large quantities. Inhalation of microplastics can provoke severe problems in the lung.

Humans are exposed to microplastics everywhere via food consumption and inhalation. The annual intake of microplastics by humans has been estimated to range from 70 000 to over 120 000 particles a year depending on age, gender, region, and consumption[99]. This includes an estimated 70 000 particles inhaled in air and 50 000 particles ingested in food and drink.

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91 IPCC Working Group III Report: Mitigation of Climate Change (2022) https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/

92 Cabernard, L., Pfister, S., Oberschelp, C. et al. Growing environmental footprint of plastics driven by coal combustion. Nat Sustain 5, 139–148 (2022).

93 Phytoplankton response to polystyrene microplastics: Perspective from an entire growth period - ScienceDirect

94 Can microplastics pose a threat to ocean carbon sequestration? - ScienceDirect

95 Phytoplankton response to polystyrene microplastics: Perspective from an entire growth period - ScienceDirect

96 Can microplastics pose a threat to ocean carbon sequestration? - ScienceDirect

97 Royer, S.-J. et al., 'Production of methane and ethylene from plastic in the environment', *PLoS ONE*, Vol. 13, No 8, 2018, Public Library of Science.

98 European Chemicals Agency, Opinion of the Committee for Risk Assessment and Opinion of the Committee for Socio-Economic Analysis on an Annex XV dossier proposing restrictions on intentionally-added microplastics, ECHA/RAC/RES-O-0000006790-71-01/F and ECHA/SEAC/RES-O-0000006901-74-01/F, 2020 (https://echa.europa.eu/documents/10162/a513b793-dd84-d83a-9c06-e7a11580f366).

99 Kieran D. Cox, Garth A. Covernton, Hailey L. Davies, John F. Dower, Francis Juanes, and Sarah E. Dudas (2019). Human Consumption of Microplastics. Environmental Science & Technology 2019 53 (12), 7068-7074 DOI: 10.1021/acs.est.9b01517

The consumption of seafood, containing microplastics, is one of the main concerns for humans[100]. There is evidence to suggest that additives such as dyes or plasticisers could cause toxicity, carcinogenicity and mutagenicity.[101,102] Pellets are likely to carry toxic chemicals as well on their surface since persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs), dichloro-diphenyltrichloroethane (DDT), hexachlorocyclohexanes (HCHs), and polycyclic aromatic hydrocarbons (PAHs) can be easily adsorbed to their surface and then released over time. [103] The concentrations of these substances adsorbed onto plastic pellets are highly variable. The health impacts of POPs are not immediate but result rather from chronic, cumulative and long-term exposure.[104]Microplastics, including pellets would also pass up the food chain through plants which absorb synthetic contaminants from the soil[105]. Human exposure to microplastics through drinking water is believed to currently be low in Europe[106], but a systematic review of available evidence is lacking[107]. People that predominately drink bottled water may ingest an additional 90 000 particles of microplastic a year[108]. Work is ongoing to produce up-to-date knowledge on the occurrence and possible toxic effects of ingesting micro- and nanoplastics via food products and beverages to provide a basis for risk assessment.[109] CUSP, the European Research Cluster to Understand the Health Impacts of Micro- and Nanoplastics is also carrying out research in this area[110].

Although additional research is still required on exposure to airborne microplastics, their prevalence in urban zones is concerning: one study found microplastics in all urban air samples and identified 92% of them as fibrous.[111] Apart from inhaling fibres as fine dust in outdoors environments, humans are also exposed to indoor airborne microplastic pollution.[112] When inhalation rates are high,

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[100] Cox, K. D. et al., 'Human consumption of microplastics', Environmental Science and Technology, Vol. 53, No 12, 2019, pp. 7068–7074.

[101] Gasperi, J., et al., Microplastics in Air: Are We Breathing It In?, *Current Opinion in Environmental Science & Health*, 1–5. 2018. https://doi.org/10.1016/J.COESH.2017.10.002

[102] Blackburn, K., Green, D., The potential effects of microplastics on human health: What is known and what is unknown, *Springer, Ambio*, 51:518–530, 2021.

[103] Corcoran P. L. et al., A comprehensive investigation of industrial plastic pellets on beaches across the Laurentian Great Lakes and the factors governing their distribution, *Science of the Total Environment*, 747:141227, 2020.

[104] Nadal, M. et al., Climate change and environmental concentrations of POPs: A review, *Environmental Research*, 143: 177-185, 2015.

[105] Sciencealert.com, 'Study shows how microplastics can easily clim the food chain. Should we be worried?', 2022 (https://www.sciencealert.com/study-shows-how-microplastics-can-easily-climb-the-food-chain-should-we-be-worried).

[106] WHO (2019) Microplastics in drinking-water. Geneva: World Health Organization; Licence: CC BY-NC-SA 3.0 IGO.

[107] EurEau, 'Microplastics and the water sector', 2019 (https://www.eureau.org/resources/briefing-notes/3940-briefing-note-on-microplastics-and-the-water-sector/file); Koelmans, A., Hazimah Mohamed Nor, N., Hermsen, E., Kooi, M. et al., 'Microplastics in freshwaters and drinking water: Critical review and assessment of data quality', *Water Research*, Vol. 155, 2019, pp. 410-422.

[108] Cox, K. D. et al., Ibid.

[109] Shopova et al., 'Risk assessment and toxicological research on micro- and nanoplastics after oral exposure via food products', EFSA Journal, 2020 https://doi.org/10.2903/j.efsa.2020.e181102

[110] CUSP cluster - The European Research Cluster to Understand the Health Impacts of Micro- and Nanoplastics (cusp-research.eu)

[111] Wright S.L. et al., 'Atmospheric microplastic deposition in an urban environment and an evaluation of transport', Environ Int, Vol. 136, 2020.

[112] Plastic Soup Foundation _ Do clothes make us sick, 2022. This study found that 30% of the dust captured in air conditioning filters from dormitories, offices, and living rooms were microplastic fibres, with polyester, rayon, and cellophane as the dominant polymers. Fibre fragments are released from clothes and indoor textiles through use, wear and tear, the washing of garments, and drying. Fibres cannot always be cleared, for example by coughing. The dimensions of the fibres also play a role in toxicity. Thinner fibres are inhalable as their elongated shape allows fibres to deeply penetrate into the lungs. Longer fibres are more persistent and toxic to lungs cells. Fibres < 0.3 µm wide and >10 µm long are most carcinogenic.

accumulation of microplastics will occur in certain organs impacting their health. This process will cause chronic inflammation, which is known to be a leading cause of diseases such as cancer, heart disease, asthma, and diabetes. Both cellulosic and plastic microfibers were found in lung tissue taken from patients with different types of lung cancer. According to the same study, this may particularly affect people with a viral infection or children whose lungs are still developing. Also, children under the age of six inhale three times more microplastics than an average adult.

Several studies on the occupational exposure of textile workers show (as early as 1975[113]) that the inhalation of microplastic fibres from textiles can lead to pulmonary disease such as interstitial lung disease (linked to nylon flock exposure[114]). Chronic exposure to plastic microfibres in urban air, indoor[115] or outdoor[116], also raises concerns about the need for action reducing microplastic emissions in European cities.

A recent study[117] analysed 17 studies on the toxicity of microplastics to human cells establishing detrimental impacts (including cytotoxic), triggering immune responses, causing oxidative stress, and the shape of microplastics influencing these negative effects (irregularly shaped microplastics had more adverse effects than spherical ones). However, it also states that the "overall certainty of the body of evidence" is low due to the fact that researchers couldn't access the original data. High levels of exposure to microplastics are believed to induce inflammatory reactions and toxicity, possibly due to the additives used to produce the plastic.[118] In addition, microplastics could potentially act as vectors for pathogens and microbes[119].

However, the precautionary principle should be applied since the presence of microplastics in human stool[120] demonstrate intestinal exposure. In addition, some studies seem to suggest that microplastics can be found in pregnant women's placenta,[121] and more recently, in human blood[122].

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[113] Pimentel, J. C., Avila, R. and Lourenço, A. G., 'Respiratory disease caused by synthetic fibres: A new occupational disease', *Thorax*, Vol. 30, No 2, 1975, pp. 204–2019.

[114] Boag, A., Thomas V., Fraire, A., Kuhn, C. et al., 'The pathology of interstitial lung disease in nylon flock workers', *American Journal of Surgical Pathology*, Vol. 23, No 12, 1999, pp. 15–39.

[115] Dris, R., Gasperi, J., Mirande, C. et al., 'A first overview of textile fibres, including microplastics, in indoor and outdoor environments', *Environmental Pollution*, Vol. 221, 2017, pp. 453–458.

[116] Dris, R., Gasperi, J., Rochr, V. et al., 'Microplastic contamination in an urban area: A case study in Greater Paris', *Environmental Chemistry*, Vol. 12, No 5, 2015.

[117] Danopoulos, E., Twiddy, M., West, R. and Rotchell, J., 'A rapid review and meta-regression analyses of the toxicological impacts of microplastic exposure in human cells', *Journal of Hazardous Materials*, Vol. 427, No 6, 2022.

[118] Potential Health Impact of Environmentally Released Micro- and Nanoplastics in the Human Food Production Chain: Experiences from Nanotoxicology | Environmental Science & Technology (acs.org)

[119] Microplastics from textiles: towards a circular economy for textiles in Europe — European Environment Agency (europa.eu)

[120] Schwabl, P. et al., 'Detection of various microplastics in human stool', *Annals of Internal Medicine*, Vol. 171, No 7, 2019, pp. 453–457, American College of Physicians.

[121] Ragusa, A. et al., 'Plasticenta: First evidence of microplastics in human placenta', *Environment International*, Vol. 146, 2021, Elsevier BV. ; Dusza, H.M. et al, 'Uptake, Transport, and Toxicity of Pristine and Weathered Micro- and Nanoplastics in Human Placenta Cells', *Environmental Health Perspectives*, Vol; 130, No 9, 2022.

[122] Leslie, H. A. et al., 'Discovery and quantification of plastic particle pollution in human blood', *Environment International*, Vol. 163, 2022, Elsevier BV.

2.4 Economic impacts

In addition to the versatile effects on environment, climate and health, there are potentially negative impacts on the economy as well. Some of these impacts are related to microplastics in general, including pellets, others to pellets specifically.

The growing evidence/awareness of microplastics' presence in seafood, salt, honey, fruits, vegetables and drinking water could undermine consumer confidence and bear economic consequences.

There are potential negative economic impacts on activities such as commercial fishing and agriculture (e.g. reduced fishing due to impacts of microplastics on marine eco-systems and fauna, which eats it) as well as recreation and tourism (reduced attractiveness due to impacts of microplastics on beaches and vulnerable areas like national parks, rivers and lakes[123]).

Clean-up costs are often unknown and operations are usually the responsibility of local communities with a negative impact on their budgets. For example beach clean-ups are estimated to cost EUR1 000 000 per year for the city of Marseille (France)[124]. SOS Mal de Seine Association highlighted the lack of capacity of public authorities to deal with large-scale pollution of pellets on beaches (e.g. caused by lost containers). As a matter of fact, clean-up operations are complex to undertake because these particles are difficult to see due to their size and that vegetation may hide them. They should also be carried out within an hour of an incident to prevent widespread pollution by wind, rain, and/or tides. Monitoring costs of plastic pellet ingestion by species are also unknown. However, the costs of La Rochelle Aquarium's monitoring of microplastic ingestion by loggerhead sea turtles was a total of EUR50 000 over four years. Another pertinent example is the monitoring of microplastic ingestion by fulmars provided by ornithological groups, which costs EUR33 300 for one winter season.

[123] Plastic Giants polluting through the backdoor; Silent Pollution – Who is contaminating Puglia's coastline with plastic pellets?; Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines; Microplastic pollution in the surface waters of Italian Subalpine Lakes; Granulés plastiques industriels sur le littoral français

[124] OSPAR Background document on pre-production Plastic Pellets, 2018

Annex 8:
Problem definition – pellet losses to the EU environment

1 PROBLEM DEFINITION

Current practices for handling pellets lead to losses at each stage in the supply chain, causing adverse environmental and potential human health impacts.

Plastic raw materials come in different forms, including pellets, flakes, powders and in liquid forms, all referred to collectively as "pre-production plastic pellets"[125]. In Europe, approximately 80 % of all plastic raw materials produced are in the form of round to oval granules of approximately 2 mm to 5 mm in diameter[126]. A relevant part of the remaining 20% is even smaller than 2mm, such as powders, and a minor part can be slightly bigger. It is common sense to tackle all these pellets together. This will also ensure pellets that might be slightly bigger will still be subject to possible legislation, thus avoiding possible attempts by industry to avoid relevant legislation by making pellets slightly bigger than 5mm. Figures from literature often refer to "pellets", irrespective of their dimension.

1.1 The pellet supply chain

Pellets can reach the environment through losses occurring at every stage of the supply chain: production (virgin or recycled), processing (compounding, masterbatch making, converting, etc.), logistic operations (transport, storage and tank cleaning), waste management, etc. Therefore, tackling pellet losses clearly requires a supply chain approach.

The pellet supply chain is complex. Virgin pellets are manufactured at large installations, and then stored in silos; they are mostly either filled directly into tankers, or packed for transport to conversion sites, where final plastic products are made. Losses can also occur at recycling facilities, where post-consumer plastic waste is recycled back into pellets in order to be reintroduced into the plastic manufacturing cycle[127].

Box 7: Companies handling pellets

Companies handling pellets are categorised as follows:

- producers who create virgin plastic pellets from oil, gas and other raw materials;
- recyclers who collect, sort, clean and process plastic waste into recycled plastic flakes or pellets;
- traders/brokers who purchase the plastic material and store it or otherwise handle it before selling it to converters or exporting;

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[125] The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission, OSPAR Background document on pre-production plastic pellets, 2018. Technically, according to ISO 472:2013, a pellet is a "small mass of preformed moulding material, having relatively uniform dimensions in a given lot, used as feedstock in moulding and extrusion operations".

[126] PlasticsEurope, 'PlasticsEurope Operation Clean Sweep® Report 2017', 2017 (https://www.opcleansweep.eu/application/files/8316/3456/6233/PlasticsEurope_OCS_progress_report-2017.pdf).

[127] Hann, S., Sherrington, C., Jamieson, O., Hickmann, M., Kershaw, P., Bapasola, A., Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products, Eunomia.

- intermediary facilities that handle the plastic material between the producer and the processor, such as storage and repacking facilities;
- processors who transform the plastic pellets by either mixing them with other materials to alter their physical properties or by transforming them directly into manufactured goods (the former are called compounders and the latter converters);
- distributors who sell (a small portion of) the plastic pellets to sectors such as construction;
- logistic companies; and
- waste management companies.

Producers: in Europe, there are close to 100 large polymer-producing companies that are members of the trade association “Plastics Europe”.[128] These companies produce some 54.8 million tonnes of virgin pellets per year and represent 90% of the total EU production. In 2021, circa 138,000 people worked for plastic manufacturers in the EU27. The number of individual enterprises was around 2300. In 2021, plastic manufacturers generated a turnover of EUR 117 billion.

Processors: the situation of the processors is significantly different: the trade association “European Plastic Converters” (EuPC) totals about 51 national and European industry associations, representing 90% of the total EU processing, equivalent to approximately 48 000 individual companies, out of which 66% are micro-companies (some 31 400 micro-enterprises handling an average tonnage below 100T and representing an average turnover of EUR 300 000 annually, equivalent to 4% of the total turnover of the industry)[129]. Converters employ 1.3 million people and have an annual turnover of EUR 269 billion[130].

Processors transform raw pellets by either mixing them with other materials to alter their physical properties (changing their melting point, colour, insulation properties, etc.) or by transforming them directly into manufactured goods. The former is called compounders and the latter converters. Compounders can either be part of a converter’s system to alter their physical properties on the same site that they are manufacturing the finished product or independent members of the value chain supplying new pellets (thus adding a link to the value chain where loss is possible).

Transporters: the “European Chemical Transport Association” (ECTA) represents approximately 100 transport companies active in the transport of chemical products including pellets[131]. These ECTA members are the major Logistic Service Providers in this sector in Europe and most of them are not SMEs. They cover 30% of the total pellet transport in Europe. Beyond ECTA members, transporters are largely micro and small entreprises, ca. 13 000.

Transporters move plastic pellets from their manufacturing grounds to the facility they will be used in. Transport occurs by three main delivery mediums: Sea cargo ships; Road lorries; Railways; Air. Each distribution method uses different types of containers to store plastic pellets, ranging from small bags (20-25 kg) to silo trucks (up to 35 t) and large maritime containers. Not all bags are sealed, airtight and puncture-resistant to prevent damage and tears.

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[128] Plastics Europe, ‘Membership’ (https://plasticseurope.org/about-us/membership/).
[129] European Plastic Converters (EuPC), ‘Organisation’ (https://www.plasticsconverters.eu/).
[130] Source Eurostat (20210 figures) for EU-27 (Statistics | Eurostat (europa.eu))
[131] European Chemical Transport Association, ‘List of ECTA and ECTA RC* Members 2023’ (https://www.ecta.com/organization/list-of-members/).

Other logistic operators: the "European Federation of Tank Cleaning Organizations" (EFTCO) declares 630 tank cleaning stations in Europe, out of which at least 440 deal with tanks containing pellets. Also, there would be around 850 warehouses in Europe storing pellets. These companies are largely micro and small enterprises. They provide intermediary services to the supply chain, aside from transporters. These intermediary points are important as they represent additional stages at which pellets are handled and can be lost.

Waste management companies: they collect waste pellets from processors to treat them. Producers, processors and intermediary facilities typically employ commercial waste management firms to handle their waste.

Recyclers: in 2021, there were some 730 plastic recycling companies in the EU[132]. They occupy more than 20 000 employees and create a turnover of EUR 8.5 billion annually. In 2021, they produced 7.6 million tonnes of recycled pellets, while the installed capacity is roughly of 11 million tonnes. 165 plastic recycling companies are members of the trade association "Plastics Recyclers Europe" (PRE) regrouping both industry associations and individual companies, mostly large companies. These companies represent 80% of the EU market installed capacity.

More information on the share of SMEs in the pellet supply chain is presented in Annex 12.

1.2 Pellet losses

While the pellets supply chain is mainly grouped into the above mentioned categories, there are several intermediate steps where pellet losses can occur, such as:

- Production
    - Granulation: cutting with a knife in the water nearby or in the pellet receptacles in the factory
    - Packaging (bagging or tanking)
    - Unloading by handling or pneumatic
    - Technical problems: pneumatic accidents with plug
    - Electrostatic phenomenon
- Compounding (similar steps as for production)
- Processing (conversion or transformation of pellets into products)
    - Unloading of pellets
    - Delivery in bags, octabins or tanks
    - Storage
    - Conversion
- Logistics
    - Storage in silos by pneumatic
    - Palletisation of containers = bags (big bags) or octabins
    - Bagging fractionation steps
    - Handling pallets of bags or octabins
    - Installation of pallets in unconfined storage parking lots
    - Loading of pallets on flatbed trailers or in (road) containers
    - Chronic losses during road or rail transport and accidental losses
    - Chronic losses shipping and accidental losses

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[132] Plastics Recyclers Europe, 'Plastics Recycling Industry in Europe: Mapping of Installed Plastics Recycling Capacities 2021 Data', 2023 (https://www.residuosprofesional.com/wp-content/uploads/2023/03/Plastics-Recycling-Industry-in-Europe-2023.pdf).

    - Chronic losses during port handling and accidental losses

Other steps where pellet losses can occur are:

- Waste and cleaning steps
    - Operating waste
    - Recovery of empty containers for recycling
    - Tank washing
    - Cleaning of flatbed trailers
- Water used in different processes can also contain pellets
    - Granulation water
    - Cleaning water
    - Recycled water
    - Washing water
    - Retention water
    - others (stormwater, road washing and leaching)

The Commission of the regional convention for the protection of the Marine Environment of the North-East Atlantic (OSPAR)[133] distinguishes the following:

- Pellet **spill** as a "One-off escape of pellets from primary containment (not necessarily resulting in loss to the environment)";
- Pellet **loss** as a "One-off or prolonged escape of pellets to the environment".

Spills – if not contained – may end up as "losses" in the environment. A part of these pellets are recovered (in the wastewater treatment system for example), the other part is considered as lost or released into the environment.

Figure 7: Pellet losses in the environment

[133] OSPAR Commission, 'Guidelines in support of Recommendation 2021/06 on the reduction of plastic pellet loss into the marine environment', 2021 (https://www.ospar.org/documents?v=46269).

Pellet losses can be the result of:

1) chronic, ongoing pellet incidents during routine operations. This usually occurs as a result of lack of awareness and improper training, poor handling and housekeeping practices and due to the absence of pellet loss preventive and mitigating measures.

2) acute, one-off, pellet incidents. This usually occurs as a result of accidents during transport or major equipment failures in the absence of pellet loss preventive and mitigating measures.

1.2.1 Chronic pellet losses

Chronic pellet losses typically happen during both bulk and packed loading and unloading operations at special installations and during transport and logistic operations. The report from the plastics producers on Operation Clean Sweep[134] corroborates this presumption by adding process and mixing points as other pellet loss hotspots. The report states that: "*The majority of companies (97%) have analysed the sources of potential pellet spills at their facilities and identified that loading and unloading areas, process and mixing points are the three main locations where pellets losses occur more often at different sites*".

The main reasons of these losses are the following[135]:

- In the **production process**, the most common causes of pellet losses are the incompletely sealed conveying systems, damaged or leaky packaging, rail hopper car and bulk truck cleaning operations, lack of a containment system, failure of the containment system during heavy rainfall, infrequent or inadequate housekeeping, unsealed or unsecured rail hopper car valves and the lack of employee awareness.

- During **transport**, pellet losses occur due to incompletely sealed bags or leaking bag valves, improper bag storage practices, lack of employee awareness, inadequate training of forklift operators, infrequent routine maintenance, improperly or inadequately sealed or secured rail hopper car valves, lack of a containment system or other control mechanisms, improper handling of pellet cargo at ship docks and aboard ship, overfilling of storage silos, displacement of the conveyor system ports and accidents of ships carrying pellets.

- In **processing facilities**, pellet losses can occur because of the lack of communication between industry management, inadequate employee awareness and training, inadequate facilities like lack of waste-, or storm-water containment systems in place, careless routine operations, inadequate housekeeping practices, easily damaged or leaky packaging and improper unloading and warehousing procedures.

There is evidence of point source input near plastic processing plants, where the abundance of plastic pellets or powders can be relatively high.[136] Chronic pellet incidents have been reported at production

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[134] Plastics Europe, 'Operation Clean Sweep® Progress Report 2019', 2020 (https://plasticseurope.org/knowledge-hub/operation-clean-sweep-progress-report-2019/).

[135] US Environmental Protection Agency, 'Plastic Pellets in the Aquatic Environment: Sources and Recommendations', 1992 (http://www.globalgarbage.org/13%20EPA%20Plastic%20Pellets.pdf).

[136] Norén, F. & Ekendahl, S., 'Microscopic Anthropogenic Particles in Swedish Waters: many more than believed', 2009, Schwerin, Germany: Helsinki Commission.

sites in the Netherlands[137], Belgium[138], Spain[139], the UK coastline, Scotland[140], Denmark[141] and Sweden[142]. Logistic platforms like ports are hotspots for pellet losses, and the ports of Rotterdam, Antwerp and Tarragona have been reported to be heavily polluted locations by several organisations active in the monitoring of pellet losses[143]. An important part of chronic pellet incidents happens also during the transport of pellets across land (e.g. road and rail), such as in Belgium[144], or during maritime transport[145].

1.2.2 Acute pellet losses

Acute pellet incidents have happened in industrial facilities in Italy[146] and during the transport of pellets across land, e.g. in France[147] and during maritime transport, e.g. in the Netherlands[148] or in Denmark[149]. Acute pellet incidents occurring in the form of containers lost at sea result in large quantities of pellets released directly into the marine environment[150]. Some big incidents with unknown origin have also to be mentioned such as the ones in Southampton, England[151] and in the Loire-Atlantique coastline of France[152] among several others in Europe and worldwide[153].

Box 8: Examples of major acute pellet incidents during maritime transport

2012: In Hong Kong, after being blown by Typhoon Vicente on 24 July 2012, some containers belonging to Chinese oil giant Sinopec which were carrying over 150 tonnes of plastic pellets, were blown into the sea, washing up on southern Hong Kong coasts, such as Shek O, Cheung Chau, Ma Wan and Lamma Island. The spill disrupted marine life and was credited with killing stocks of fish-on-fish farms[154]. 2017: A nurdle spill of about two billion nurdles (49 tonnes) from a shipping container in Durban Harbour required extended clean-up efforts. These nurdles have also been spotted washing up on the shore in Western Australia[155].

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137 Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf (plasticsoupfoundation.org)
138 Ecaussinnes (Belgium): Surfrider Foundation tackles industial plastic granules
139 New report out exposes alarming impacts of plastic pellets across Europe - Good Karma Projects
140 Fife beach 'worst' for nurdle pollution - BBC News
141 Tackling sources of Marine Plastic Pollution through effective corporate engagement: a Danish Case Study
142 The unaccountability case of plastic pellet pollution - ScienceDirect
143 Plastic Giants polluting through the backdoor. New report out exposes alarming impacts of plastic pellets across Europe - Good Karma Projects
144 Ecaussinnes (Belgium): Surfrider Foundation tackles industial plastic granules
145 Sources, fate and effects of Microplastics in the marine environment: a global assessement
146 Nurdle pollution hotspot identified in Italy (nurdlehunt.org.uk)
147 Morbihan. Un camion perd sa marchandise, 28 tonnes de granulés en plastique sur la route (ouest-france.fr)
148 24 million plastic pellets from MSC Zoe on northern Dutch coastline – The Northern Times
149 Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines – KIMO (kimointernational.org)
150 In 2021, the container ship MV X-Press Pearl caught fire and sank losing approximately 1680 tonnes of plastic pellets in a single event (some 84 billion pellets). In Europe, in 2020, the MV Trans Carrier lost more than 10 tonnes of plastic pellets in the German Bight. Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines – KIMO (kimointernational.org) 24 million plastic pellets from MSC Zoe on northern Dutch coastline – The Northern Times
151 Plastic pollution at Chessel Bay nature reserve in Southampton | Daily Echo
152 Les plages de la côte Atlantique polluées par une marée de granulés plastiques, l'Etat porte plainte (lemonde.fr)
153 https://www.nurdlehunt.org.uk/nurdle-finds.html
154 Lyn, T.E., 'Sinopec pledges help to clear Hong Kong plastic spill', Reuters, 2012 (https://www.reuters.com/article/us-pollution-hongkong-sinopec-idUSBRE8780I920120809). https://www.reuters.com/article/us-pollution-hongkong-sinopec-idUSBRE8780I920120809
155 Two Oceans Aquarium, 'The Great Nurdle Disaster: What to do if you find nurdles', 2017 (https://www.aquarium.co.za/blog/entry/the-great-nurdle-disaster-what-to-do-if-you-find-nurdles). https://www.aquarium.co.za/blog/entry/the-great-nurdle-disaster-what-to-do-if-you-find-nurdles

2018: A semi-truck crash led to the release of bright blue-coloured nurdles into Pocono Creek and the waterways of the Lehigh Valley, Pennsylvania.

2020: On 23rd February 2020, the MV Trans Carrier lost more than 10 tonnes of plastic pellets in the German Bight when the cargo on board moved during a storm, damaging one of the containers, which broke open[156].

2020: During a thunderstorm on August 20th, a 12 m shipping container with 25 tonnes of nurdles fell off the CMA CGM Bianca ship into the Mississippi River in New Orleans. No official clean-up took place[157].

2021: On 2 June 2021, the cargo ship "X-Press Pearl" containing 1680 tonnes of plastics pellets[158] sank off the coast of Sri Lanka, spilling chemicals and microplastic nurdles and causing the worst environmental disaster in the country's history[159]. The actual quantity of pellets lost to the environment is unknown.

Existing monitoring programs in Europe show the presence of plastic pellets in the marine environment. In addition to those implemented in the framework of the Marine Strategy Framework Directive, which requires all Member States to monitor microplastic litter on beaches[160], there are programs like the Port of Antwerp's collaboration with PlasticsEurope[161]. In the area of the port of Antwerp, home to 10 pellets producers, in 2017, about 4 tonnes of plastics pellets were collected in the environment centred on the port area during a citizens' action, with most pellets found close to the production plants[162]. The Port of Antwerp has been running the Antwerp Zero Pellet Loss Platform since 2017 with the aim of improving the implementation of the OCS programme in the port of Antwerp. In 2022, an OVAM representative[163] confirmed that "there are still pellet losses around the Port of Antwerp".

Since the 1970s, plastic pellets have been observed in marine environments around the world, including at sites which are not close to petrochemical or polymer industries. These have been documented using different observation protocols developed by NGOs such as SOS Mal de Seine and Fidra. This demonstrates that while pellet losses can be concentrated in one geographical area, they are also extremely mobile and can be dispersed by surface water and sea currents, as well as through the air.

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[156] KIMO, 'Plastic pellets spill pollutes Danish, Norwegian, Swedish coastlines', 2020 (https://www.kimointernational.org/news/plastic-pellets-spill-pollutes-danish-norwegian-swedish-coastlines/).

[157] Nola.com, 'No cleanup planned as millions of plastic pellets wash up along Mississippi River and flow to the Gulf', 2020 (https://www.nola.com/news/environment/article_b4fba760-e18d-11ea-9b0b-b3a2123cf48b.html).

[158] United Nations Environment Programme, 'X-Press pearl maritime disaster Sri Lanka – Report of the UN Environmental Advisory Mission', 2021 (https://www.unep.org/resources/report/x-press-pearl-maritime-disaster-sri-lanka-report-un-environmental-advisory-mission).

[159] The Guardian, 'Sri Lanka faces disaster as burning ship spills chemicals on beaches', 2021 (https://www.theguardian.com/world/2021/may/31/sri-lanka-faces-disaster-burning-ship-spills-chemicals-beaches).

[160] In 2016, Spain started the MSFD subprogram on microplastics on beaches, and pellets were detected with an average concentration of 47.8 pellets/kg or 419.2 pellets/m2. Currently, the MSFD Technical Group on Litter is developing a protocol for monitoring pellets on beaches.

[161] Plastics Europe, 'Port of Antwerp Activity report 2021', 2021 (https://plasticseurope.org/knowledge-hub/port-of-antwerp-activity-report-2021/).

[162] Rethink Plastic Alliance, Surfrider Foundation Europe, & Break Free from Plastic, 'Plastic Giants polluting through the backdoor', 2020 (https://rethinkplasticalliance.eu/wp-content/uploads/2020/12/bffp_rpa_pellets_polluting_through_the_backdoor.pdf).

[163] Ovam, Personal communication, 2022.

1.3 Pellet pathways

Spilled pellets can reach the environment and become losses through several pathways.

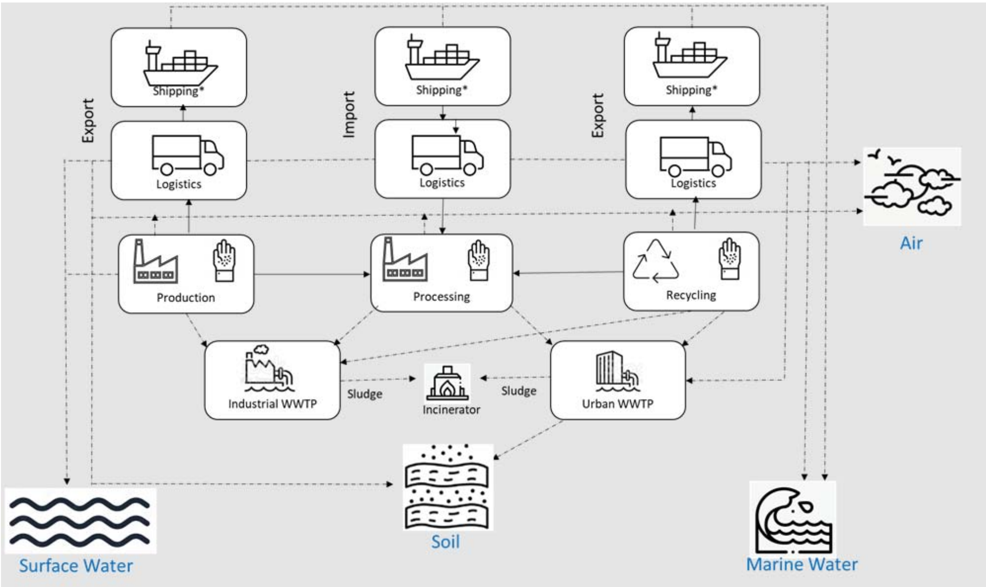

Figure 8: Pellet pathways (solid lines represent pellet movements and dotted lines are loss pathways)

The plastic pellet value chain is not airtight, and there are numerous opportunities for pellets to be lost into the environment. Pellets are released by the plastics industry at all stages of their life-cycle: during production, conversion, transport and storage (at every facility they are handled in). When pellets are spilled, they can reach the environment through two routes:

Direct releases into the environment:

- **Aquatic environment**: Pellets may be released directly into waterways, during handling operations, in particular at ports or during cargo transport at sea.
- **Land environment**: Pellets may be released at site or during transportation due to leaking packaging or during handling when transferring between different modes of transportation.
- **Air**: some pellets are in the form of powder and could be found in air when not properly contained.

Discharges in wastewater: via rainwater into storm-water drains, or wastewater treatment systems (WWT).

When pellets are spilled during logistic and shipping operations, they normally reach the environment directly and end up in water, land, and sometimes air.

Lost pellets may be carried by rainwater into storm-water drains. These transport the water into the urban wastewater treatment (WWT) plants, when connected, which is approximately 65% of the cases. The pellets may then be discharged into the aquatic environment through storm-water discharges or, where the sewage and storm sewers are combined, through WWT discharges. Normally, stormwater drains are designed to collect and carry rainwater, melted snow, and other precipitation from the land surface. Stormwater drains are typically separate from wastewater drains, which carry sewage and other household or industrial wastes to wastewater treatment plants. In some cases, depending on local regulations and infrastructure, stormwater and wastewater may be combined in a single drain. Some may discharge directly into nearby water bodies, while others may flow into retention ponds, infiltration basins, or other types of stormwater management systems. In urban areas, stormwater may also be collected and treated before discharge to reduce the risk of flooding or water pollution.

When pellets are spilled inside installations where pellets are handled, dry or wet cleaning is possible. In the case of dry cleaning, pellets are collected and then go to waste management (mostly for incineration), except for recyclers who collect and put them back in the recycling process. Wet cleaning pushes pellets to drains. From there, spilled pellets typically reach industrial wastewater treatment in the case of production installations. Processing and recycling installations are either linked to industrial or urban wastewater treatment systems.

In industrial wastewater treatment facilities, pellets are mostly captured in sludge and incinerated. However the effluent may still contain some pellets (particularly, flakes and powders). In urban wastewater treatment facilities, pellets are also captured in sludge (between 95-99%, depending on the treatment efficiency). Depending on the sludge management, microplastics are either destroyed (through incineration, for example) or released into the environment if sludge is spread on agricultural lands (on average 50% of all sludge in the EU is applied in agriculture as fertilizer). These pellets may stay in the soil or ultimately reach the aquatic environment (runoff to surface water or through soil to groundwater). Pellets can also reach water via overflows, bypassing the wastewater facilities.

Therefore, the main pathways of pellets lost are water-related, i.e. urban, rain and storm water for losses occurring in terrestrial areas and marine water for losses at cargo handling installations at ports or occurring during cargo transport at sea.

1.4 Scale of the problem

While observable, these losses are not routinely measured, or indeed readily measurable at any specific step. There is no harmonised methodology for measuring pellet losses. Neither pellet loss measurements have been made at different steps of the supply chain, nor are any systemic monitoring and reporting data available within the Member States or the industry to calculate pellet losses. Hence, it is impossible to establish exact figures on pellet losses at each step because it depends on the installation size, actors involved, management practices, etc., and all these aspects are very heterogeneous in the EU.

Efforts to quantify the amount of pellets entering the environment typically apply a ‘loss rate’ as well as a number of handling steps to the total pellet volume handled. Robust empirical evidence to inform a ‘loss rate’ or a number of handling steps is scarce. However, the greater the number of steps at which pellets are handled, the greater the opportunities for loss.

The major handling steps occur at production plants (of both virgin and recycled pellets), processing installations and during logistic operations, i.e. all loading and unloading operations to transport pellets from one installation to another including warehouse installations, where pellets are stored and/or re-packed, and cleaning installations.

Several studies use the figures for pellet losses of 0.01%-0.04% (according to Sundt et al. (2014)[164]. However, this figure is an estimate from just one processor and is based on measurement in the effluent, so it does not measure losses at other steps of the supply chain, nor emissions happening otherwise, i.e. direct emissions to air, water and soil. Given the high uncertainty and potential double counting, rates in the range of 0.001% and 0.1% have been suggested by some studies such as Peano

[164] Norway (2014) Sources of microplastic pollution to the marine environment, Report for Norwegian Environment Agency.

et al. (2020)[165]. Compared to the total pellet volume, loss estimates in various publications show a wide variation (see table below), making it difficult to estimate the exact magnitude of the problem[166]. The reason for such a large variation is that the actors involved in the supply chain range from very small micro-enterprises to large companies and the level of awareness and measures in place to prevent pellet losses vary considerably. Similarly, the number of handling steps in a typical supply chain is influenced by the size of the operation, which is often driven by the demand for specific plastics products and also external factors (e.g. petrol prices, pandemic, economic crisis, energy price).

During the stakeholder meeting of 12 December 2022, stakeholders overall agreed with the approach but had diverging opinions on the loss rates (the industry considers them too high) and the number of handling steps (NGOs consider them too low[167]).

OSPAR[168] has further detailed the reasons leading to the lack of reliable information as follows:

- Most of the data were collected by interviews or questionnaires and not by measurements;
- The number of companies in the studies is relatively low;
- Different phases of the plastic cycle are involved (transport and production);
- Different companies may be involved (producers, transporters, storage companies and converters);
- The difference in the definition of pellet loss: some respondents seem to focus on the total pellet spill. In contrast, other respondents focus on the fraction of pellets that are washed into the drains or surface waters. An unknown fraction of the lost pellets will be collected and disposed of with solid waste; and
- Different study designs: For example, the German study estimated resource efficiency (production yield) by comparing the mass of the feedstock purchased and the mass of the final product sold, whereas, in other studies, the mass of pellet spills was estimated based on observations.

Due to the lack of data and awareness, it was difficult to provide exact numbers on pellet loss. This is well exemplified by the fact that all estimates in literature on pellet losses during the production phase are based on one single Norwegian plant.

To take into account these uncertainties, a range of loss rates is used to calculate the losses occurring at four major steps: production, processing, recycling and logistics. It is estimated that losses happen at a higher rate at processing and recycling installations because of relatively small installations and large number of handling steps (0.02%-0.06% of the total volume processed/recycled) than at production ones (0.01%-0.03% of the total volume produced), and at an even higher rate during transport and logistic operations (0.03%-0.12%) because of pellets normally entering the environment directly. These rates count for the major handling steps in production, processing,

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[165] Peano et al., 'Plastic Leak Project', 2020 (https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/plastic-leak-project/).

[166] OSPAR, 'Assessment document of land-based inputs of microplastics in the marine environment', 2017 (https://www.ospar.org/documents?v=38018 Page 22).

[167] Seas at Risk provided a long list of different handling steps where pellet losses could occur, however without any figures on loss rates.

[168] OSPAR Commission, 'Assessment document of land-based inputs of microplastics in the marine environment', 2017 (https://www.ospar.org/documents?v=38018).

recycling and transport/logistic phases and do not take account of other handling steps occurring in other phases (e.g. distribution), for which no data is available. These figures are therefore at the same time uncertain due to the lack of a standardised methodology to measure pellet losses and scarce data, and conservative. As said, losses depend on the volume handled, type of facility, variability in pellet handling practices across the sector and Member states, etc. These figures will be improved once the reporting obligation under REACH (and possibly complemented with a harmonised methodology under this initiative) is in place.

Pellet loss calculations were made using these ranges of pellet loss ratios (lower and higher figures) for the four types of operations, namely virgin pellet production, recycling, pellet processing and logistics. These pellet loss ratios are applied to the volume of pellets handled during different steps of the pellet supply chain.

The table below presents a recap of the main evidence available to date.

Table 45: Summary of Literature on microplastic emissions due to pellets

Author and Year	Area of Study	Estimate of Pellet Loss	Basis of Estimate
OECD (2009)[169]	USA	The emission factor (EF) for dust emissions from transferring solid powders is estimated at 5 kg per tonne (0.5%)	This was the default emission factor as found in a previous USEPA (2006) model to estimate dust releases from transferring solid powders, using data from industries including paint and varnish formulation, plastic manufacturing, printing ink formulation, rubber manufacturing, and chemical manufacturing
Nova Institute (2015)[170]	Germany	0.1 – 1.0% of total plastics production 21000 to 210 000 tonnes/year for Germany	Estimates of resource efficiency comparing how much raw material is needed to make a tonne of manufactured product
Norway (2014)[171]	Norway	0.09% of total plastics production (0.05% from transport and 0.04% from processors) 450 tonnes/year for Norway	The transport estimate is based on the OECD (2009) emission factor for dust emissions from transferring solid powders and an assumption that 10% of this will not be contained by spill control measures. A Norwegian reprocessor provided the estimate of 0.04%.
Denmark (2015)[172]	Denmark	On average, 0.01% of raw material consumption at plastics facilities. Maximum 0.0013% of raw material	Estimates were provided by processors who have joined OCS in a survey undertaken by the Danish Plastics Federation. The figures represent the loss to sewage from within the companies'

[169] OECD, 'Emission Scenario Document On Adhesive Formulation', 2009 (https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2009)3&doclanguage=en)

[170] Essel, R. et al., Report for the German Federal Environment Agency 'Sources of microplastics relevant to marine protection in Germany', 2015 (https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_64_2015_sources_of_microplastics_relevant_to_marine_protection_1.pdf).

[171] Sundt, P. et al. Sources of microplastics-pollution to the marine environment, Norwegian Environment Agency Miljødirektoaret, 2014

[172] Lassen et al. Microplastics - Occurrence, effects and sources of releases to the environment in Denmark, The Danish Environmental Protection Agency, 2015.

		consumption for processors that have joined OCS. Total emissions = 3 to 56 tonnes/year for Denmark	area (incl. unloading from trucks that deliver raw materials). The authors adjust the potential for bias in providing this information by assuming the average facility will lose ten times as many pellets.
Boomerang Alliance (2015)[173]	Australia	1% of domestic production, relating to a medium scenario of nurdle loss in domestic production and transport. 10,000 tonnes/year for Australia	The source of this estimate is not given in the paper – not based on empirical evidence.
EC/Eunomia (2016)[174]	EU	0.04% losses of domestic production from production, of which 0 – 57% will be captured in wastewater treatment. 0.05% losses of domestic production from transport, of which 10 – 50% will be captured in some way before they reach the oceans. 24,000 to 48,450 tonnes/year for Europe. The data was reported as unreliable / unrepresentative in the report.	Both pellet loss figures are taken from the Mepex study. The wastewater capture is calculated from 63% of EU population being connected to tertiary wastewater treatment. In the best case 90% of microplastics are captured in these facilities and the worst case, no microplastics are captured. The capture of losses from transport is an assumption reflecting the likelihood that pellet spills that occur during transport – especially oceanic – will not be captured in a wastewater treatment system
Eunomia (2016)[175]	UK	0.001 – 0.01% loss at each stage (four stages studied – producers, processors, storage and transport, offsite waste management) 105 to 1054 tonnes/year for the UK	Loss rates based on Danish EPA (Denmark, 2015). The lower bound of this range assumed that every UK facility loses no more pellets than the Danish processors reported that they lost. The Danish EPA study assumes that the average facility loses ten times more than the best performing, but this provided the highest rate of pellet loss reviewed that could be used in the study. Instead of better data, and supported by personal communication with a Scottish processor, this estimate was therefore used for the worst-performing facility, i.e., the upper bound figure.
Sweden (2016)[176]	Sweden	Pellet loss is calculated at two points – a 0.04% emission factor is assumed from plastic pellet production, and a lower and upper estimate of 0.0005% - 0.01% loss rate is estimated from pellet handling at processors. The latter is estimated as net emission figures (i.e. emissions to the environment).	The pellet loss from production figures is taken from the (Norway, 2014) study. The handling figure is based on (Denmark, 2015)

[173] Boomerang Alliance, Submission to Australian Senate inquiry 'The threat of marine plastic pollution in Australia', 2015 (https://assets.nationbuilder.com/boomerangalliance/pages/158/attachments/original/1445317763/Environment_Communications_marine_plastic_sub77.pdf?1445317763).

[174] Eunomia, 'Report to DG Environment on Study to support the development of measures to combat a range of marine litter sources', 2016.

[175] Eunomia, 'Report for Fidra on Study to Quantify Pellet Emissions in the UK', 2016.

[176] Magnusson et al. Swedish sources and pathways for microplastics to the marine environment, Swedish Environmental Protection Agency, 2016.

		310-533 tonnes/year for Sweden	
IUCN (2017)[177]	Global	Losses are computed at four stages: production of primary plastics, manufacturing of plastics, transport on land (for domestic uses of plastics products) and water (for interregional trade of plastics products), as well as plastic end-of-life. Optimistic (0.000003%) / central (0.00001) / pessimistic (0.0001%) of microplastics losses per stage	Loss rates are wrongly stated to be based on Fidra 2016. No other basis for the range of loss rates is provided. Fidra's assumption is that in this report there was a reporting error.
UN Environment (2018)[178]	Global	0,04% losses during production and processing. The average value, i.e. 0.005%, (estimate between 0.0005% and 0.01%.) was used for estimating losses during loading, reloading and transportation of the pellets. 30,000 tonnes/year global	The loss rates figures were taken from Norwegian polystyrene plant where a loss of 0.4 g/kg was reported (Norway, 2014). This value was used to estimate losses from the production and processing of pellets. The loss of pellets during transport and handling was calculated based on (Sweden, 2016) report.
Ryberg et al. (2019) [179]		0,04% losses during Production. Between 0,001% to 0,01% during processing. 0,0035% during handling and transportation. 20,000 tonnes/year global	The study uses four sources to estimate the losses (Norway, 2014), (Denmark, 2015) (Sweden, 2016) and Eunomia 2016[180] Production losses based on (Norway, 2014). Processing losses based on (Denmark, 2015) and Eunomia 2016 Handling and Transportation losses based on (Sweden, 2016) and Eunomia 2016

1.5 Chronic losses in reference year

High volumes of pellets are produced and handled every year, both globally and in Europe. There is a direct relationship between the amount of pellets produced and the amount released in the environment.

In Europe, in 2019, about 65.3 million tons of pellets (57.9 million tonnes of virgin, 6.5 million tonnes of recycled, and 0.9 million tonnes of bio-based) were produced in the EU. In the same year, 12.7 million tonnes of pellets were imported to Europe to be converted into final plastic products at a converting site in the EU, while 14.9 million tonnes of pellets were exported.

[177] International Union for Conservation of Nature, 'Primary Microplastics in the Oceans: A Global Evaluation of Sources', 2017 (https://portals.iucn.org/library/sites/library/files/documents/2017-002-En.pdf).
[178] Ryberg et al. Mapping of global plastics value chain and plastic losses to the environment, UN Environment, 2018.
[179] Ryberg et al. Global environmental losses of plastics across their value chains, Resources, conservation and recycling, 2019 https://doi.org/10.1016/j.resconrec.2019.104459
[180] Eunomia, 'Report for Fidra on Study to Quantify Pellet Emissions in the UK', 2016.

This impact assessment has found that the amount of pellets lost to the environment in the EU in 2019 can be estimated to be between 52 140 tonnes and 184 290 tonnes (see the table below for the the value chain)**, equivalent to 0.08% to 0.28% of total pellet volumes in the EU.**

Table 46: Pellets lost (tonnes per year) per sector and per size of the companies

	Micro	Small	Medium	Large	Total
Production	0	0	0	7222 – 21 665	7222 – 21 665
Waste management, including recycling	0	0	0	1448 – 4345	1448 – 4345
Conversion	611 – 1834	2445 – 7334	5583 – 16 748	6961 – 20 884	15 600 – 46 800
Logistics	2378 – 9513	4529 – 18 116	7109 – 28 436	13 854 – 55 414	27 870 – 111 480
Total	2990 – 11 347	6974 – 25 450	12 692 – 45 185	29 485 – 102 308	52 140 – 184 290

The calculations are explained in Annex 9, on the baseline.

Figure 9 shows the global distribution of pellets losses, as well as the importance of these losses.

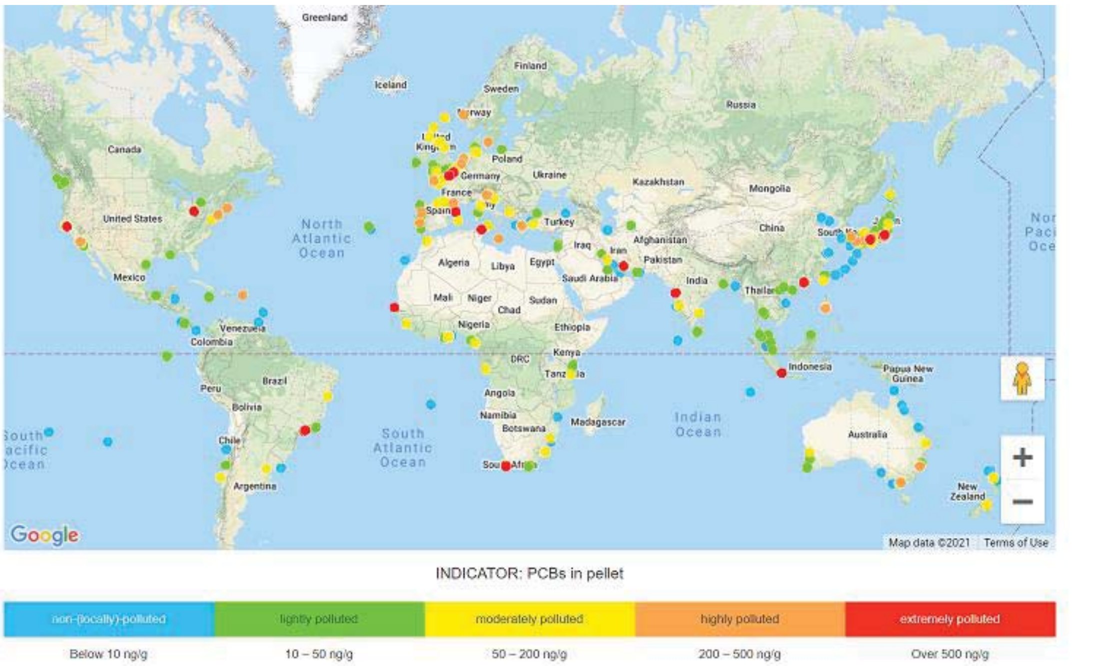

Figure 9: Scale of pellet losses at global level[181]

[181] International Pellet Watch, 'Where can we find the plastic resin pellets?' (http://pelletwatch.org/where#:~:text=Plastic%20resin%20pellets%20are%20distributed,trash%2C%20wood%2C%20shell).).

2 ADVERSE IMPACTS

Four types of adverse impacts can be observed from pellets finding their way into the environment: 1) on the environment itself; 2) on climate; 3) on human health; 4) and on the economy.

These impacts are described in Annex 7.

3 PROBLEM DRIVERS

There are several market and regulatory failures.

3.1 Market failures

1) **Prices do not reflect negative externalities**: The activities of economic operators do not integrate the negative externalities caused by pellets finding their way into the environment, leading to a suboptimal market outcome. On one side, due to their small size, pellets are easy to spill; on the other side, it is relatively costly to prevent spills or to clean up after spills as good handling practices require measures to be taken, such as training of staff. The cost of lost pellets, incurred by economic operators involved in the production, use and transport of pellets, is not sufficiently high to motivate a change in behaviour. In addition, once spilled, pellets are considered contaminated and therefore become waste[182]. There are no incentives for economic operators to integrate the negative externalities caused by pellets finding their way into the environment.
2) **Imperfect information**: Economic operators do not have sufficient information to be fully aware of the pellets which are unintentionally lost from their operations (and of consequential impacts). This applies notably to the smaller companies present in the pellet supply chain, mostly on the conversion side. As no systematic monitoring and reporting systems are in place, they are not aware of quantities released, and because there is no or insufficient awareness raising about the impacts, they are not aware of the negative externalities. Furthermore, as information on available preventive and mitigating measures by responsible companies is not sufficiently promoted throughout the supply chain, they are not aware of possible actions to be taken. Under these circumstances, it is difficult for economic operators to make sustainable choices when investing in new equipment, determining their internal procedures and choosing partners along the supply chain. A lack of specific support for the smallest companies present in the supply chain, especially on the conversion side, also explains a suboptimal market outcome.

As such, economic operators do not sufficiently integrate concerns about pellet losses in their operations and no sufficient information about quantities, impacts, actions etc., is routinely sought or promoted.

3.2 Regulatory failures

Existing EU legislation does not address pellets sufficiently: The absence of specific requirements to implement best handling practices is arguably the most significant of the problem drivers. While existing EU regulatory frameworks could be relevant (governing marine litter, water, industrial emissions, waste, packaging, chemicals and transport activities), they do not specifically address the issue of pellet losses and their responsible handling to prevent and reduce losses to the environment.

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[182] Hann, S., Sherrington, C., Jamieson, O., Hickmann, M., Kershaw, P., Bapasola, A., Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products, Eunomia.

At the national level, the very large majority of facilities involved in the conversion of pellets or in logistic operations related to pellets are too small to attract attention and receive routine visits from environmental regulators as to for instance implementation of waste legislation.

Pellets are very partially covered by the REACH restriction on microplastics intentionally added to products[183]. The restriction proposal does not prevent the placing on the market of pellets but does foresee lighter measures for so-called 'derogated' uses, meaning uses of microplastics at industrial sites, including plastic pellet sites, where releases can be prevented through risk management measures. These lighter measures are namely an 'instructions for use and disposal' requirement along the supply chain, and a 'reporting' requirement, as outlined in detail in Annex 6. All together, the reported information on all 'derogated' uses would help identify high releases and prioritise them for further regulatory risk management. However, as they apply to all 'derogated' uses, these lighter measures are generally defined and not specific to each single 'derogated' use. Also, they do not help as such to effectively reduce pellet losses or prevent them (e.g. they are not a requirement on their handling), and the reporting requirement is not based on a methodology to measure pellet losses (it was left to the industry to develop a methodology).

The Marine Strategy Framework Directive addresses the monitoring and assessment of the impacts of microlitter, including microplastics, in coastal and marine environments in a way that they can be linked to sources[184]. Currently, a guidance document is under development in view of a harmonized method to monitor the presence of plastic pellets along EU coastlines. However, this work does not include specific requirements concerning the prevention or reduction of pellet losses at source.

The revised Urban Waste Water Treatment Directive (UWWTD)[185] proposes to measure microplastics in the inlets and outlets of the urban WWT plants (including in the sludge) for agglomerations. The measures proposed in the UWWTD are only end-of-pipe solutions and no specific requirements concerning the prevention or reduction of pellet losses at the source are foreseen.

The Sewage Sludge Directive (SSD)[186] does not address microplastics. During its evaluation, the concept of source control i.e. targeting substances such as microplastics and micropollutants at source, was widely supported by stakeholders in order to improve circularity in the wastewater treatment sector. Indeed, for the sludge and/or water is to be reused, stakeholders highlighted that there is a need for tracking and preventing pollution at source.

The recast of the Drinking Water Directive (DWD), the update of the Groundwater Directive (GWD) and the Environmental Quality Standards Directive (EQSD) all include provisions related to microplastics monitoring at the end-of-life stage only.

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[183] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

[184] EUR-Lex - 32017D0848 - EN - EUR-Lex (europa.eu) "…micro-litter shall be monitored in the surface layer of the water column and in the seabed sediment and may additionally be monitored on the coastline. Micro-litter shall be monitored in a manner that can be related to point-sources for inputs (such as harbours, marinas, waste-water treatment plants, storm-water effluents), where feasible."

[185] Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01991L0271-20140101).

[186] Council Directive of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (86/278/EEC) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01986L0278-20220101).

The Industrial Emissions Directive (IED)[187] aims to prevent and control pollution arising from industrial activities in large industrial installations, and is only partially suited to address pellet losses as a form of pollution occurring along the entire supply chain. While activities like the production of polymeric materials, such as pellets, on an industrial scale fall under the scope of the IED, other activities like the conversion, transport or storage of pellets, usually operated by small and medium enterprises, are not covered. In addition, the BAT Reference Document (BREF) for the production of polymers was adopted in 2007 and does not address the specific issue of pellet losses.

Waste legislation such as the Waste Framework Directive (WFD)[188] and Packaging and Packaging Waste Directive[189] does not specifically address the pellet loss issue as they do not regulate emissions during the production of products or packaging. The WFD imposes Member States a generic obligation to take waste preventive measures addressing the industrial generation of waste as pellets can be. The Commission could adopt guidelines to assist Member States in preparing their programmes and preventive measures based on the WFD. Nevertheless, the implementation of these guidelines by Member States is voluntary thus not ensuring the harmonised implementation of preventive measures throughout the EU and the level playing field among economic operators.

4 OBJECTIVE

4.1 General objectives

The general objective of this initiative is to contribute to the reduction of microplastic-related pollution by preventing and reducing pellet losses to the environment that are due to current handling pellet practices at all stages of the supply chain within the EU, thus reducing the adverse environmental, economic and (potential) human health consequences of pellet pollution..

4.2 Specific objectives

Accordingly, the above general objective translates into three specific objectives:

- To reduce and prevent pellet losses in an economically proportionate manner to a level consistent with the Commission’s 2030 target of a 30% reduction in both intentional and unintentional microplastic releases (compared to 2016 levels);
- To improve information on the magnitude of pellet losses throughout the pellet supply chain, in particular the accuracy of loss estimates, and to raise awareness among relevant actors; and
- To ensure the appropriate mitigation of impacts on SMEs involved in the pellet supply chain.

[187] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast) (annexe 6 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0075-20110106).

[188] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705).

[189] European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01994L0062-20180704).

Annex 9:
Baseline

To develop the baseline for pellet losses to the environment, the following methodology was used due to a lack of pre-existing harmonised methodology, along with significant knowledge gaps in data and reporting.

1 THE PELLET SUPPLY CHAIN

In the pellet supply chain, pellet losses can occur at different steps of production, processing, and logistical activities. It is important to distinguish between the three types of chains detailed below to consider which activities are relevant. However, the magnitude of pellet losses will depend on the number of intermediate steps and on pellet handling practices at different facilities.

- For **pellets produced and processed in the EU**, pellet losses could occur during all three activities.
- For **pellets produced in the EU and exported**, pellet losses could occur at the pellet production facilities and during the logistics for export.
- For **pellets imported into the EU and processed in the EU**, there could be losses during import logistics and losses during processing.

The pellets supply chain is mainly grouped into three main categories: **production, processing and logistics**. Each step contains several steps where pellets losses can occur (see Annex 8). There is however hardly any info on the pellet spills and losses at each step. Therefore a different method needs to be used to estimate pellet losses to the environment.

For production, one also needs to distinguish between virgin pellet production and pellets produced through plastic recycling (pre-consumer and post-consumer), as recycling plants also include small facilities and have therefore higher risks of pellet losses.

The data sources and assumptions used to estimate the total quantity of pellets production are the following:

- 2019 is taken as the baseline year, as 2020 is an outlier because of COVID, and we are seeing positive growth trends again from 2021;
- For virgin pellets, the projections are made from 2019 figures[190]; a growth rate of 0.9% per year is assumed till 2030[191];
- The source for recycled pellets production data (2019-2021) is Plastic Recyclers Europe; a growth rate of 5.6% per year is assumed[192];

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[190] Plastics Europe changed the calculation method in 2021, excluding adhesives, paints and coatings, thus not used to be coherent with previous year estimates and also with import/export figures

[191] Plastics Europe and SystemIQ

[192] K 2022 - Trend Report Europe https://www.k-online.com/en/Media_News/Press/Technical_article/K_2022_-_Trend_Report_Europe

- The source for bio-based pellets production data (2019-2021) is Plastics Europe; for a growth rate CAGR of 14% for 2022-2027[193], and the same trend is assumed to continue till 2030;
- Pellets imports and exports figures for virgin pellets are from Eurostat; a growth rate of 0.9% is assumed till 2030.

Using these assumptions, the total pellet production is expected to reach about 79 million tonnes in 2030. If we take into account imports and exports, the net volume of pellets used in the EU would be around 76 million tonnes in 2030. The total figures estimated here are within 1% range compared to the estimates made by the recent OECD scenario[194] that used a modelling approach (see Figure 10).

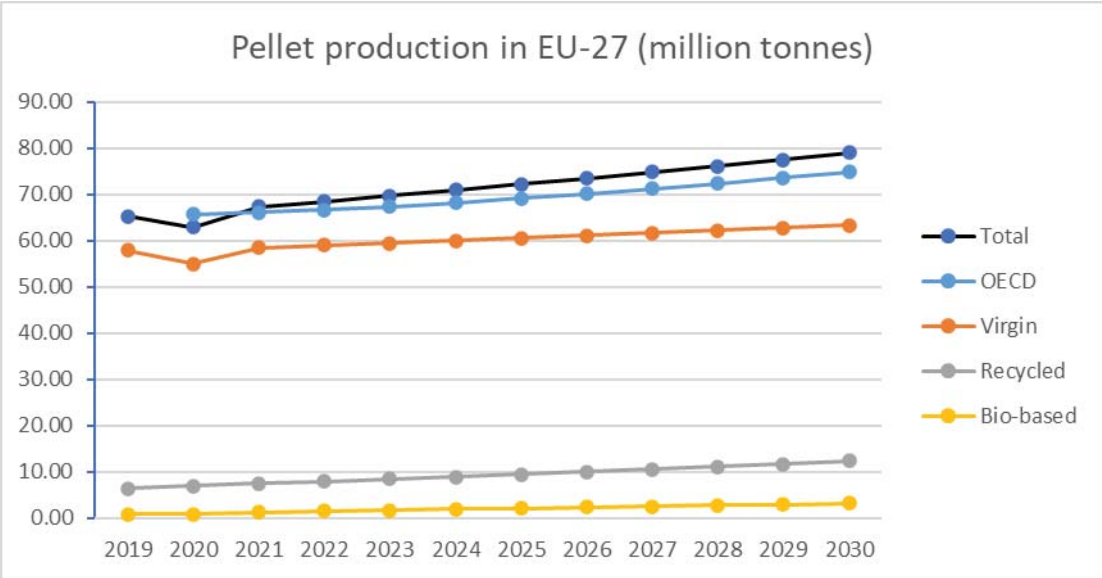

Figure 10: Pellet production volumes in EU-27 and projections until 2030

2 How will pellet losses evolve in 2030?

To define the projected development of total pellet losses in 2030, consideration was given to the following: 1) Existing and forthcoming EU legislation; 2) National and international initiatives; 3) Industry initiatives. These pieces of legislation and initiatives are presented below.

2.1 Existing and forthcoming EU legislation

The existing and forthcoming EU legislation with relevance for pellet losses is described in detail in Annex 6. This legislation includes the REACH restriction on unintentionally added microplastics, the Marine Strategy Framework Directive, several pieces of water-related legislation, the Industrial Emissions Directive and the Waste Framework Directive. Globally this legislation is not explicitly considered in the baseline as (1) the analysis was done at the same time and it was not clear which measures would be proposed, or more importantly (2) the measures applying or under consideration

[193] Nova Institute (2023) Bio-based Building Blocks and Polymers Global Capacities, Production and Trends 2022–2027 https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2022-2027-short-version-pdf/

[194] OECD (2022) Global Plastics Outlook: Policy Scenarios to 2060. https://www.oecd.org/publications/global-plastics-outlook-aa1edf33-en.htm

are limited in scope and impact, or generic (mainly reporting, monitoring or provisions for larger plants only).

2.2 National and international initiatives

A few Member States have already started to introduce measures to tackle pellet losses. These measures are summarised in Table 47 and presented in detail in Annex 6.

Table 47: Member State actions targeting pellet losses

Country	Actions
Austria	• Law adopted addressing "filterable substances" to which pellets belong
Belgium (Flanders)	• Introducing environmental permit system / Best Available Techniques • Examining an environmental management system with possible certification
Denmark	• Monitoring • Waiting for OCS certification scheme implementation and Commission's proposal
France	• Law adopted providing minimum obligations to prevent pellet losses for all actors in the supply chain along with mandatory external auditing
The Netherlands	• Monitoring • Waiting for OCS certification scheme implementation
Spain	• Promoting OCS certification scheme implementation
Sweden	• Revising current guidelines to make them more comprehensive and include more actors across the supply chain

France is the only Member State to have adopted legislation specifically targeting pellet losses. This legislation covers businesses making and handling pellets in quantities higher than 5 tonnes including logistic platforms but not transporters. The threshold has been reduced from what initially proposed i.e. 10 tonnes following public consultation. Businesses are subject to equipment and procedural obligations to prevent the loss and leakage of pellets, and are required to be regularly audited by independent and accredited certification bodies[195]. Obligations remain of a relatively generic nature. For instance, a business must identify areas where pellets are more likely to spill, check that the packaging used is designed to minimise the risk of spills and train and raise awareness among staff. As a unique transparency measure, the company must make the summary of the auditing report available on its website. The Decree entered into force on January 1, 2022 for new sites, while for existing sites, it will enter into force in 2023, at the same time as equipment obligations.

In 2021, the British Standards Institution published the Publicly Available Specification PAS 510:2021[196], for use by organisations of any size across the pellet handling supply chain. It builds on the industry-led Operation Clean Sweep® (OCS) programme (see Annex 6) by creating a

[195] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official "Lois et Décrets" no. 0092 du 18 avril 2021 [JORF] [Official journal "Laws and Decrees" no. 0092 of 18 April 2021], 18 April 2021, Fr.

[196] BSI Knowledge, 'Plastic pellets, flakes and powders. Handling and management throughout the supply chain to prevent their leakage to the environment. Specification - PAS 510:2021101', 2021 (https://knowledge.bsigroup.com/products/plastic-pellets-flakes-and-powders-handling-and-management-throughout-the-supply-chain-to-prevent-their-leakage-to-the-environment-specification?version=standard).

standardised and consistent approach to risk management and containment of pellets[197]. The PAS might be considered for further development as a British standard or constitute part of the UK input into the development of a European or International standard on pellets.

In 2021, the parties to the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) adopted the non-binding Recommendation 2021/06[198] to reduce the loss of plastic pellets in the marine environment by promoting the timely development and implementation of effective and consistent pellet loss prevention standards and certification schemes for the entire plastic supply chain. The Recommendation was accompanied by supporting guidelines which set out essential requirements for standards and certification schemes. The first full implementation report is due in January 2025, with an interim report due in 2024. A preliminary interim report was informally shared by OSPAR in February and the actions reported by the Member States that are parties to the OSPAR Convention are presented in the above Table 47.

In the International Maritime Organization (IMO), a Correspondence Group on Marine Plastic Litter from Ships looked at measures that could be relevant in reducing the environmental risk associated with the maritime transport of plastic pellets. While three primary measures including packaging were identified as particularly relevant to reduce the environmental risks associated with the maritime transport of plastic pellets (and a voluntary circular to this effect was drafted), the Group was not in a position to conclude on the most appropriate instrument for mandatory measures[199]. The Group noted that experience gained from the implementation of voluntary measures could be useful in the further consideration of the most appropriate instrument for mandatory measures.

A similar international initiative is ongoing on containers lost at sea, and discussions are held on the possibility of making the information on containers lost at sea available publicly (to date, such information is reported only to insurance companies). If retained, this measure would allow for a better understanding of the scale and magnitude of pellets lost at sea and would facilitate liability identification and compensation arrangements in line with the polluter pays principle.

2.3 Industry initiatives

Since 2015, the European plastic manufacturing industry has progressively adopted the Operation Clean Sweep® (OCS) programme[200] as a voluntary pledge to work towards zero plastic pellet losses. This programme is presented in detail in Annex 6.

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[197] The PAS provides requirements in the following areas: a) Organizational responsibilities; b) Leadership and commitment; c) Competence, training and awareness; d) Risk assessment of pellet loss to the environment; e) Operational controls, i.e. prevention, containment and clean-up, procurement and suppliers; f) Internal and external communication; g) Performance evaluation, i.e. monitoring and documentation, auditing and verification of conformity; h) Improvement, i.e. internal and external non-conformity and corrective action, and continual improvement.

[198] www.ospar.org/convention/strategy

[199] The three primary measures identified as relevant are: Packaging provisions for plastic pellets carried at sea; Provisions for notifying the carrier so that containers containing plastic pellets can be identified; Stowage provisions for freight containers containing plastic pellets. Among the options for mandatory measures, the Group considered the three following options/instruments: Assignment of an individual UN Number (class 9) for plastic pellets transported at sea in freight containers (UN Number); Amendment to Appendix I of MARPOL Annex III that would recognize plastic pellets as a “harmful substance” (Harmful substance); A new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

[200] www.opcleansweep.eu

While best practices are generally well understood, they have not been comprehensively implemented. As of April 2023, 2548 companies have committed to OCS[201]. This figure includes all PlasticsEurope's members (these are producers; adherence to OCS is mandatory for the members of this association). Only 2% of EuPC's members (converters) have committed to OCS (around 1 000 converters out of 48 000); and only some 500 transport companies. As no precise reporting has been made available within OCS, it is not possible to say whether those who have committed have also effectively or fully implemented the programme, with evidence showing the opposite. Both acute and chronic pellet incidents have been reported to continue over the last years, including at sites that are OCS signatories[202].

The recent launch of the OCS Certification Scheme (OCS CS) aims to address these issues. Recognising the low uptake of OCS by the industry, in 2019, European plastic manufacturers (PlasticsEurope) and converters (EuPC) announced plans to develop a voluntary certification scheme building on OCS and including requirements, third-party, independent auditing, certification and some level of transparency (all aspects not foreseen under the current OCS programme). In January 2023, the new scheme was officially launched by its promoters. It is presented in detail in Annex 6.

While going in the right direction, the new scheme constitutes only a partial attempt by the industry to adopt a genuine supply chain approach and pursue the zero pellet pollution objective effectively. First of all, while the requirements are in principle applicable to all companies handling pellets, and all companies can get audited and certified, when fully in place, the new scheme will be required only for producers (adherence to the existing OCS programme is already mandatory for the members of PlasticsEurope since 2019[203]). Not all producers are members of PlasticsEurope. Thus, the new scheme will not be binding for key players in the pellet supply chain, such as converters, transporters, warehousing operators and recyclers.

EuPC, representing converters, found it difficult to make adherence to the new scheme mandatory for their members (to date, adherence of converters to the existing OCS programme is very low). As explained in Annex 8, members of EuPC are European and national associations representing close to 50,000 individual companies, out of which 66% are micro-companies. It is estimated that the certification process is relatively short for producers, (PlasticsEurope expect all their members to be certified by the end of 2024, some producers reporting however a longer period before certifying all their sites), while the process is set to be much longer for converters.

Transporters, warehousing operators and clean tankers are observers of the new OCS certification scheme and will be assessed (not certified) under the chemical industry's Safety and Quality Assessment for Sustainability (SQAS) system, which has contained requirements to tackle pellet losses starting since March 2023[204]. Full alignment between the new OCS certification scheme and the SQAS system is still pending. In particular, there are no plans currently to force OCS-certified

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201 www.opcleansweep.eu

202 Regarding chronic pellet losses in the Netherlands, Belgium and Spain, see https://www.plasticsoupfoundation.org/wp-content/uploads/2022/03/Westerschelde-plastic-nurdles-versie-definitief-21-11-2021-2.pdf; https://surfrider.eu/en/learn/news/ecaussinnes-belgium-surfrider-foundation-tackles-industrial-plastic-granules-1211028228325.html; https://goodkarmaprojects.org/2020/11/20/new-report-out-exposes-alarming-impacts-of-plastic-pellets-across-europe/?lang=en.

203 OCS becomes an intrinsic part of PlasticsEurope's DNA - Operation Clean SweepOperation Clean Sweep (opcleansweep.eu)

204 A first addition to the SQAS assessment questionnaire was made in January 2022. The current version of the questionnaire is available here https://www.sqas.org/downloads/ts2022/SQAS%202022%20TS%20Questionnaire%20and%20Guidelines%20Rev%202%20(English).docx

companies to work exclusively with SQAS-assessed transport companies. To date, there are approximately 3000 transport companies which are SQAS-assessed and even more transport companies which are non SQAS-assessed. According to the sector, SQAS-assessed transport companies cover 80% of the total pellet transport of virgin pellet producers in Europe. Clean tankers are mostly SQAS assessed, while among warehousing operators only a part is SQAS assessed.

To test the new scheme, nine pilot audits covering producers, converters and transporters were held in 2021 in five countries: Belgium, Netherlands, Portugal, Spain and France. The bodies that conducted these audits were well-known bodies like Aenor, Bureau Veritas, SGS, etc. All audited companies failed to pass. The strongest point observed by auditors was a good involvement of management, while the weakest one was related to the objective of encouraging partners to pursue the same objectives.

At the end of 2021, FFI decided to resign from the Supervisory Board of the new OCS certification scheme arguing that it did not fully align with the guidelines of the OSPAR Recommendation 2021/06, and citing issues with the governance of the scheme, the level of transparency, the lack of a formal standard from a recognised standardisation body, the fact that the whole supply chain is not captured adequately, and the lack of timelines for compliance. FFI called instead for the introduction of effective legislation applicable to all pellet handling companies and based on a supply chain approach to eliminate this source of pollution fully[205].

Recyclers are neither promoters nor observers of the new scheme and have their own certification scheme in place (RecyClass), which has a section on pellet losses requiring the implementation of a procedure to prevent leakage within the premises and surrounding of the recycling plant, and ensure the training of staff. To go a step further, recyclers are conducting a study on potential areas in the recycling process where microplastics could be generated and released, and on preventive measures. The recommendations of this study will be used to complete the RecyClass certification scheme's pellet loss/microplastics requirements.

2.4 The baseline

All in all, the above national and international initiatives are expected to contribute to very limited reduction in pellet losses by 2030. France is the only country to have adopted specific national legislation to prevent pellet losses via legal obligations. The relevant provisions are relatively generic and do not cover transporters. However, the baseline considers an estimated reduction from it. The other national initiatives are non-legislative and limited in scope (e.g. research and monitoring activities). Both the BSI PAS and the OSPAR Recommendation provide for a non-binding comprehensive set of measures to be taken and are reference documents in the field. However, in both cases, it is up to the companies or parties to implement such measures, and it was not possible, at the moment of the impact assessment, to evaluate their precise implementation. The IMO work on pellets focuses on one aspect only i.e. shipping of pellets, and has resulted so far in voluntary measures only, with very limited effects up to date.

[205] FFI call for the introduction of effective legislation that will require all pellet (flake and powder) handling companies across the whole supply chain to provide independent verification that pellet loss prevention measures have been implemented, maintained and monitored for effectiveness towards the goal of zero pellet loss to the environment, prior to materials being placed on the market. They also call for tighter restrictions on the packaging and labelling of pellets being prepared for transport to reduce the risk of loss and improve communication. Finally, EU legislation should complement international maritime legislation for pellets currently being considered by IMO to reduce the risk of catastrophic pellet pollution at sea.

Once fully in place, the new industry-led OCS certification scheme is expected to contribute to some reduction in pellet losses by 2030. It is difficult to assess the take-up of the new scheme by the industry, and therefore its effectiveness. This counts equally for similar schemes by the recyclers or logistics companies (RecyClass and SQAS).

For the baseline, it has been assumed that by 2030:

1. 90% of the total virgin pellet volume produced (by the members of PlasticsEurope) and 5% for the non-PlasticsEurope members, will be certified compliant against OCS new rules and will be effectively implementing such rules with a success rate ranging from 60% to 80%;
2. 20% of the total recycled pellet volume will be certified compliant against RecyClass pellet provisions and will be effectively implementing the new provisions with a success rate ranging from 40% to 60%;
3. 30% of the total volume processed will be certified compliant against OCS new rules and will be effectively implementing such rules with a success rate ranging from 40% to 60%;
4. 40% of the total volume handled by logistics companies will be SQAS assessed and will be effectively implementing such a scheme with a success rate ranging from 40% to 60%; and
5. The French legislation will cover about 85% of the French pellet volume (about 10% of the EU volume), leading to a 60-80% pellet loss reduction in 2030.

Based on the pellet loss calculations taking into account industry efforts (OCS new rules, RecyClass and SQAS) and Member State legislation (France), **in 2030, there will still be pellet losses in the range of <u>42 050 – 170 266 tonnes per year</u>**.

Table 48: Emissions in 2030 (in tonnes) considering the impact of ongoing/upcoming initiatives

	Low emission scenario	**High emission scenario**
Without considering ongoing initiatives	62 178	219 355
OCS reduction potential:		
• Producers	4 130 - 5 507	12 390 - 16 521
• Recyclers	197 - 296	592 – 889
• Processors	2 005 - 3 007	6 015 - 9 022
• Logistics	4 726 - 7 089	18 905 - 28 357
French legislation	3 171 - 4 228	11 187 - 14 916
Pellet losses in 2030 in the baseline scenario	**42 050 - 47 948**	**149 651 - 170 266**

Annex 10:
Policy options to reduce pellet losses

1 METHODOLOGY TO IDENTIFY MEASURES

Measures, i.e. specific technological and behavioural standards/changes affecting pellet losses, were identified from collected evidence (literature review) and stakeholder consultation (OPC, targeted interviews and workshops, targeted SME survey).

Overall, 173 ideas were identified during desk research and in the stakeholder workshops conducted in November 2021 and December 2022. After eliminating the duplicates, the long list of measures was as follows:

- Development of measurement standards for pellets;
- Voluntary Commitment to industry-led OCS certification scheme;
- Reduction target: devise a reduction target for pellet losses considering the current situation;
- Development of a universal information leaflet and labelling for packaging of plastic pellets for their transport;
- Training obligations (with regular updates) for all actors in the plastic pellet value chain;
- Ensure that all containers used for transport and storage are environmentally sealed, airtight and puncture resistant to prevent damage and tears;
- Classify pellets as harmful in the International Maritime Law (MARPOL Annexes III and V and inclusion of pellets in the International Maritime Dangerous Goods (IMDG) Code as hazardous or dangerous substances). Slots below deck or in more protected areas would be used to reduce the risk of container loss at sea;
- Mandatory reporting system for containers lost at sea in international waters. (Not just to insurance companies);
- Address/sanction big pellet losses under the EU Environmental Crime Directive;
- Support for SMEs, including financial incentives;
- Extended producer responsibility system for pellets / Set up an environmental damage remediation fund, financed by industry;
- Obligation for all supply chain players to prevent pellet losses through measures embedded in EU law;
- All installations, producing, converting, handling, transporting etc., can only operate having an environmental permit issued by a competent authority, by using the EU Industrial Emissions Directive;
- Independent verification of best practices using well-designed standards and certification schemes as promoted by the Commission of the regional convention for the protection of the

Marine Environment of the North-East Atlantic (OSPAR)[206];

- Prohibition on discharges (zero tolerance threshold similar to Formosa Plastic Consent Decree).

2 SCREENING OF MEASURES

The identified measures were screened using the criteria defined in the Better Regulation Tool #16.

From the outset, the option of developing standardised methods to measure pellet losses was retained (Option 1).

Voluntary commitments like the one under the industry-driven OCS and OCS certification scheme were considered as suitable options to address the identified problem driver 'Market failure (prices do not reflect negative externalities)'. In particular, the new industry-led OCS certification scheme was first retained as an option, then, discarded as the new scheme has in the meantime been launched by its promoters. Therefore, this impact assessment considers such commitment as part of the baseline.

The option of developing voluntary verification of best practices using well-designed standards and certification schemes is ongoing under the work of the Commission of the regional convention for the protection of the Marine Environment of the North-East Atlantic (OSPAR) and in the framework of the above mentioned industry efforts. Therefore, this impact assessment considers such development as part of the baseline. Also, certification is an essential part of Option 2.

Information/awareness raising on the handling of pellets throughout the pellet supply chain, and the development of a universal information leaflet and labelling for packaging of plastic pellets for their transport, were considered as suitable options to address the identified problem driver 'Market failure in the shape of imperfect information'. However, this impact assessment considers that this would be better taken up by the mandatory requirements in Option 2.

Training obligations (with regular updates) for all actors in the pellet supply chain were also considered as a suitable option, however, again, this impact assessment considers that this would be better taken up by the mandatory requirements in Option 2. Indeed, training is an essential part of this option.

The possibility of using the Industrial Emissions Directive to address pellet losses at relevant installations was discarded on the ground of effectiveness, efficiency and relevance. The IED is not suited to address pellet losses as a form of pollution occurring along the entire supply chain. While activities like the production of polymeric materials on an industrial scale fall under the scope of the IED, other activities like the conversion, transport or storage of pellets, usually operated by small and medium enterprises, are not covered. The permits are primarily designed for large installations with multiple environmental issues. Moreover, the BAT Reference Document (BREF) for the production of polymers was adopted in 2007 and does not address the specific issue of pellet losses.

[206] https://www.ospar.org/convention/text

The possibility of using the Environmental Crime Directive[207] to sanction all pellet losses was discarded on the ground of the limited scope of this legal instrument due to its nature (criminal law) and therefore not adequate to address all types of unintentional losses.

Supporting SMEs, including via financial incentives, is integrated in option 2 as a way to mitigate the regulatory burden on SMEs.

The possibility of setting extended producer responsibility schemes and environmental damage remediation funds, financed by industry, were discarded on the ground of technical feasibility and relevance. EPR targets a product, while for pellets, we have different types of "producers", those who manufacture the pellets, those who transform them into a product etc. Also, EPR aims to tackle the end-of-life, i.e. when the product becomes waste, while for pellets, it is a diffused pollution issue along the entire supply chain.

Classifying pellets as a "harmful substance" in the International Maritime Law was seen by some stakeholders as a positive measure to reduce the environmental risk associated with the maritime transport of pellets. However, an initiative on this precise issue is currently ongoing in the International Maritime Organization with the support of the European Union. At the same time, the Ship Source Pollution Directive is under revision, and one of the options could be to extend the scope of this Directive to MARPOL Annex III, where pellets could be classified as "harmful substance". Therefore, while addressing the maritime transport of pellets by means of more stringent packaging or stowing provisions may help reduce pellet losses at sea, this impact assessment considers such initiatives as part of the baseline. The same applies to developing a mandatory reporting system for containers lost at sea in international waters (initiative ongoing). On these acute pellet incidents, while losses of pellets coming from containers lost at sea are very visible and impactful on the shores affected, these losses are estimated not to represent the biggest losses in quantities.

The table below summarises the measures that have been screened out from the evaluation as well as the reasons for their exclusion.

Table 49: Discarded measures

Problem Area	Measure Title	Reason for screening out
Market failure/ Information/knowledge failure	Support for SMEs, including financial incentives	This measure is integrated in option 2 as a way to mitigate the regulatory burden on SMEs.
Market failure / Information failure	Development of a universal information leaflet and labelling for packaging of plastic pellets for their transport	The information on good practices exists, but is not well enough implemented. However, this impact assessment considers that this would be better taken up by the mandatory requirements in option 2.
Market failure / Information failure	Training obligations (with regular updates) for all actors from the plastic pellet value chain	Such obligations would help, but this impact assessment considers that this would be better taken up by the mandatory requirements in option 2.

[207] Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law.

Market/Regulatory failure	Extended producer responsibility (EPR) / Set up an environmental damage remediation fund, financed by industry	This measure is discarded on the ground of technical feasibility and relevance. EPR targets a product, while for pellets, we have different types of "producers", those who manufacture the pellets, those who transform them into a product etc. Also, EPR aims to tackle the end-of-life, i.e. when the product becomes waste, while for pellets, it is a diffused pollution issue along the entire supply chain.
Regulatory Failure	Independent verification of best practices using well-designed standards and certification schemes as promoted by OSPAR.	The verification of the best practices could be ensured by the industry-led OCS CS; this impact assessment considers this as a part of the baseline.
Regulatory failure	Prohibition on discharges (zero tolerance threshold similar to Formosa Plastic Consent Decree)	This relates to intentional illegal discharges. This is not a relevant measure, as pellet loss is an "unintentional" release.
Regulatory failure	All installations, producing, converting, handling, transporting etc., can only operate having an environmental permit issued by a competent authority.	This measure is discarded on the grounds of effectiveness, efficiency and relevance. The production phase of polymers is already covered by the Industrial Emissions Directive (IED) but the concerned BREF was adopted in 2007 and does not address the specific issue of pellet losses. In addition, The IED is not suited to address pellet losses as a form of pollution occurring along the entire supply chain.
Regulatory failure	Sanction big pellet losses under the EU Environmental Crime Directive	This measure is discarded on the ground of legal feasibility. While it may be relevant to sanction big losses of plastic pellets (causing serious pollution and environmental impacts), currently, there are no legal obligations in place or deriving from EU law regarding plastic pellets. Therefore it is not possible to identify any breach of legislation. The sanction for duty-holders on the ground would become possible once such obligations are in place.
Regulatory failure	Classifying pellets as a "harmful substance" in the International Maritime Law	An initiative on this precise issue is currently already ongoing in the International Maritime Organization with the support of the European Union.
Regulatory failure	Developing a mandatory reporting system for containers lost at sea in international waters	Ongoing initiative with the support of the European Union.f

3 FINAL LIST OF MEASURES / OPTIONS

Four options for action were identified.

Option 1: Mandatory standardised methodology to measure pellet losses

Under this option, the Commission initiates the development of a standardised method to measure pellet losses from the range of relevant pellet-related industrial activities (i.e. production, conversion, recycling, transport and other logistic operations), to be used for the reporting on estimates of quantities released on an annual basis, as obliged under the REACH restriction. The new standard will improve the quality of the reporting on the quantities released (one methodology for all instead of several, different ones) improving the information on the magnitude of pellet losses throughout the pellet supply chain, while also raising awareness among relevant actors as they can measure pellet spills and losses and assess their evolution over time.

Currently, there is no standardised methodology to measure pellet losses. It is expected that under REACH, there will be a reporting requirement on estimates of quantities released on an annual basis for pellet manufacturers and downstream users[208], but not a methodology. This option would be developed via the European Standards Organisation (CEN), which typically takes 3-4 years to complete. The umbrella association of European converters (EuPC) is developing for the OCS certification scheme signatories a methodology for measuring such losses, named the Bow-tie model, and this work can serve as the basis of the harmonised methodology. This model focuses on a risk analysis to identify, at first, the most probable sources of pellets leakages that should be solved in priority. Once the risk areas have been defined, the model proposes several ways to quantify the losses based on the available information (e.g. amount of pellets sent to waste) or on amounts of pellets collected in existing prevention (trays, buckets etc.) and mitigation (vacuum cleaners, filters, etc.) barriers.

This option addresses the problem drivers of market (imperfect information) and regulatory failures.

Option 2: Mandatory requirements to prevent and reduce pellet losses in a new EU law

Under this option, mandatory requirements are defined and imposed on the entire pellet supply chain thus maximising the opportunities of preventing and reducing pellet losses. The requirements to comply with at the site level are based on those already identified by stakeholders in the framework of the BSI PAS and OSPAR recommendation and the industry-led OCS certification scheme. Firms will need to provide evidence of the following:

1. The creation and publication of internal procedures such as defining organisational responsibilities, a pellet loss prevention policy with pellet loss prevention objectives, a regular risk mapping exercise and corresponding risk management assessment at site level;
2. Competence, training and awareness of staff to prevent, contain and clean up spills including maintaining a record of spills;
3. Operational controls including preventive, mitigating and clean up measures and equipment;
4. Communication of implemented policies, measures and objectives both within the organisation and externally, as well as of improvement as reaction to non-conformity.

A risk mapping exercise needs to be performed to identify the leakage potential of all necessary, handling steps in all high-risk areas and pathways to the external environment. According to industry,

[208] In REACH, 'downstream users' are defined as "any natural or legal person established within the Community, other than the manufacturer or the importer, who uses a substance, either on its own or in a mixture, in the course of his industrial or professional activities. A distributor or a consumer is not a downstream user. A re-importer exempted pursuant to Article 2(7)(c) shall be regarded as a downstream user". Concretely, pellet converters, recyclers as well as storing operators who own the pellets would be considered as downstream users under REACH. Transporters are not all downstream users but emissions during transport would also need to be reported by the relevant downstream user. Instead, would not be covered by the reporting obligation: importers, distributors, storing operators who store the pellets for third parties, retailers and consumers. A transitional period of 24 months is set for the entry into force of the reporting requirement.

special attention should be given to the following areas where there is a high likelihood of loss to the environment: nearby sewers and drains that do not have any pellet collection facilities or that are not connected to the facility's WWTP; in areas with high traffic (e.g. near gates); in areas close to the fence line; nearby gravelled or non-paved areas; in areas where pellets being spilled or lost may be picked up by the wind or water (rain and storm water) and transported outside[209]. Once this is done, there needs to be a risk management assessment performed to determine where actions are required for equipment, best practice handling, mitigation and remediation.

Knowing that the first step should be to avoid all unnecessary handling of pellets, preventive barriers include "Avoidance of Unnecessary Handling" (as the possibility of minimising the number of transfer points in the supply chain is the starting point for reducing spill opportunities) and "Best Practice Handling". The latter can take the form of collection and retention trays. Mitigation and clean-up measures can take the form of filters, vacuum systems to remove accumulated pellets, and tools for immediate cleaning (shovel, broom, brush, vacuum cleaner).

This is also the option of mandatory external auditing and certification. To demonstrate compliance with the defined mandatory requirements, all pellet handling companies including logistic platforms and transporters must be externally audited and certified at the site level by independent certifying bodies selected among accredited organisms, in order to operate. This implementation approach is consistent with the non-binding OSPAR Recommendation, adopted by OSPAR contracting parties including the EU and 11 Member States, which promotes certification schemes for the entire supply chain. It is also fully in line with the polluter pays principle as the cost of the audits would be borne by the industry itself, and it allows for a harmonised implementation across the EU as a whole, ensuring a level playing field among operators. Certification obligations will be imposed in a phased manner. Once externally audited, companies must notify the public authority about the outcome of the external audit. In the case of non-compliance, they are also responsible for imposing corrective measures and, where relevant, penalties.

This option does not include reduction targets and it is assumed that over a period of time the certification process will deliver results. Once the measure under Option 1 is in place, the reduction targets could possibly be defined. The measure under Option 1 would enable measuring its possible success rate.

There will be a 5 tonnes/year threshold for the requirements (as done in the existing French legislation[210] - this limit was decided as a consequence of a public consultation in France). It avoids requiring costly investments with very limited environmental benefits in terms of pellet loss reduction.

This option addresses the problem drivers of market and regulatory failures.

Option 3: Improved packaging for pellet logistics

This option aims to ensure that all bags and containers used for pellet logistics (transport, storage etc.) are environmentally sealed, airtight and puncture-resistant to prevent damage and tears, which could lead to pellet losses. The option imposes the use of specific types of bags and containers for

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[209] SQAS

[210] Décret no 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement [Decree n. 2021-461 of 16 April 2021 related to the prevention of the leakage of industrial plastic pellets into the environment], Journal official "Lois et Décrets" no. 0092 du 18 avril 2021 [JORF] [Official journal "Laws and Decrees" no. 0092 of 18 April 2021], 18 April 2021, Fr.

pellet handling, transport and storage. It can be set up as an independent legislation or can be implemented as part of the legal proposal in Option 2.

This option addresses the problem drivers of market and regulatory failures.

Option 4: EU target to reduce pellet losses

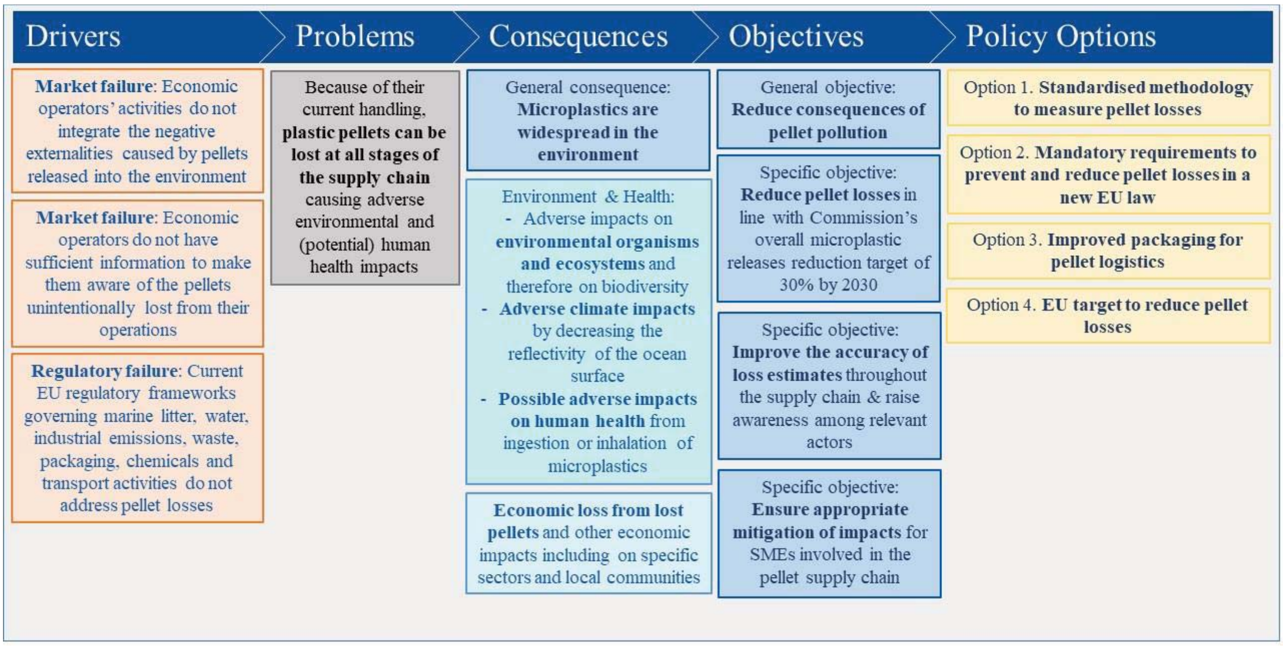
This option is to establish an EU reduction target in line with the Commission's overall microplastic releases reduction target of 30% by 2030. Each Member State must introduce the necessary transposing legislation and measures to ensure delivery, including compliance assurance and reporting by economic operators to track progress against the target. Periodic reporting by competent national authorities to the Commission would also be necessary to ensure delivery and appropriate remedial action in case of shortfall in reducing pellet losses.

This needs an established harmonised measuring methodology or standard (Option 1) first. Without it, it would be challenging to establish a baseline and measure the achievement/non-achievement of the established target.

4 THE INTERVENTION LOGIC

The diagram below sets out the underlying reasoning of this impact assessment by illustrating the logical connection between the problem, its drivers the specific objectives and the policy options which are assessed in Annex 11.

Figure 11: The intervention logic



Annex 11:
Impacts of Policy options to reduce pellet losses

1 IDENTIFICATION AND SCREENING OF IMPACTS

The first step in assessing the impacts of a policy option is to identify the significant ones, both direct and indirect. The following table sets out the impacts that were considered as significant in this impact assessment.

Table 50: Impact categories and indicators with degree of significance (+, ++, +++)

Broad impact category	**Indicator**	**Significance**
Environmental impacts		
Quality of natural resources	Change in quality of ecosystems and biodiversity: reducing pellet losses improves ecosystems and biodiversity	+++
Efficient use of raw materials	Change in the efficient use of raw materials: reducing pellet losses reduces the amount of pellets that become waste (and need to be recycled)	+
International environmental impacts	Change in quality of ecosystems and biodiversity outside the EU due to transboundary nature of pellet pollution: reducing pellet losses improves ecosystems and biodiversity globally	+
Climate change	Reducing pellet losses has positive effects on plankton and therefore on climate change	+
Economic impacts		
Society & economy at large	Change costs to society when taking action to reduce pellet losses, including clean up and monitoring costs, reduced ecosystem services from activities like commercial fishing and agriculture, tourism and recreation in areas affected by losses	++
Businesses including SMEs	Change in benefits to businesses when taking action to reduce pellet losses, including reduced waste (and reduced value loss for pellets that are lost) and other economic benefits Change in costs (adjustment and administrative costs) to businesses when taking action to reduce pellet losses, including costs for SMEs present in the supply chain	++ +++
Internal market and competition	Change in costs due to improper functioning of the internal market due to internal market fragmentation	+
End users	Change (increase) in prices of final plastic products to end users as a negative knock-on effect of change in costs to businesses	+
EU competitiveness	The additional costs are likely to have minor negative impact the competitiveness of EU pellet producers as their competitors outside the EU will not be affected	+
Innovation / Technological development / digital economy	The innovation and research impact category covers the impacts on technological development related to the sectors concerned	+
Social Impacts		
Public health & safety	Effects of measures on public health because of risks to food chain; effects of measures on safety at work (pellets spilled on the floor)	+

Sensitive populations	Effects of measures on sensitive populations in areas affected by pellet losses (ports, beaches, protected areas, etc.)	+
Employment	Effects of measures on employment (additional job opportunities in the plastic sector)	+
Administrative burden		
Public authorities	Change in costs to public authorities in the Member States and to the European Commission	++

Then, the significant impacts have been examined by indicating whether they are likely to be positive or negative and which stakeholder groups they are most likely to impact. Colour coding is used to summarise the impacts referring to the direction (positive or negative) and size (small or large). Note that for several indicators no extensive quantification has been possible, due to the lack of available data. In these cases, the assessment is based on expert judgement provided via the underpinning support study.

Table 51: Coding used to present likely impacts

Score	Description
+++	Very significant direct positive impact or benefit
++	Significant direct positive impact or benefit
+	Small direct positive impact or benefit
(+)	Indirect positive impact or benefit
+/-	Both direct positive and negative impacts, and balance depends on how implemented
0	No impact or only very indirect impacts
(-)	Indirect negative impact or cost
-	Small direct negative impact or cost
--	Significant direct negative impact or cost
---	Very significant direct negative impact or cost
High	High Benefits significantly outweigh costs of measure
Medium	Medium Benefits on balance outweigh costs of measure
Low	Low Benefits close to or even below costs of measure
Uncertain	Potential high benefits, but significant questions as to whether the measure can deliver outcome

The outcome of this step is the final list of likely impacts.

Table 52: Screening of impacts

Impact	Impacts	Stakeholder groups impacted	Justification for inclusion / exclusion
Environmental impacts			
Quality of natural resources	+++	Reduced pellet losses lead to better quality of natural resources (improved eco-systems and biodiversity)	The objective is to reduce pellet losses and related adverse impacts on the environment, so this is a key impact category
Efficient use of raw materials	+	Reduced pellet losses lead to fewer pellets becoming waste	Less pellet losses leads directly to the more efficient use of pellets
International environmental impacts	++	Reduced pellet losses lead to improved ecosystems and biodiversity globally	Pellet pollution is trans-boundary (it affects both cross-border river basins and seas) and global pellet pollution is an important key impact category

Climate change	+	No specific group is impacted	Reducing pellet loss will lead to less GHG emissions, for example, during all steps of the plastic value chain, but as well due to indirect effects on plankton growth.
Economic impacts			
Society & economy at large	+	Reduced pellet losses lead to less costs on society (e.g. clean up costs) and economy at large (sectors such as commercial fishing and agriculture, recreation and tourism)	The objective is to reduce pellet losses for environmental, societal and economic reasons
Businesses including SMEs	--	Industrial operators bear the costs of taking action to reduce pellet losses. However, reduced pellet losses lead to less value loss when pellets are lost for those owning them, and to other economic benefits for operators in general including SMEs (e.g. modernised equipment, improved reputation and level playing field among operators)	The objective is to reduce pellet losses in an economically proportionate manner, so this is a key impact category. Certain costs could be unbearable for some of the SMEs present in the pellet supply chain thus the need for mitigating measures
Internal market and competition	+	A few Member States are starting to take action to reduce pellet losses	If action is taken at EU level, the functioning of the internal market can be improved (same obligations on every operator, level playing field among them)
End users	-	Measures could negatively affect consumers through price increases.	Measures could negatively affect consumers through price increases.
Third countries and international relations	-	There could be limited effects on countries outside of the EU with both direct and indirect impacts	There could be limited effects on countries outside of the EU with both direct and indirect impacts.
Innovation / technological development / digital economy	?	Research and innovation institutes and industry	Development of a common monitoring methodology and innovative measures to prevent and reduce pellet losses
Social impacts			
Public health & safety	+	Reduced pellet losses lead to improved public health (less polluted food chain) and safety at work (less pellets spilled on the floor)	The objective is to reduce pellet losses and related adverse impacts on public health, so this is a key impact category
Affected populations	+	Reduced pellet losses lead to less negative effects on populations in affected areas	Reducing negative effects on affected populations, e.g. working in tourism, agriculture, fisheries, incl. less clean-up costs and health impacts
Employment	+	Reduced pellet losses lead to more job opportunities in the plastic sector	Estimation of job opportunities
Administrative burden			
Administrative burden on businesses	--	Industrial operators bear the costs of taking action to reduce pellet losses including administrative costs	The objective is to reduce pellet losses in an economically proportionate manner, so this is a key impact category

Public authorities: MS	-	Member State public authorities (at local, regional and/or national levels) depending on pellet responsibilities (activities of data collection, verification, correction and enforcement)	The objective is to reduce pellet losses in an economically proportionate manner, so this is a key impact category
Public authorities: European Commission	-	European Commission depending on pellet responsibilities	The objective is to reduce pellet losses in an economically proportionate manner, so this is a key impact category

The economic impacts are primarily related to the economic costs of implementing the measures, and the environmental impacts are primarily related to the environmental benefits associated with the reductions in pellet losses.

Whilst it is not feasible to quantify or value changes in environmental impacts, reductions in pellet losses will reduce the negative environmental impacts compared to the baseline. In most cases, the reductions will affect emissions to all environmental compartments. Hence, the environmental impacts will be more or less proportional to the reduced losses. There will also be associated changes in GHG emissions, as microplastics releases, including pellets, affect plankton and therefore the absorption of GHG. Similarly, the social impacts, which include possible negative human health effects, are also likely to be affected proportionally to the reduction in pellet losses. It means that all measures have more or less the same types of environmental and social impacts, and only the magnitude differs.

The approach to the assessment of cost impacts draws on evidence identified during the literature review and stakeholder consultations. In many cases, the costs are affected by multiple factors, so the cost estimates presented are generally order of magnitude estimates. Similarly, many factors influence the assessment of the reduction potential and its likely fulfilments, so the assessment provides an order of magnitude of the options.

All calculations are made in relation to the baseline for 2030.

2 Option 1: Mandatory standardised methodology to measure pellet losses

This option proposes a standardised measurement methodology to be used for the reporting on estimates of quantities released on an annual basis, as obliged under REACH. This option would also be beneficial for all the other options as it would allow them to tackle the information failure problem driver and enable their effective implementation.

Environmental impacts

Under this option, there are **no direct reductions of pellet losses, but a standardized methodology to measure such losses will enable relevant actors to tackle them, thus reducing pellet losses to the environment**. The common standard will improve the quality of the reporting on the quantities released (one methodology for all instead of several, different ones) improving the information on the magnitude of pellet losses throughout the pellet supply chain, while also raising awareness among relevant actors as they can measure pellet spills and losses and assess their evolution over time. It is already a necessary step to measure any reduction measure's success rate.

This option will benefit all other options as the magnitude of pellet losses is a critical knowledge gap.

Social impacts

No significant social impacts are expected.

Economic impacts

This option will entail **both costs and savings**. The cost of developing (and testing) the methodology will be one-off and will depend on the time required to develop the methodology. The European Standards Organisation (CEN) typically takes 3-4 years to complete the process, and has mostly members from the industry. It could be seen if the industry bears this cost entirely or if the Commission can support such development through a dedicated study (e.g. the one being conducted for tyre abrasion). The advantage of the latter approach is more likely if the standard has to be taken up in legislation.

When developing the common standard, CEN will take into account the methodology that is being developed under the OCS certification scheme.

Therefore, the cost of this measure will be related to developing a draft method and calibrating it through the data collected by initial monitoring. It will be important to conduct such monitoring along the whole supply chain, viz., from pellets production, conversion and recycling, along with transport and logistic operations between different supply chain steps. Modelling approaches could also be used to validate different scenarios, e.g. the difference between virgin vs recycled pellet products, small production facilities vs larger ones, etc.

Table 53: Assumptions used for calculating the costs of Option 1

Description	Data	Unit	Source
Number of people working full time necessary to elaborate the standard between 12 and 36 months[211]	7.25	persons	ISO website
Mean cost of labour in EU of one expert working full-time	39.5	EUR/hour	Eurostat
Number of hours per week in a full-time job (48 working weeks/year)	40.6	hours/week	Eurostat
Number of companies conducting tests for testing the standard	30	Number	Assumption
Number of experts necessary per company to conduct the tests	1	person	Assumption
Number of hours necessary per company to conduct the tests	24	hours	Assumption

This assessment has estimated the cost of developing the common standard to be between EUR 558 087 (12 months development) and EUR 1 674 263 (36 months development). The testing cost at one facility will cost about EUR 700-1500 per test, depending on the installation size. Assuming that about 1 000 installations will test the standard during the development phase, the testing will cost between EUR 700 000 and 1 500 000. The total would be between EUR 1 258 000 and 3 174 000 (rounded figures). As the common standard would be based on developments under the OSC certifications scheme, it is estimated that the lower end of the cost estimation is more likely.

Once the standard is operational, it will need to be implemented in the value chain. The application frequency and sample size of measuring pellet losses will need to be decided and could depend on company size. The costs for a company will vary depending on the number of installations of the

[211] The ISO sub-committee 14 of the technical committee ISO/TC 61 on the environmental aspects of plastics is comprised of 29 members (the national standardisation organisations).standardization organisation). We assume that each member contributes 0.25 FTE to work on the committee.

company and their size. Furthermore, with time, the application of the standard methodology could be automatised, and costs brought down.

The implementation costs to be incurred by the industry to use the common standard, once this is developed and tested, are already considered under the REACH restriction (as part of the reporting costs) and do not need to be taken into account here. These costs will consist of the costs for the companies to set up specific reporting systems and for the public authority to set up verification and evaluation systems[212]. There is however no concrete information available at this moment on how the reporting obligation under REACH would look like in practise (mainly as it has been voted only recently). Once this information is available, this standardised measurement methodology will need to be coherent with specific requirements.

At the same time, imposing a standardised methodology to measure pellet losses has the potential to save costs on different levels:

- The plastic industry is developing a methodology, however, it is not clear how much such a method would be accepted by the whole value chain. Some partners in the value chain could develop their own methodology. Some Member States might also develop a methodology on their own. Under Option 1, there is only one cost for developing the methodology, and not several.
- More importantly, businesses will have to apply only one methodology in the different parts of the supply chain and in different countries.
- The verification and evaluation of the reporting by the public authority will be simplified.

While it is difficult to do an exact cost-benefit assessment, the cost savings would be higher than the development costs for the standard. These cost savings are fully in line with the Communication COM(2021) 219 final on joining forces to make better laws.

Stakeholder views: Stakeholders generally agree on this option. In the targeted SMEs consultation conducted early 2023, a standardised methodology to measure pellet spills and losses was mentioned by 51% of respondents as a support measure that could best help them to take action to reduce pellet losses. The testing cost of one facility would be about EUR 700 per test, which means a proportionally greater cost for small compared to large companies. However, these costs are already covered under the REACH restriction.

Summary: This is the basis for setting up the framework to measure pellet losses and thus fundamental for monitoring pellet losses and their evolution in the future. It will facilitate and improve the quality of the reporting under REACH, while also raising awareness among relevant actors as they can measure pellet spills and losses and assess their evolution over time. While an exact cost-benefit assessment could not be made, the cost savings are expected to be higher than the development costs of the standard.

Table 54: Summary of impacts of Option 1

Economic impacts	Environmental impacts	Social impacts

[212] For the Committee for Socio-economic Analysis (SEAC), established under REACH, the total costs of reporting could be substantial as the number of companies affected is likely to be large. SEAC considers that there are different options to reduce such costs, e.g. by excluding certain actors (small or micro-sized companies) from the requirement or by setting a threshold for microplastics volumes used or released to be reported. However, SEAC did not draw a firm conclusion on how these different options would compromise the value of information obtained and hence the benefits of reporting in terms of facilitating better risk management.

Cost savings	No environmental impacts but will contribute to better monitoring of losses in other options	No relevant impacts are expected

3 Option 2: Mandatory requirements to prevent and reduce pellet losses in a new EU law

In this option, imposing mandatory requirements and certification for all pellet handling companies is the EU's responsibility. Industry bears the costs of the external auditing and certification. Public authorities in Member States are responsible, in the case of non-compliance, for imposing corrective measures and, where relevant, penalties.

As it is a mandatory approach covering the full value chain with explicit requirements, a certification scheme and a check in case of non-compliance, we estimate that the sector will have a high degree of compliance (95% of the total virgin pellet volume handled) and will be effectively implementing such rules with a success rate ranging from 80 to 95% (meaning that pellet losses would reduce with these percentages).

Economic impacts

In this option, industry costs were calculated based on data input from a survey conducted by the industry. As the data was based on Belgium's experience and on a survey answered mainly by enterprises located in Western Europe, a correction factor was used to apply these costs at the EU level (EU average wage is 29 EUR/h, Belgium average wage is 41 EUR/h). The correction factor was applied to all costs, not only for personnel costs as price levels differ across EU Member States and therefore it would better describe actual additional costs of the measure.

What would be the costs of this option for the sector?

There is little direct information available regarding the costs to companies of taking measures to adhere with best practice handling. Discussions with stakeholders in the course of this IA suggest that the costs of implementing Option 2 could be limited as the plastics industry is already moving towards measures and a system of external auditing and certification based on OCS. Some transporters and other firms in the logistics chain already implement similar measures as best practice from a health and safety standpoint. However, some costs could still be significant for some companies, in particular those that have not introduced any measure to counter pellet losses.

Direct compliance costs for the sector

This option requires that all supply chain actors comply. The cost of this option varies significantly according to the type of actor (producer, converter, transporter, storage, and recycler) in question, and to the size of the installation or company. For example, micro and small companies (which constitute meaning 89% of all converters, but only 20% of turnover) would be significantly affected by the costs incurred by the upgrade of their facilities, the introduction of procedures including internal and external audit and the training of their personnel. There is also a significant number of transport companies needing certification, thus increasing the measure's costs.

a) <u>Producers and Converters</u>

According to estimates from the converting industry, the cost of setting up this option is calculated as described in the table below. The costs of 100t, 1kt, 10kt and >50kt/year presented above represent on average the costs for a micro, small, medium and large converting enterprise. The costs for the micro-enterprises were extrapolated from the three other categories. Large plant costs are also applied to the plastic producers (including virgin and recycled plastics, plastic export and import) as they are generally large companies. This is consistent with the figure of the plastic production (about 1 FTE per 500 kt handled)[213].

Table 55: Potential costs incurred by plastic converters

Type of cost – Type of enterprise	Plant capacity 100 t /year Micro		Plant capacity 1 kt/year Small		Plant capacity 10 kt /year Medium		Plant capacity > 50 kt /year Large	
	Resource	**EUR/ year**	**Resource**	**EUR/ year**	**Resource**	**EUR/ year**	**Resource**	**EUR/ year**
Personnel: dedicated resource	5 persondays/ year @ 303 EUR/day	1 514	20 persondays/ year @ 303 EUR/day	6 055	60 persondays/ year @ 303 EUR/day	18 164	120 persondays/ year @ 303 EUR/day	36 328
Personnel: training of staff	2.5 x ½ persondays/ year = 1.25 persondays @ 303 EUR/day	363	10 x ½ training/year = 5 persondays @ 303 EUR/day	1 514	30 x ½ training/year =15 persondays @ 303 EUR/day	4 541	70 x ½ training/year = 35 man/days @ 303 EUR/day	10 596
Personnel: internal audit	1 personday/year @ 303 EUR/day	303	5 persondays/ year @ 303 EUR/day	1 514	5 persondays/ year @ 303 EUR/day	1 514	5 persondays/ year @ 303 EUR/day	1 514
Cleaning equipment(vacuum cleaners, brooms, shovels)	EUR 4 000 amortised over 6 years	472	EUR 4 000 amortised over 6 years	472	EUR 12 000 amortised over 6 years	1 415	EUR 12 000 amortised over 6 years	1 415
Panels, signage	EUR 3 750 amortised over 6 years	442	EUR 7 500 amortised over 6 years	884	EUR 7 500 amortised over 6 years	884	EUR 7 500 amortised over 6 years	884
Collection and retention trays, containment systems	EUR 5 000 amortised over 6 years	590	EUR 10 000 amortised over 6 years	1 179	EUR 30 000 amortised over 6 years	3 537	EUR 30 000 amortised over 6 years	3 537
Miscellaneous external services (sewer map etc.)	EUR 5 000 amortised over 6 years	590	EUR 10 000 amortised over 6 years	1 179	EUR 10 000 amortised over 6 years	1 179	EUR 10 000 amortised over 6 years	1 179
Cost of auditing (external)		707		1 061		1 061		1 061
Automated transport system								17 683
Sewage treatment systems/ improvement of sewage/ construction	EUR 50 000 amortised over 10 years	3 537	EUR 100 000 amortised over 10 years	7 073	EUR 150 000 amortised over 10 years	10 610	EUR 300 000 amortised over 10 years	21 220
Maintenance cost		354		707		2 829		17 683

[213] Personal communication from a main plastic producer

Type of cost – Type of enterprise	Plant capacity 100 t /year Micro		Plant capacity 1 kt/year Small		Plant capacity 10 kt /year Medium		Plant capacity > 50 kt /year Large	
	Resource	EUR/ year	Resource	EUR/ year	Resource	EUR/ year	Resource	EUR/ year
Cost/year (EUR)	**8 870**		**21 638**		**45 733**		**113 098**	
Cost/tonne (EUR/t)	**88.70**		**21.64**		**4.57**		**2.26**	

The total cost for producers and converters was then calculated based on the volume (tons) of pellets handled by enterprise type.

In the plastic converters industry, there are ca 48 000 enterprises. The breakdown of converters according to the size of the plant in 2019 (in 2021, the shares are similar) has been calculated with Eurostat data and is as follows:

- Micro - 4% of the pellet volume processed
- Small - 16% of the pellet volume processed
- Medium - 36% of the pellet volume processed
- Large - 44% of the pellet volume processed

Although micro-enterprises represent 66% of the enterprises in the processing sector, their overall turnover accounts for less than 4% of the sector. Both Plastics Europe and PRE have confirmed that their members are not SMEs. However, recyclers are generally small installations, even if they belong to a large company.

b) Logistics

Costs for the logistics operators were not available. There are three main parts in logistics:

- Transport,
- Storage or warehouses,
- Cleaning stations.

The cost for these were calculated at enterprise level, based on the basic assumption that the measures needed to be taken by a firm are largely similar and will mostly depend on the size of the firm. As an important part of the cost are related to personnel, it was assumed that a firm with the same number of persons would occur the same cost structure, and this for the main classes: micro-, small, medium and large enterprises. For the storage providers, the same cost as for converters were taken. For the transport providers, there are no costs related to equipment and investments, only to personnel, external auditing and miscellaneous (see the table below).

Table 56: Potential costs incurred by the transport providers per type of enterprise

Type of cost	Micro	Small	Medium	Large
	EUR/ year	EUR/year	EUR/ year	EUR/ year
Personnel: dedicated resource	1 514	6 055	18 164	36 328
Personnel: training of staff	363	1 514	4 541	10 596

Personnel: internal audit	303	1 514	1 514	1 514
Cost of auditing (external)	707	1 061	1 061	1 061
Total	**2 887**	**10 143**	**25 280**	**49 498**

The total costs for transport was calculated based on the number of firms working in the sector. The sector structure of the transport sector (all types of goods - rail, road, water and inland water), according to the number of persons working in the enterprise is as follows [214]:

- Micro - 81% of the transport providers
- Small - 16% of the transport providers
- Medium - 2.6% of the transport providers
- Large - 0.4% of the transport providers

It was assumed that not all micro enterprises in the transport sector will be subject to additional costs under this option for the following reasons:

- There will be a 5 tonnes/year threshold for the requirements, so not all micro enterprises will be concerned.

- After setting up new rules for the pellets transport, it is expected that certain enterprises will no longer transport pellets, especially among micro enterprises, so the costs will not occur. This is even more the case as in transport the size of the micro enterprises seem smaller than in converting (e.g. a one truck company).

- Eurostat data estimates the data on micro-enterprises with "low reliability".

  Therefore we assume that only 50% of the micro enterprises will be concerned with the higher costs under this option.

Based on the transport sector input, about 50 large companies are dealing with pellets, all members of the European Chemical Transport Association (ECTA). Starting from this figure, the assumptions above, and assuming that the transport of pellets follows the same division of enterprises as the total transport, the number of enterprises per size could be calculated, and therefore the costs for the transport sector.

Based on these calculations, it results that about 4-5% of the transport companies are working with pellets. We assume that a similar part and enterprises structure for the storage providers or warehouses (NACE H 52.1) who are dealing with pellets.

There will be no additional costs for tank cleaning stations as the ones, who are dealing with pellets, are already complying with SQAS which has similar requirements. The profile of these tank cleaning stations is the following:

[214] Eurostat 2021: Nomenclature of Economic Activities (NACE) codes were included – H 49.2 - Freight rail transport, H 49.4 - Freight transport by road and removal services and H 50.4 - Inland freight water transport. Data for H 50.2. Sea and coastal freight water transport was not available by Eurostat. For inland water transport, the same structure as for rail transport was assumed.

Table 57: Enterprise structure of cleaning stations (enterprises)

Number of employees	Number	% over Total
Less than 10	300	68
10-50	125	28
More than 50	15	4
Total	**440**	**100**

It is still possible that additional external auditing would be needed. An audit costs around EUR 707 for a micro-enterprise, and EUR 1061 for small and medium enterprises. In that case, the cost would be:

440 warehouses x (68% x 707 EUR + 32% x 1061 EUR) = 224 587 EUR

Based on the above, we estimate that, ca 13 000 transport providers, 850 storage or warehouse providers and 440 cleaning stations are dealing with pellets and will be affected by the requirements.

Note: The analysis is done using a rough estimate of the costs per tonne. However, to deal with pellet losses, both investments (fixed costs) and variable costs will depend on the progress made by companies in the meantime through their voluntary commitments. The upfront investment costs will be relatively more important for SMEs, especially for micro-enterprises than for other enterprises. Micro-enterprises could therefore merit receiving special attention.

Costs taken up in the base line

As the industry has already started implementing some of the proposed measures through their voluntary programs, such as OCS CS and RecyClass, some of these costs will already be incurred in the business-as-usual scenario, i.e. under the baseline. We use the following volume assumptions for the costs incurred under the baseline:

- about 70% (referring to the efficiency rate of loss reduction) of the 90% of the total virgin pellet volume produced (by the members of Plastics Europe) and 5% for the non-Plastics Europe members;
- about 50% (referring to the efficiency rate of loss reduction) of the 20% of the total recycled pellet volume produced;
- 50% (referring to the efficiency rate of loss reduction) of the 30% of the total volume processed; and
- 30% (referring to the efficiency rate of loss reduction) of the 40% of the total volume handled by logistics companies (transport – storage).

These values are based on the ones used to estimate the baseline. Where, in the baseline, a lower and higher boundary were proposed, the average value was taken here.

Stakeholder views: When consulted in the framework of the open public consultation (Annex 2), stakeholders agreed that there is improper handling of pellets. The umbrella association of European converters, EuPC, pointed to limited resources as a barrier to implementing voluntary measures under the industry-driven OCS programme. More recently, the umbrella association of European manufacturers, PlasticsEurope, agreed the most effective approach to tackling pellet losses is mandatory external auditing and certification building on OCS and applied to all actors throughout the supply chain. Producers therefore considered a legislative proposal requiring certification of an OCS-like pellet loss prevention management system would be very quickly implementable throughout the whole supply chain because it would benefit from the existing industry initiative and would reinforce it.

A second consultation targeting all SMEs handling pellets was conducted from January to February 2023 in all EU languages (Annex 12). Based on the 330 replies received, it emerged that for a majority of respondents, only a lighter version of requirements could be imposed on such companies. Specifically, they reported that the requirement on the training of staff should be made mandatory in the same way for all companies, but the obligation of being externally audited and certified should not be imposed at all on SMEs. The survey also indicated that the direct economic impacts of this option would be too high to be sustainable for micro and small companies, as well as companies with capacities below 1000t. Among the various best handling practices, the mandatory use of specific equipment and of specific packaging (i.e. airtight, puncture-resistant and environmentally sealed) was identified as the most expensive measure. Generally, the cost per tonne of the measures to be implemented would become insignificant for companies with capacities above 5000t. Finally, financial support and standardised methodology to measure pellet losses were identified as the support that would best help respondents.

In light of the above, three sub-options have been considered and assessed in the form of lighter requirements for the micro, small and medium companies present in the pellet supply chain (see table below). A derogation for companies making and handling pellets in quantities lower than 5 tonnes will also apply in all scenarios. Such an approach will avoid requiring costly investments which would only deliver very limited environmental benefits in terms of pellet loss reduction.

These lighter requirements are also justified following the principle of proportionality and the need to match the nature and intensity of a given measure to the identified problem.

Sub-options "Lighter requirements for micro-, small- and medium-enterprises"

From the calculation above, it is clear that the relative cost for an SME are higher than for large companies. It was therefore estimated that lighter requirements would be needed to alleviate a part of these costs. This is also consistent with the replies and request received through the stakeholder consultations.

The lighter requirements assume that:

- There will be no requirement for a sewage treatment system and maintenance;
- Certification requirements will be reduced to 5 years for micro-enterprise and 3 years for small ones; and
- A reduction of 10% reduction of personnel costs.

With these reduced requirements, we assume that the pellet loss will be 35% higher for converter and 20 % for logistics (for transport, there is no sewage treatment system, thus neither related requirements) from these companies than under the main scenario. This assumption means that the other requirements are still the most important ones to reduce pellet losses, but that there is already a significant increase in pellet loss.

Table 58: Costs for lighter requirements for micro, small and medium sized companies for typical plant capacities

Type of cost **Type of enterprise**	**Plant capacity 100 t /year** **Micro**		**Plant capacity 1 kt/year** **Small**		**Plant capacity 10 kt /year** **Medium**	
	Resource	**EUR/year**	**Resource**	**EUR/year**	**Resource**	**EUR/year**
Personnel: dedicated resource	10% lower than main option	1 362	10% lower than main option	5 449	10% lower than main option	16 384
Personnel: training of staff		327		1 362		4 087
Personnel: internal audit		272		1 362		1 362
Cleaning equipment (vacuum cleaners, brooms, shovels)	Same as main option	472	Same as main option	472	Same as main option	1 415
Panels, signage		442		884		884
Collection and retention trays, containment systems		590		1 179		3 537
Miscellaneous external services (sewer map etc.)		590		1 179		1 179
Cost of auditing (external) (normally every year)	Every 5 years	141	Every 3 years	354	Every 3 years	1 061
Sewage treatment systems/ improvement of sewage/ construction	No sewage treatment		No sewage treatment		No sewage treatment	
Maintenance cost	No maintenance cost		No maintenance cost		No maintenance cost	
Cost/year (EUR)		**4 196**		**12 242**		**29 872**
Cost/tonne (EUR/t)		**41.96**		**12.24**		**2.99**

As with the main option 2, the equivalence for the logistics sector is made.

The cost of implementing Option 2 would be 742 and the sub-options 2a, 2b, and 2c would be 615, 516 and 479 million EUR/year respectively.

The cost-effectiveness of the options range from **2672 EUR/tonne avoided** per year to **26 342 EUR/tonne avoided** per year, depending on the sub-option and the lower/higher estimation of losses.

The cost of measures under option 2 and its sub-options vary between sectors (see table below).

Table 59: The cost of measures under option 2 and sub-options 2a, 2b and 2c for the value chain (M EUR/year) (without taking the savings into account)

	Option 2	**Option 2a**	**Option 2b**	**Option 2c**
Plastic converters	616.36	497.70	402.29	365.51
Plastic producers, including recyclers	65.92	65.92	65.92	65.92
Transport providers	51.32	45.42	42.99	42.41
Storage providers	8.12	5.88	5.13	4.68
Total	***741.72***	***614.92***	***516.32***	***478.51***

Table 59 shows the costs for the different parts of the value chain. However, this does not yet take into account the benefits of the pellets saved, which are quite important, see the following table, which is only done for option 2b.

Table 60: Summary of impacts in 2030 of Sub-option 2b per part of the supply chain

	Plastic converters	**Plastic producers, incl. recyclers**	**Transport & storage**	**Total**
Cost of the measure (M€/y)	402.3	65.9	48.1	516.3
Savings from pellet losses (M€/y)	10.1 - 40.7	2.4 – 16.2	16.1 – 91.3	28.6 – 148.3
Net cost to business (M€/y)	375.7 – 491.2*			

* It is not possible to calculate the net cost for each part of the supply chain as it is not clear who benefits exactly from reduced pellet losses. This depends on who owns the pellets and can valorise the savings from less pellets lost. This is not known for the pellets in transport and storage.

The additional costs are likely to negatively impact the competitiveness of the EU pellet producers as their competitors outside the EU will not be affected. According to EuPC the turnover of the plastics sector in the EU27 in 2021 was EUR 405 billion[215]. Therefore, this additional estimated cost of option 2b would represent about 0.13% of the EU plastics sector turnover and would only have a very minor impact on the competitiveness.

What would be the cost for the public authorities?

The costs arising will depend on the manner it is implemented in Member States. The focus is on administrative costs, i.e. procedures to follow, monitoring, delays, complaint-handling mechanism, access to justice, etc. Further costs can be related to competent authorities for the setting up of the system, i.e. one-off costs at the beginning as well as some costs for the maintenance of the system and compliance promotion, such as awareness raising, information to stakeholders, training of officials, developing and providing of guidance and capacity building of public authority officials and enforcement actions. However, it may not be necessary to set up a new system in Member States as some of these mechanisms already exist through other legislation, such as IED, Environmental Liability Directive, Environmental Crime Directive, UWWTD, and synergies could be achieved by integrating some of the costs for public authorities related to pellet losses. These costs vary

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significantly across Member States depending on the current situation on implementing environmental legislation.

Further to that, it could be envisaged that the public authorities in the Member States would be required to hold a public register of certified companies to ensure full transparency and traceability of the supply chain, including to ensure compliance with the requirements. This registry could done through an existing system to lower the costs. This would imply separate minor reporting costs (EUR 188 000 per year) for the economic operators (notifying the public authority about the outcome of the external auditing, as the reporting on the pellet losses to ECHA already will be required), and processing costs for the public authorities in the Member States. Also, there might be minor additional costs related to reporting obligations to the Commission to ensure compliance with the regulation as the Commission could assemble such system. However, this would be a minor task for Member States as they would have necessary data in the registry.

About 50 person days in average would be needed to set up the system for receiving the notification from the companies, about 20 days each year for compiling and quality assurance and appropriate follow-up measures (e.g. enforcement) for each Member State. Using average Eurostat wages (EUR 29/hour), we can estimate the processing costs, including data collection, verification, correction, and enforcement to be EUR 313 000 (total annualised one-off administrative costs of EUR 36 700, discounted at 3% over 10 years) for the first year and EUR 125 000 per year for the whole EU. These cost will vary across Member States as it would be higher for larger ones and lower for smaller ones.

What would be the benefits for the sector?

For businesses owning the pellets, this option could reduce the estimated economic loss of EUR 42 – 170 million coming from about 42 050 – 170 266 tonnes per year tonnes of pellets lost in 2030 (1000 EUR/t, mainly coming from less pellets lost by logistics, but also by producers and converters as described in Table 48 in Annex 9). (Prices of plastics are fluctuating and depend on the exact polymer type and the stage of processing).

Benefits for SMEs from implementing the BSI PAS (a system with similar requirement in the UK to reduce pellet losses) were reported to be:

- modernised equipment thanks to grants they secured;
- less legacy pellet pollution, which had previously been extensive around the sites;
- reduced waste (and lower waste management costs);
- improved staff awareness and training;
- reduced fire risk because proper and regular site assessments revealed build-up of dust in areas previously unchecked;
- involvement of suppliers/customers – all site visitors are required to read and accept rules relating to proper pellet management; and
- Improved reputation.

What would the benefits of this option be for the economy at large and society?

Under this option, reducing pellet losses may have positive knock-on economic impacts on sectors such as tourism. In some coastal areas (such as in the vicinity of Antwerp and Tarragona ports[216]),

[216] https://surfrider.eu/wp-content/uploads/2020/11/report-pellet-pollution-2020.pdf

pellets can be found in significant quantities including in protected areas[217]. Their removal would reinforce the attractivity of these areas for tourism purposes.

Similarly, the reduction of pellet losses into the environment may have positive knock-on economic impacts on commercial fishing and agriculture, in areas where these activities are particularly affected by the releases with significant harm to ecosystems and biodiversity. In particular, there will be fewer pellets lost into the marine environment and, thus, fewer perturbations to all marine organisms, including economically important organisms such as oyster and seabass[218]. Considering that the ecosystem services provided by the Ocean are estimated to be worth over USD 24 trillion, the regulation of microplastics and the protection of marine ecosystems and habitats seems to be of significant importance[219]. Similarly, there would be fewer pellets lost in the installations' wastewater and in the sludge resulting from their treatment. Consequently, there will be less pellets lost to the soil after sludge application on agricultural land.

Benefits also include avoided costs to society. Cleaning up pellet pollution and remediation measures can cause harm to ecosystems as it is almost impossible to specifically remove them without affecting the environment they are spilled into[220]. They are also challenging to local communities in terms of technological, human and financial resources. For example, it was estimated that beach clean-ups cost the city of Marseille (France) an average of EUR 1 000 000 per year[221]. KIMO Netherlands reported that the clean-up costs of the 2019 pellet spill of the MSC Zoe in the Wadden Sea would be approximately EUR 100 000 annually[222]. These are obviously only examples. Even if there are no figures available, the sum of the clean-up costs for the whole EU shore should be much higher.

By applying the costs of the clean-up operations of the 2017 MSC Susanna loss in Durban, South Africa, (where 35.8 tonnes of pellets were collected over the period of the operation) to an EU context, each tonne of pellets on average costs EUR 1.21 to EUR 1.82 million to collect.

Environmental impacts

As this option requires that all actors of the supply chain comply with mandatory requirements and certification (with the only exception of companies making and handling pellets in quantities lower than 5 tonnes), the main expected environmental impact from this option is a **significant reduction of pellet losses** that are likely to be harmful to ecosystems and biodiversity and may affect human health.

The overall reduction is expected to be **between 27 128 tonnes/year (low emission scenario) and 148 879 tonnes/year (high emission scenario)**, representing a 65% and 87% reduction overall, respectively (compared to the baseline). It will also save annually 106 – 583 of GHG emissions in kilotonnes of CO2 equivalent [223].

When providing for lighter requirements for the **smallest or micro-enterprises**, the reduction of pellet losses ranges from **26 730 tonnes/year to 147 227 tonnes/year** (105 – 576 ktCO_2e). With lighter requirements for the micro and **small enterprises**, the reduction of pellet losses ranges from

217 The unaccountability case of plastic pellet pollution - ScienceDirect

218 Zhu, X. et al. (2020) 'Bioaccumulation of microplastics and its in vivo interactions with trace metals in edible oysters', Marine Pollution Bulletin, 154, 111079. doi: https://doi.org/10.1016/j.marpolbul.2020.111079 83 Barboza, L.G.A et al. (2018) 'Microplastics cause neurotoxicity, oxidative damage and energy-related changes and interact with the bioaccumulation of mercury in the European seabass, Dicentrarchus labrax (Linnaeus, 1758)', Aquatic Toxicology, 195, pp. 49-57. doi: https://doi.org/10.1016/j.aquatox.2017.12.008.

219 WWF Report 2015; Reviving the ocean economy

220 UN Environment; Marine Litter - Socioeconomic Study, 2015

221 OSPAR Background document on pre-production Plastic Pellets 2018

222 Fishing for Litter fleet cleans up after MSC Zoe but who pays the costs? – KIMO (kimointernational.org)

223 Calculation is based on the report "Plastic leakage and greenhouse gas emissions are increasing - OECD"

25 142 tonnes/year to 140 621 tonnes/year (98 – 551 $ktCO_2e$). **Similarly,** with lighter requirements for micro-, small and **medium-enterprises**, the reduction of pellet losses ranges from **21 569 tonnes/year to 125 757 tonnes/year** (84 – 492 $ktCO_2e$).

Social impacts

This measure will require additional staff to prevent pellet losses and for training. Applying the same assumptions made on the share of the volume between small, medium and large factories, implementing the measure would need from 3772 to 4103 FTE personnel.

Since this option may increase the cost of plastic raw materials, the general public may be impacted by an increase in the cost of plastic goods. Since plastic is used everywhere, any increase in its cost will be felt in society. However, the cost increase is likely to be limited as the cost of the measure is small compared to the turnover of the sector. For large companies, in particular, it is possible that the manufacturer would absorb such a slight increase in its production costs and that consumers would be unaffected.

Summary: The introduction of mandatory requirements and certification would result in significant reductions of pellet losses. The more losses are avoided, the greater the positive impacts are for the environment and for economic activities like commercial fishing, agriculture, tourism and recreation. the costs incurred by the sector under Option 2 and its sub-options (without micro/without micro and small companies/ without micro, small and medium companies) may increase the cost of plastic goods produced and/or converted in the EU. There would be a cost for public administrations as they would be in charge of monitoring its implementation, but this would be via a unique instrument i.e. a public register of certified companies.

This option has less risks as to the probability of reaching the objectives and massively reduces the number of free riders. The system is set up in a way to limit public costs as it involves third party auditing and certification. The possibility of a public register of certified companies at national level would further increase the transparency and traceability of the supply chain, with limited processing costs for the public authorities in the Member States.

Costs for business are expected to be higher in the beginning as some investments need to be done and go down afterwards. There will also be a learning curve reducing costs later on.

Table 61: Summary of impacts in 2030 of Option 2 and its sub-options 2a-2c

	Option 2	**Option 2a: Lighter requirements for micro-enterprises**	**Option 2b: Lighter requirements for micro-and small enterprises**	**Option 2c: Lighter requirements for micro-, small and medium-enterprises**
Environmental impacts (i.e. reduced pellet losses) (tonnes)	27 128 – 148 879	26 730 – 147 227	25 142 – 140 621	21 569 – 125 757
Environmental impact (GHG emission savings) (tonnes of CO_2 eq)	106 210 – 582 890	104 655 – 576 424	98 437 – 550 560	84 446 – 492 366

<table>
<tr><th></th><th>Option 2</th><th>Option 2a: Lighter requirements for micro-enterprises</th><th>Option 2b: Lighter requirements for micro-and small enterprises</th><th>Option 2c: Lighter requirements for micro-, small and medium-enterprises</th></tr>
<tr><td colspan="5">Economic impacts</td></tr>
<tr><td>Cost of the measure (M EUR/year)</td><td>742</td><td>615</td><td>516</td><td>479</td></tr>
<tr><td>Savings from the pellet losses (M EUR/year)</td><td>27 - 149</td><td>27 - 147</td><td>25 – 141</td><td>22 - 126</td></tr>
<tr><td>Net cost to businesses (M EUR/year)</td><td>593 - 715</td><td>468 - 588</td><td>376 - 491</td><td>353 - 457</td></tr>
<tr><td>Cost-effectiveness (EUR/tonne/year)</td><td>3 982 – 26 342</td><td>3 177 – 22 005</td><td>2 672 – 19 536</td><td>2 805 – 21 186</td></tr>
<tr><td>Savings from GHG emission (MEUR/y)^</td><td>11 – 58</td><td>10 – 58</td><td>10 – 55</td><td>8 – 49</td></tr>
<tr><td>Other economic impacts</td><td colspan="4">Public Administrations: increased costs for data collection (i.e. public register) and overall monitoring of the implementation, intervention in case of non-compliance (i.e. enforcement of the sanctions)
Citizens: limited increase of the cost of plastics goods
Tourism and recreation: increased attractivity through the reduction of pellets in coastal areas and other vulnerable areas
Fisheries: fewer pellets released in water and improved ecosystem services due to fewer pellets absorbed by marine organisms and animals in areas affected
Agriculture: fewer pellets released on soils and improved ecosystem services due to fewer pellets affecting soil properties in areas affected</td></tr>
<tr><td>Other environmental impacts</td><td colspan="4">Society: fewer costs related to clean up and remediation activities by local communities in affected areas</td></tr>
<tr><td>Social impacts (jobs in FTE)</td><td>4103</td><td>4004</td><td>3858</td><td>3772</td></tr>
</table>

Note: 1 tonne of CO^{2} estimated value is 100 EUR€/t. Therefore, it can add 8 – 58 M EUR€/year in savings.

* Net cost: cost – savings. In every option there are 2 scenarios of the projection of the pellet losses. Therefore, higher pellet loss reduction refers to lower costs and vice versa.

4 Option 3: Improved packaging for logistic of pellets

This option targets in particular the logistics sector operators to prevent losses from transport, intermediate storage and handling during these operations. The option imposes the use of specific types of bags and containers for pellet handling, transport and storage and, where relevant, product design measures. It can be set up as an independent piece of legislation or can be implemented as part of the legal proposal in Option 2.

What would be the costs of this option?

Current packaging materials used to transport pellets are:

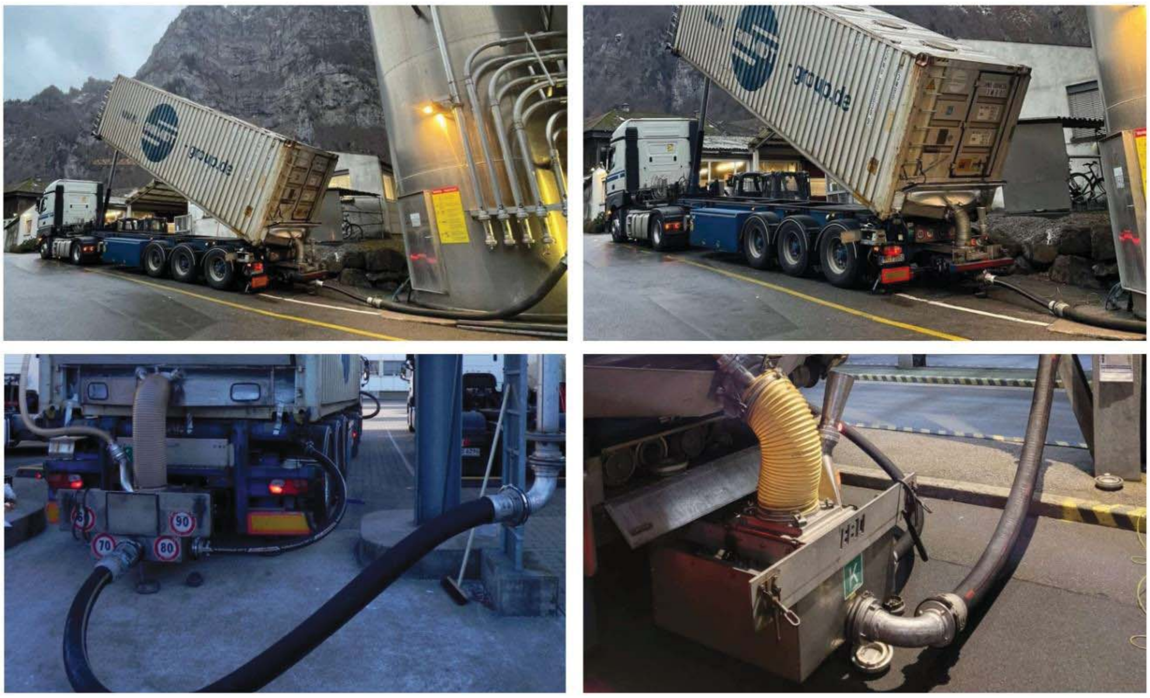
- plastic bags (containing up to 25kg of pellets) stacked on pallets with a total weight of up to 1.5 tonnes;
- octabins (cardboard containers containing between 0.5 and 1.3 tonnes of pellets);
- big bags, containing from 0.5 to 1 tonne of pellets;
- containers, containing up to 25 tonnes of pellets; and
- silo trucks, containing up to 35 tonnes of pellets.

These different packaging materials do not present the same pellet loss risks, with plastic bags holding the most risk for pellet losses and silo trucks the least. As shown in the figures below, silo trucks have airtight suction mechanisms and the loading and unloading of these trucks leave little room for pellet spills, but if they are spilled, then they are collected for disposal.

Figure 12: Loading pellets into a silo truck

Source: Schmidt-heilbronn Company

Figure 13: Unloading pellets from a silo truck



Source: Schmidt-heilbronn Company

The costs of imposing specific packaging and accompanying measures could be potentially high, especially for producers, who may have to change their production lines since plastic bags are automatically filled on-site through their own manufacturing chain. Similarly, logistics operators will have to adapt their transport and storage approaches depending on the type of packaging.

Plastic bags are the packaging materials which would be targeted first because of their poor resistance to tears during operations. In its background document on pre-production plastic pellets[224], OSPAR mentions that plastic bags and octabins could be replaced with reusable rigid HDPE barrels or with intermediate bulk containers (IBC). IBC Containers' pricing ranges from EUR 165 up to 4500 [225] while HDPE barrels are cheaper and cost between EUR 13 to 40[226] depending on their specifications e.g. size, material, and type of opening. Replacing existing machinery and processes might also generate extra costs. Another approach could be to use thicker plastic bags which are more resistant to tears.

[224] OSPAR Commission, Background document on pre-production plastic pellets, 2018, https://www.ospar.org/documents?v=39764. Accessed 12 Apr 2022.

[225] www.ibctanks.com/chemical

[226] www.hasdrums.com.sg

Figure 14: Returnable rigid HDPE barrels

Figure 15: Intermediate bulk containers (IBC)

The IMO Correspondence Group on Marine Plastic Litter from Ships that is looking at how to reduce the environmental risk associated with the maritime transport of plastic pellets considered packaging provisions for plastic pellets carried at sea as primary measures to take forward for further assessment.

However, they acknowledge the high cost of this measure to the industry because production facilities are already fitted with bagging lines to package pellets. The bags have several advantages over the rigid containers and the IBC because they enable flexibility in the size of shipments and prevent dust contamination. Bags are also more suitable to fill up means of transport, and therefore increase freight loads. This reduces the number of freights so GHG emissions and transport costs would be lower when using bags.

Data is lacking on:

- the volume of pellet losses due to packaging in general and specific packaging types, and the share of these losses in the overall pellet loss estimates;
- the market shares of the different types of packaging used for pellet transport; and
- the cost difference between actual packaging and improved packaging.

What would be the benefits of this option?

This option could potentially significantly reduce pellet losses during transport and intermediate storage, as well as handling during these operations. Also, with increased efficiency in their processes, the sector would gain from the investments. However, no quantification could be made to estimate the losses due to torn plastic bags or octabins.

Economic impacts

Due to important data gaps, it was not possible to quantify the direct investment and compliance costs for the sector deriving from this option.

The cost of this option would probably be high, relative to turnover, but so could the gains in terms of pellet loss prevention. However, the cost per tonne of pellet losses avoided is expected to be higher than with Option 2 because it will force the industry to overhaul their production lines to effectively remove the bagging lines and replace for instance plastic bags with returnable rigid HDPE barrels or with intermediate bulk containers IBC. Imposing thicker more resistant plastic bags could lower such costs. However, as all these solutions mainly represent an investment cost, smaller enterprises would be affected more than bigger ones respective to their size.

Environmental impacts

This option would yield positive environmental impacts by reducing pellet losses to the environment; however, it can also increase CO2 emissions. Indeed, rigid HDPE barrels and IBC do not offer the same flexibility as plastic bags. When not entirely filled up with material, they increase storage volume for a given quantity of material, increasing the CO2 emissions incurred by transport. If thicker bags would be chosen, there would only be a minor increase of GHG emissions (As thicker bags are used, there is an increase in the amount of plastics used for the bags. This is expected to be minor compared to the GHG emissions from transport).

Social impacts

There are no social impacts foreseen for this option. However, moving towards more automated solutions like silo trucks could reduce the number of jobs (more workforce is needed for manual loading and unloading of pellet containers/bags).

Stakeholder views: While there is no precise information available on the proportion of pellet losses that can be attributed to poor quality packaging, NGOs often emphasise its relevance. Industry seems less convinced, especially in light of the expected high costs of improved packaging. The umbrella association of European manufacturers, PlasticsEurope, considers that more robust packaging of plastic pellets or prohibiting certain types of packaging does not address the root cause of the problem, and is not an effective alternative for excluding the transport sector or any other sector in the plastic supply chain from mandatory provisions.

In the second consultation conducted early 2023 targeting all SMEs handling pellets (Annex 12), respondents consistently reported the potential high costs of changing the packaging structure. In particular, it emerged that while two-thirds of respondents consider the use of specific packaging effective to reduce pellet losses, only 54% do it always or often (and a third never does it or has no opinion). Views on whether this should become a mandatory requirement are mixed: 33% in favour, 20% in favour if lighter requirements for SMEs, and 27% against, while the use of specific packaging is estimated as the most costly measure both in terms of person/days and euros/tonne/year. Financial support was identified as the form of support that would best help respondents, along with a standardised methodology to measure pellet losses.

Summary: The use of more resistant packaging materials and spill-proof packaging options would reduce pellet losses throughout the supply chain. However, the impacts differ according to the type of improved packaging chosen. While switching out plastic bags for barrels would likely present a greater reduction in losses, it would also increase the GHG emissions and costs of transport, in addition to require greater investment costs (as infrastructure will need to be replaced). Opting for thicker more resistant plastic bags would avoid these investment costs and allow for greater volumes to be transported per unit of transport. This option could be incorporated into a more comprehensive set of requirements, such as those laid out in option 2. There was not enough data to be able to calculate the precise costs, but it was estimated that the cost effectiveness of this option would be lower than for option 2.

5 OPTION 4: EU TARGET TO REDUCE PELLET LOSSES

An emission reduction target for pellet losses will be set under this option. The target can be ambitious as the plastic production and conversion industry responsible for the OCS certification scheme believes that a 95% reduction of losses in their facilities is achievable. While this seems correct if all firms would implement, it is not clear if this would be realistic, and if this 95% target is achievable for the whole sector.

This option can only be implemented if a measurement standard for pellets losses is developed (Option 1). It would also be useful to gain more knowledge before its implementation, which can be done through the REACH reporting requirement. A new piece of legislation could be used to create and enforce a pellet loss reduction target, but it could also be integrated into Option 2.

The target could be set either for the whole plastics industry, or at sector level allowing the supply chain to optimise processes to achieve the target. In the latter case, there could be differentiated targets depending on the place in the value chain.

An emission target mechanism could be set up to define and enforce the target by:

- Setting a maximum volume of pellets which can be lost either per unit of pellet produced/converted/transported in mg/kg or setting a maximum quantity of pellets which can be lost to the environment; or
- Setting a maximum percentage of the production volume that can be lost, enforced by measuring the content of catchment devices (e.g. filters) part of the plants' containment systems and sampling on the plant's premises and vicinity.

A more sector-oriented approach would require a kind of clearinghouse which would report the pellet losses every year, as well as close cooperation and engagement from all actors throughout the supply chain, which is not the case today. (For instance producers and processors are discussing together the implementation of the OCS certification scheme, but recyclers and logistics operators are still external to the process. Also, they all have different strategies, ambitions, and means to tackle pellet losses).

Whatever the approach, the thresholds will need to be refined after additional data is gathered from, for example, the REACH reporting requirements. Building on the results of this first monitoring exercise, it will be possible to define an achievable threshold for pellet losses.

Enforcement will be the main difficulty in this option; indeed, sampling protocols for pellet losses are in development, and there are currently no standards to do so.

This is a medium to long-term option, which should be in phase with the time necessary to identify the relevant threshold. Indeed, the REACH restriction on intentionally added microplastics was adopted on 25 September 2023.[227] In this restriction, the reporting on estimates of quantities released is proposed, but there are some limitations, as identified by Rethink Plastic Alliance[228] in their position paper:

- The ECHA restriction does not require the industry to report the tonnages handled, yet, this would help define a spill rate, which would be useful in defining a possible threshold;
- The ECHA restriction does not provide minimum requirements for the reporting on estimates of quantities released, but having this information would be essential to provide comparable data; and
- The entry into force of the reporting requirement takes a long time. In view of voluntary

[227] Commission Regulation (EU) …/… amending Annex XVII to Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles.

[228] Rethink Plastic alliance, PLASTIC PELLETS UNDER REACH: Strengthening requirements to enable effective supply chain legislation, Position Paper, March 2021, https://rethinkplasticalliance.eu/wp-content/uploads/2021/04/plastic_pellets_under_reach.pdf Accessed 14 April, 2022.

initiatives, which will include reporting, that the plastic pellet supply chain is putting in place, the Restriction now includes a 24-month transitional period for the reporting requirement.

The ECHA reporting requirement could be used to define a threshold for pellet emissions to the environment; however, it may need some improvements depending on the decisions to come regarding the comments made to the proposal. It will also need some more years before the data becomes available.

Once the threshold is defined, it could be possible to include it in legislation.

What would be the costs?

The cost of setting the emissions reduction targets would depend on the measurement standard developed to measure pellet losses accurately. Once developed, the standard would need to be applied over 12 to 36 months to generate a statistically strong database with and without implementing prevention, mitigation and clean-up measures. The target could be defined as the result of this observation phase.

The implementation of the targets are expected to generate the same or similar costs as the requirements under option 2. Similarly, lighter requirements would be needed for for SMEs, especially for micro and/or smaller firms to mitigate concerns raised by SMEs (e.g. lack of staff/time, lack of information on risks and solutions and lack of financial resources – see Annex 12). The follow-up costs might be higher than under Option 1 as a more stringent system would need to be set up.

What would be the costs for the public authorities?

The costs of applying the emission reduction targets through legislation would be similar as those under Option 2.

What would be the benefits?

Pellet losses would be similar as in Option 2. As discussed earlier, this will only be achieved in the medium to long term as it requires adopting a methodological standard for the quantification of pellet losses, as well as its testing in various sites of different sizes over a significant period (minimum of 12 months). This option, independently from Option 2, only looks at the objective, and not at the means to achieve it. The measurement and follow up of such spills and losses will not be feasible without having the methodology (Option 1).

Therefore this measure is not favoured in the short term.

Economic impacts

The economic impacts of this option will be on the pellets value chain. The cost to adapt procedures and sites would be comparable to Option 2 as similar prevention, mitigation and clean-up measures would be implemented. However, accurate monitoring following the measurement standard developed under Option 1 would be needed to ensure that the emissions targets are respected (not included in Option 2 which focuses on requirements and certification). Also, the public authorities in Member States will bear additional costs for compliance and enforcement.

Environmental impacts

Environmental impacts will depend on the already avoided losses through measures such as Option 2 or Option 3, but also on the ambition level set. As compliance checks and verification is estimated to be more difficult, they are expected to be slightly lower than in option 2.

Social impacts

The main social impact is additional job creation mainly for the industry, and some for the competent authorities, again relatively similar to option 2.

Stakeholder views: This option was not discussed by the stakeholders in detail. It was however mentioned that setting up a performance monitoring system, essential for such as system, would be costly.

Summary: Defining an EU emission reduction target for pellet losses, once a mandatory standardised methodology has been developed, tested and applied, can significantly reduce pellet losses as it requires preventive, mitigation and clean-up measures to be taken. However, this option, in contrast with Option 2, only looks at the objective, and not at the means to achieve it. Implementation and enforcement by the Member States seem more challenging than in Option 2. As this option requires a performance monitoring system first, its implementation would take time. Therefore this option is not favoured in the short term.

6 SUMMARY OF THE IMPACTS

The table below illustrates the economic costs of implementing the measures and the environmental benefits of reducing pellet losses for the four options assessed. Other impacts (costs and benefits) are also presented.

Table 62: Summary of impacts for the four options

	Impacts			Assessment and considerations		Benefit - cost
	Env	Eco	Soc	Cost		
Option 1	(+)	(+)	0	(+)	A mandatory standardised methodology benefits all other options, implying (development and testing) costs for the sector. It will result in cost savings as only one method needs to be developed and applied, also leading to lower verification costs.	**High**
Option 2	+++	+	+	---	Mandatory requirements and certification have the highest reduction in pellet losses, with the highest direct compliance costs for the sector.	**Medium**
2a	+++	+	+	--	The reduction of pellet losses is still very high, but costs are lower than under Option 2 thanks to lighter requirements for micro-enterprises.	**Medium**
2b	+++	+	+	-	The reduction of pellet losses is still very high, and costs are lower than under Option 2a thanks to lighter requirements for micro- and small enterprises.	**High**
2c	++	+	+	-	The reduction of pellet losses is lower than under the other sub-options, and costs are only slightly lower than under Option 2b due to lighter requirements for micro-, small, and medium-enterprises.	**Medium**
Option 3	+	-	0	--	Improved packaging reduces pellet losses throughout the supply chain (not quantified), but generates more GHG emissions (subject to the packaging type), while entailing potentially quite high investment costs for the sector.	**Medium - Low**
Option 4	++	+	+	---	An EU emission target has potentially a high reduction of pellet losses, as operators have to adopt preventive, mitigation and clean-up measures, but the enforcement might be challenging. Its costs are comparable than those of Option 2. As it depends on Option 1, it can only be implemented afterwards, leading to a delay in implementation time.	**Low**

Annex 12:
Impacts on SMEs

1 IDENTIFICATION OF AFFECTED BUSINESSES

This initiative focuses on the unintentional release of microplastics from plastic pellets. Among pellet producers, the exact number of SMEs is not known because, in Eurostat, the statistics per enterprise size are aggregated in a broader category including basic chemicals, fertilisers, plastics and synthetic rubber[229]. In this broader category, SMEs account for 24% of the total turnover. As to pellet converters, according to Eurostat[230], there are 47 710 companies manufacturing plastic products, out of which 31 400 are micro-enterprises (66%), 15 410 are small companies and medium-sized companies (32%), and 900 are large companies (2%). In terms of turnover, the micro-enterprises represent about 4%, while small companies and medium-sized companies account for 52%, and the large ones for 44%[231]. In addition, for the transport and storage sector in the number of companies (based on Eurostat 2021 data, see calculation in annex 11): 0.4% large are large enterprises, 3% medium, 16% small and 81% micro.

Regarding plastic producers, large enterprises represent 76%, while medium-sized enterprises 22% and small enterprises 2% (note: Plastics Europe estimates that there are only large firms). Among the 730 plastic recycler companies in Europe, half of them are SMEs, and there are several micro-enterprises.

2 GENERAL CONSULTATION OF SMES

The Commission first consulted SMEs through its open public consultation covering six sources, including pellets. The consultation period started on 22 February 2022 and ended on 17 May 2022, lasting 12 weeks. Among the respondents from businesses (about 67% of the 411 respondents) to the open public consultation, 85 were micro, 54 small and 36 were medium-sized enterprises. The closed-ended questions didn’t have questions specific to SMEs, and they did not respond to the open-ended questions.

In addition, five virtual stakeholder meetings were organised, where sectoral business organisations (Plastics Europe, EuPC, and PRE) participated actively. During the meeting dedicated to the identification of potential measures on pellets, the following possibilities were suggested by the business organisations:

- Voluntary implementation of EuCertPlast to prevent pellet loss by recyclers;
- Voluntary commitment to OCS certification scheme by Plastics Europe and EuPC;
- Compounding, masterbatch and converting industry’s voluntary commitment to minimise pellet losses;
- Use existing waste legislation, where appropriate, to require that pellet handling sites have adequate measures to prevent plastic pellets from being released to the environment;

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229 NACE code [C201]: Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
230 [C222] Manufacture of plastics products (not sure if it covers only convertors or other plastic product manfacturers)
231 EuPC

- Development of universal information leaflet and labelling for packaging of plastic pellets;
- Development of best practice guidelines; and
- Awareness raising and training of the personnel.

Stakeholders consistently highlighted the need for financial support for SMEs. During bilateral discussions with umbrella organisation EuPC, limited resources were indicated as a barrier to implementing the voluntary OCS certification.

3 TARGETED SME CONSULTATION

3.1 Summary of the results

A second consultation targeting SMEs that are handling plastic pellets (producers, converters, recyclers and transporters/logistics) took place via the Enterprise Europe Network from 26 January to 23 February 2023 in all EU languages. Based on the 330 replies received by 23 February 2023, the following analysis was made:

- The survey included the following list of nine individual pellet management measures:
    1) Get expert advice
    2) Undertake external audit/certification
    3) Monitor and report annual quantities
    4) Use airtight, puncture resistant packaging
    5) Have specific equipment
    6) Train staff
    7) Establish rules and procedures
    8) Have specific protocols
    9) Identify the risky locations and processes
- Respondents were asked to indicate whether they implemented these measures in their company, whether they deemed these measures effective to reduce pellet losses, and whether they would be in favour of making these measures mandatory. For seven measures, **a majority was in favour of making them mandatory under the condition that requirements are lighter for smaller companies** (Figure 18). This was however not the case for: (1) the training of staff (more than 50% are in favour of making this mandatory in any case); and (2) external auditing (49% are against making it mandatory in any case).
- Respondents were also asked to estimate the costs of the nine pellet management measures, as well as total combined costs of reducing pellet spills and losses. The analysis of these estimated costs shows **a significant burden for micro and small companies**, **as well as companies with capacities below 1 000 t** (see Table 63). Important note: as shown in Table 65 and Table 66, there is some correlation between the company size and the tonnage capacities, however, there is no perfect correlation; some micro and small companies indicate plastics processing capacities above 1 000 or even 5 000 tonnes per year while some mid-sized or large companies indicate capacities below this threshold. Among the nine pellet management measures, the use of specific equipment and of specific packaging[232] are identified as the most costly.
- **A large majority (86%)** of respondents indicated that **plastic pellet management is dealt with as an important or priority matter** in their company (Figure 16: Behavioural profile of respondents on plastic pellet management). Six pellet management measures[233] out of nine can be

[232] i.e. airtight, puncture resistant and /or environmentally sealed packaging to transport and store pellets
[233] i.e. measures related to procedures and protocols, and staff training

considered consensual (i.e. more than two-thirds of respondents do them "always" or "often", consider them effective and could accept some mandatory requirement – see Figure 16, Figure 17 and Figure 18). However, **there is no such consensus on the measures related to monitoring**[234] **and external auditing**[235] (as well as expert advice[236]) (see Figure 16, Figure 17 and Figure 18). This is coherent, as 67% of respondents do not quantify the spills and losses in their company (only 30% do so – see Figure 19) and only 22% of respondents have some mandatory environmental auditing scheme in place (while 38% have a voluntary one and 30% don't have any auditing – see Figure 21).

- **The specific case of equipment**[237]: over two-thirds of respondents indicated having specific equipment to reduce pellet losses in their company ("always" or "often") and consider this measure to be effective, but views are mixed on whether this measure should become mandatory (28% of respondents consider it should remain voluntary, 27% think it should be mandatory and 33% mandatory with lighter requirements for SMEs). This is coherent as this is a measure which respondents estimated as costly. Besides 25% of respondents mention a "lack of financial resources to buy equipment" as a barrier preventing their company from taking action to reduce pellets losses, and 52% mention "**financial support** (e.g. to invest in specific equipment)" as the measure that could help them the most (Figure 19 and Figure 20).
  The specific case of packaging[238]: while two-thirds of respondents consider the use of specific packaging effective to reduce pellets losses, only 54% do it always or often (and a third never does it or has no opinion). Views on whether this should be mandatory are mixed(33% in favour, 20% in favour if lighter requirements for SMEs, and 27% against), while the use of specific packaging is estimated as **the most costly measure** both in person/days and euros/t/year (Table 64).
- Barriers preventing respondents from taking pellet management measures fall into three main categories (Figure 19): **lack of staff/time** (55% of respondents), **lack of information** on risks and solutions (50%) and **lack of financial resources** (48%). Financial support comes first as a support measure that could best help respondents (Figure 20), followed by measures to improve information (standardised method to assess spills and losses, courses and material, workshops) and assist respondents (external expertise).
- **60% of the respondents have some external environmental auditing scheme in place** (voluntary or mandatory), and out of these, 61% think this would probably make it easier or cheaper for them to implement an audit on pellets. In other words, 37% of respondents (61% of 60%) can reasonably expect a limited cost of a new audit on pellets (Figure 21 and Figure 22).
- 71% of respondents know Operation Clean Sweep (OCS) and implement it or intend to do so, and 9% have another similar programme (the most mentioned being the IK voluntary programme 'Zero Pellet Loss' in Germany). This means **80% of respondents take or intend to take action to reduce pellet losses**. However, among these 80%, 24% of respondents, who currently implement OCS, do not indicate their intention to continue implementing OCS Europe in the future (Figure 25).

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[234] "Monitor and report annual quantities of spills and losses, including spillage incidents"
[235] "Undertake external audit/ certification / inspection on spills and losses"
[236] "Get expert advice on the risks and good practices for our company". This measure is not considered to be made mandatory.
[237] Equipment to reduce pellet spills and losses (e.g. dust remover, vacuum cleaners, protective barriers etc.)
[238] Airtight, puncture resistant and /or environmentally sealed packaging to transport and store pellets, e.g. thicker plastic bags, rigid plastic packaging or well-sealed octabins.

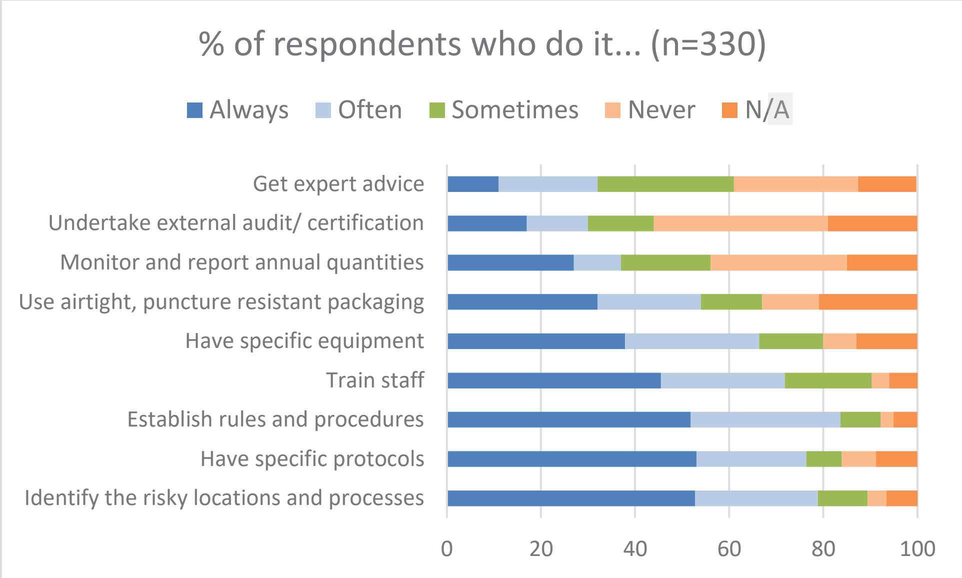

Figure 16: Behavioural profile of respondents on plastic pellet management

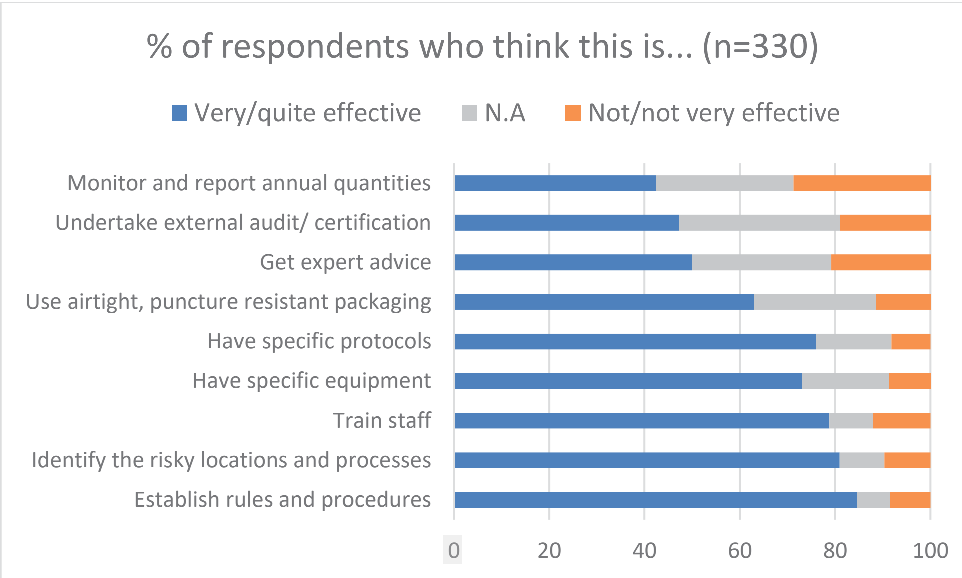

Figure 17: General opinion of respondents on the efficiency of plastic pellet management measures

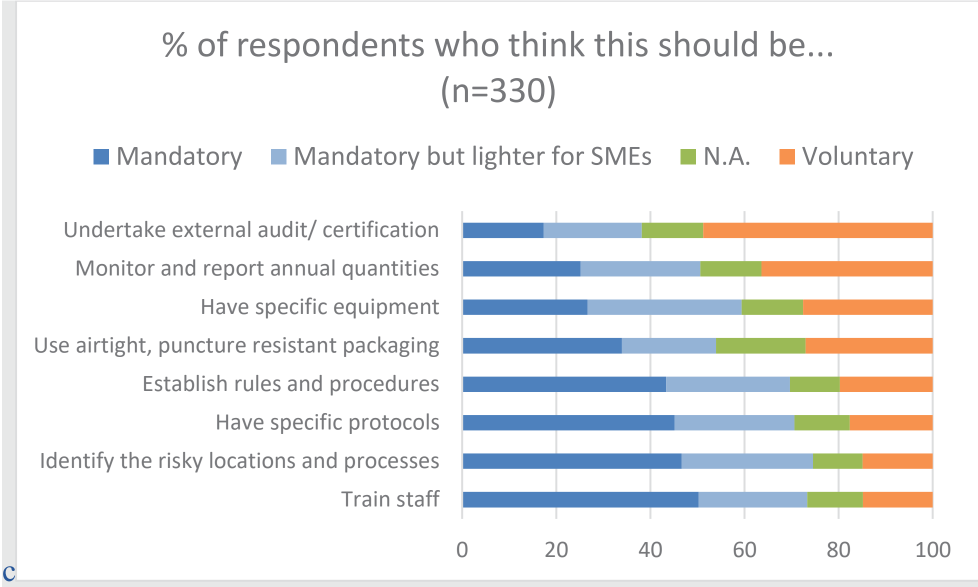

Figure 18: General opinion of respondents on the importance of possible plastic pellet management measures

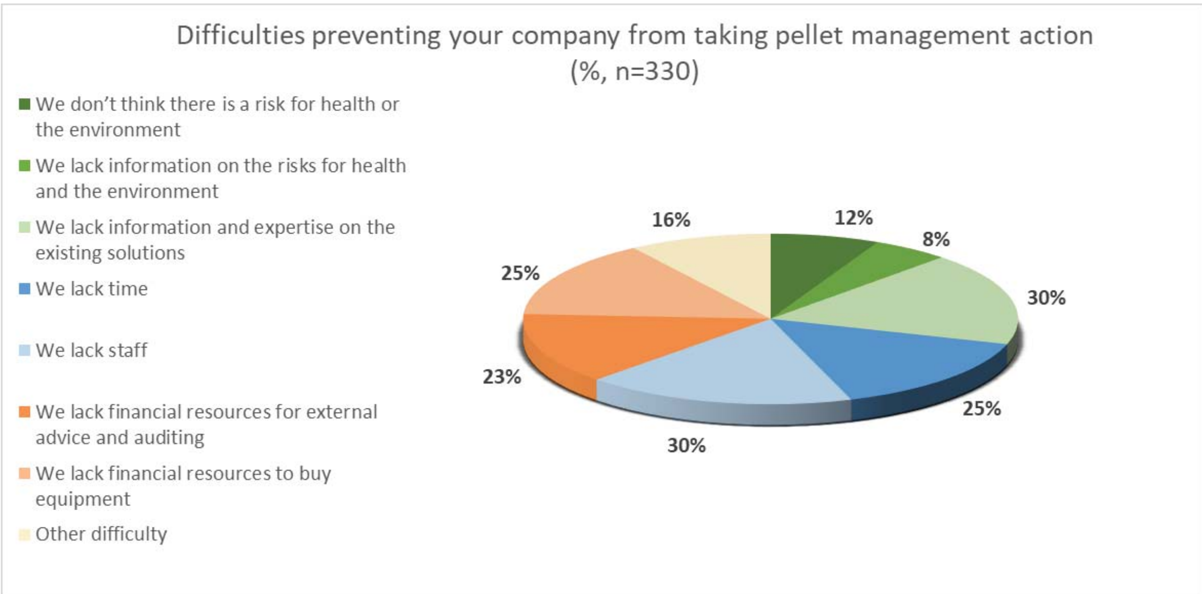

Figure 19: Barriers preventing respondents from taking pellet management measures

Among the other difficulties mentioned, we find a recurring statement around the lack of awareness (internally or among value chain partners). And the various following items: varied packaging formats from suppliers, damaged packaging, externalised storage /transport, difficulty to identify pellet containers among other containers, difficulty to measure the spills and losses, lack of space, lack of suitable equipment and technology solution.

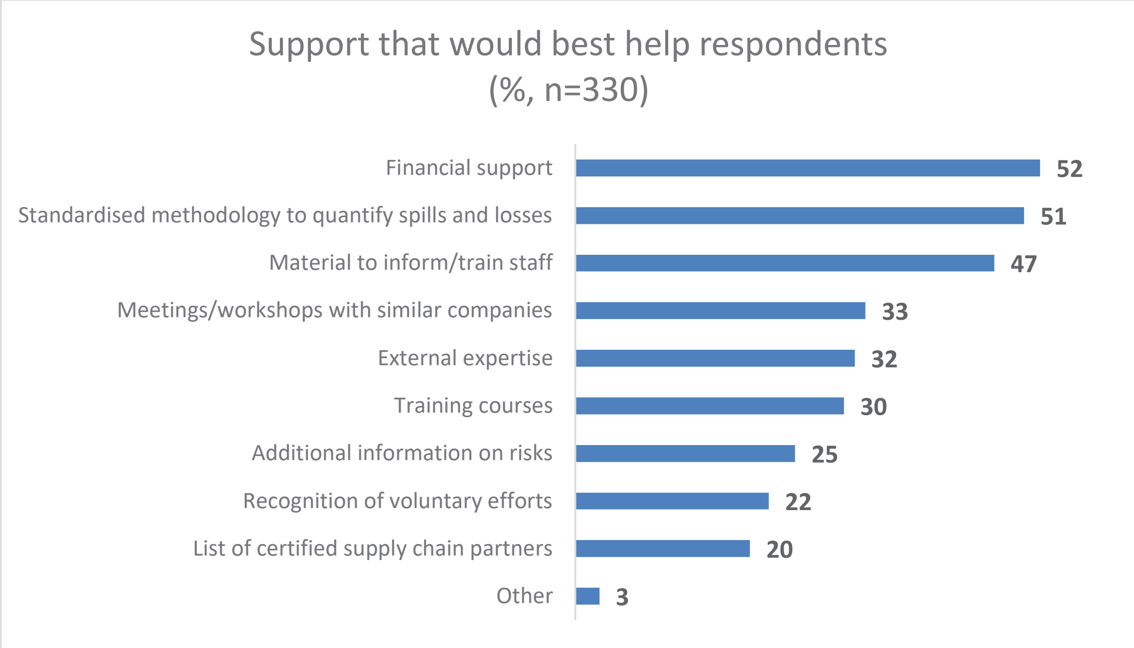

Figure 20: Support that would best help respondents

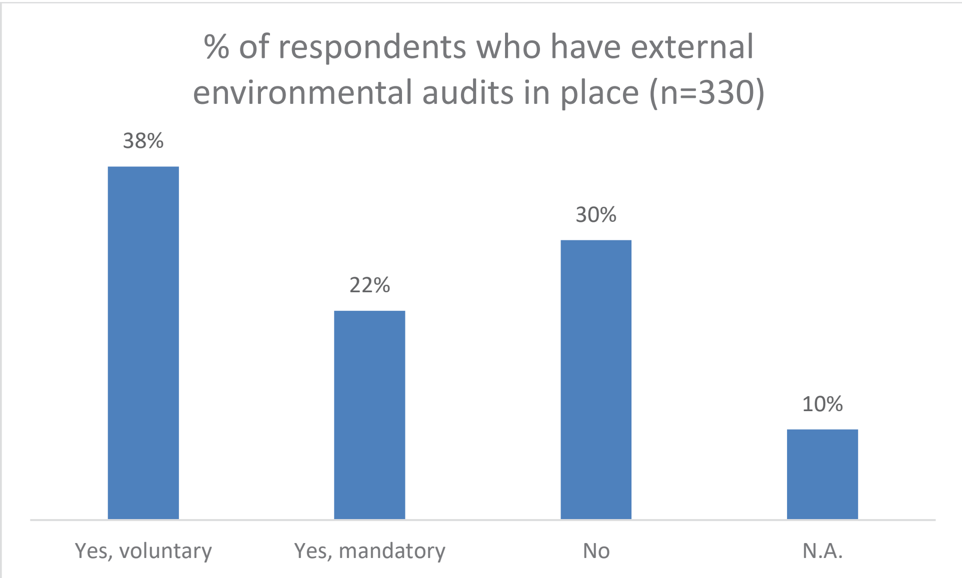

Figure 21: Respondents in percentage having external environmental audits in place

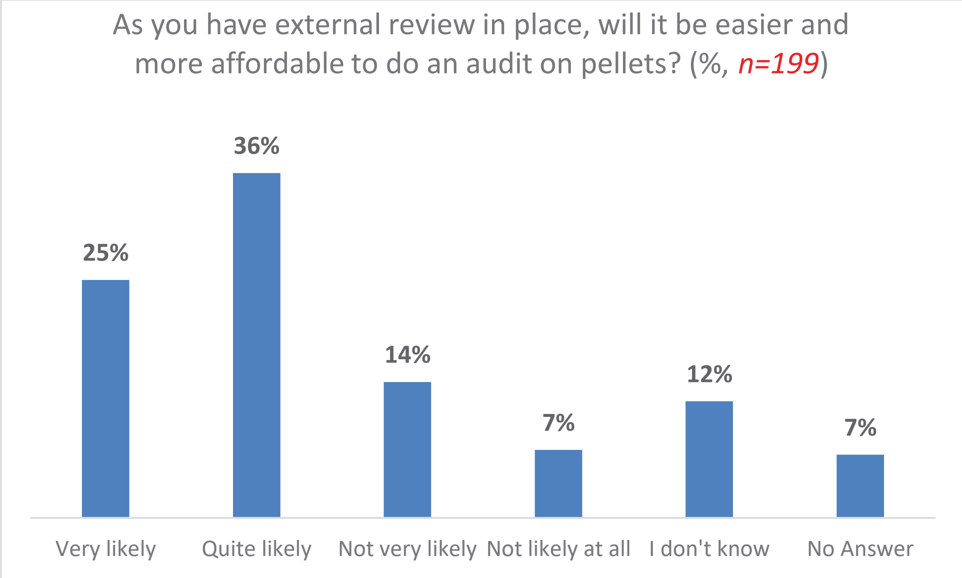

Figure 22: Audit on pellets with external review in place

3.2 Details of the results: analysis of estimated costs

Respondents were asked to estimate the costs in person/days and euros/year of the nine pellets management measures tested in the survey, plus the total combined costs of reducing pellets spills and losses in their company. The estimates show **large variations**, probably because respondents have a different understanding of the extent/depth of the measures to implement, plus they are starting from different levels of pellets management. For example, companies that replied "we implement OCS and will implement OCS Europe", i.e. companies that probably have already taken substantial action to reduce pellets losses, have estimated substantially lower investment costs for equipment in comparison with other respondents (this suggests they have likely already made investments). A company's organisation can be another factor. An extreme example comes from a large French recycler who estimated a total annual cost of EUR 950,000 and explains it as follows: "we have ***nine sites*** that handle plastic pellets overall. In question 9, we did a global estimation where the total estimated cost is ***the one of the first year*** (implementing operational procedures/systems). For the person/days/year value, we estimated 1 person per site (9 persons in total) on 220 days. This value includes all the staff involved in a year: QSE, risk analysis, training, audits, controlling, cleaning, equipment maintenance, etc."

3.2.1 Total cost of all actions to reduce pellet losses (combined cost)

The average total cost (combined cost) is **115 person /days per year** (Table 63). The larger the company, the higher the person/days (which is coherent, due to the larger operational perimeter). However, the burden is proportionally more significant for micro and small companies, considering their limited staff. The average absolute cost is **106 404 euros per year** (72 895 when retreated[239]). **The burden seems very significant for companies with a capacity below 1 000 tonnes (**Table 63**)** (this might also be due to estimated investment costs which should be amortized over several years for a more accurate cost estimation) and **significant for companies with 1 000 to 5 000 tonnes capacity** (accounting for 1 - 4% of their total sales), although the number of replies is insufficient for

[239] i.e. when removing very high or inconsistent values (e.g. negative/nil values)

this latter category to ensure definitive interpretation. The cost per tonne becomes insignificant beyond this 5 000 tonne threshold. If we assume a selling price of 800-1 800 euros per tonne of plastics, **the extra cost is considerable (3% of sales) for companies processing less than 1 900 to 4 000 tonnes per year, and substantial for companies process less than 5 900 to 13 000 tonnes per year**[240]**. The proportionally higher burden for smaller companies and capacities repeats in a similar way for all individual pellet management measures** (see below).

Table 63: Total cost for all measures (combined cost)

in person days			in euros/year/tonne		
	All data (n=163)	Retreated* (n=156)		All data (n=162)	Retreated[239] (n=150)
Average	**115**	**104**	**Average**	**984**	**600**
Micro	115	63	0-1kt	2513	1612
Small	73	67	1-5kt	27	14
Mid-sized	142	109	5-10kt	3	3
Large	370	183	10-50kt	7	7
			>50kt	3	1

* Inconsistent values (e.g. negative or extremely high) have been removed.

3.2.2 Costs per individual measures to reduce pellet losses

The sum of the costs for the individual measures is 262 person days per year, 130 069 euros/year, and 1 302 euros/tonne processed per year (Table 64). This is higher than the total combined costs shown in Table 63, which is coherent as **many companies only provided estimates for some of the measures** (i.e. they only selected those individual measures most relevant to their business operations).

Average values are however not very meaningful: more in-depth analysis shows that **costs are considerable or significant for micro and small companies and for companies with capacities below 1 000 tonnes, and limited for mid-sized companies or even negligible for large companies and capacities above 5 000 tonnes**.

The use of airtight, puncture-resistant and environmental sealed **packaging** shows the highest average costs in both person/days and euros/t/y, with **estimated significant costs for all sizes of company** (including 55 euros/t for large companies). Having specific **equipment** to reduce pellets losses is the other measure with significant costs whatever the company size (including 20 euros/t for large companies).

[240] This is however a calculation on averages, so to be used carefully. It somehow confirms the order of magnitude.

Table 64: Detailed estimated costs per measure

	Person days per year (average)	Absolute costs/y (average)	Costs in euros per tonne processed/y					
			Average for all	Micro	Small	Mid-sized	<1000 t	<5000 t
Expert advice	12.57	4443	**79**	94	107	5	217	2
Identify locations & processes	17.63	4371	**89**	774	69	13	233	1
Monitor	19.10	4905	**94**	147	36	17	83	1
Train staff	33.09	10 005	**108**	747	120	7	283	1
Establish rules & procedures	43.56	8680	**113**	288	131	33	208	2
External audit	41.20	5956	**116**	514	202	24	314	2
Have equipment	29.12	37 251	**186**	1664	112	20	528	12
Have protocols	15.98	3554	**199**	1987	32	15	515	0,8
Use specific packaging	50.01	50 914	**318**	2426	148	55	822	11
TOTAL	**262.26**	**130 079**	**1302**					

Colour	Cost represents X% of selling price of 1 tonne:
(red)	*35-133%*
(orange)	*11-35%*
(yellow)	*2-10%*
	<1%

3.3 Other detailed results

The majority of respondents indicated that it is important (49%) or very important (36%) for their company to reduce pellet spills and losses (Figure 23); however, only 31% quantify the pellet spills and losses at their site (Figure 24). 47% currently implement OCS Europe, 24% intend to implement OCS Europe in the futureFigure 25, and 9% implement another similar programme (Figure 25).

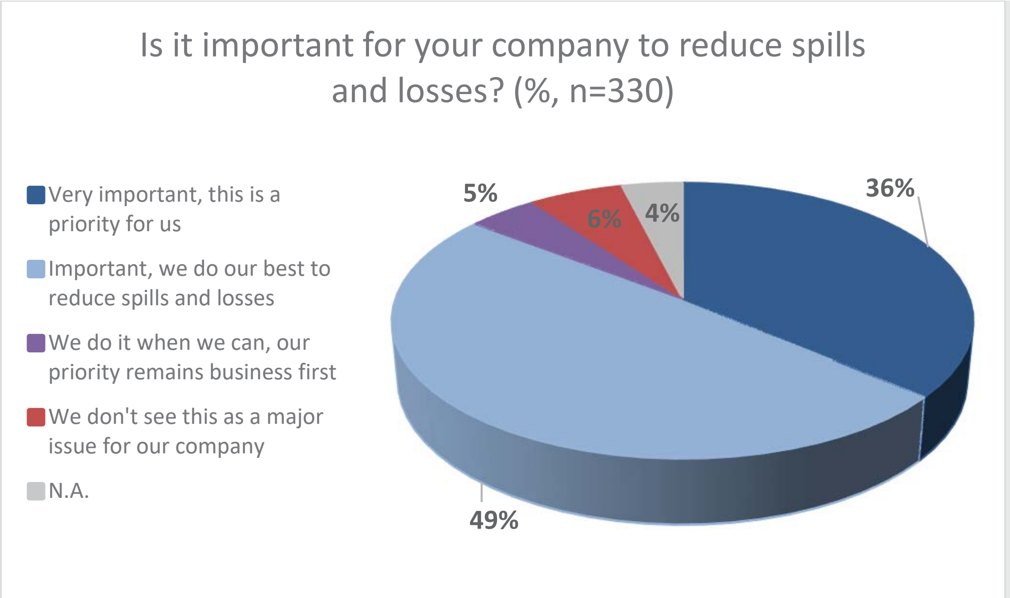

Figure 23: Importance of reduced pellet spills and losses

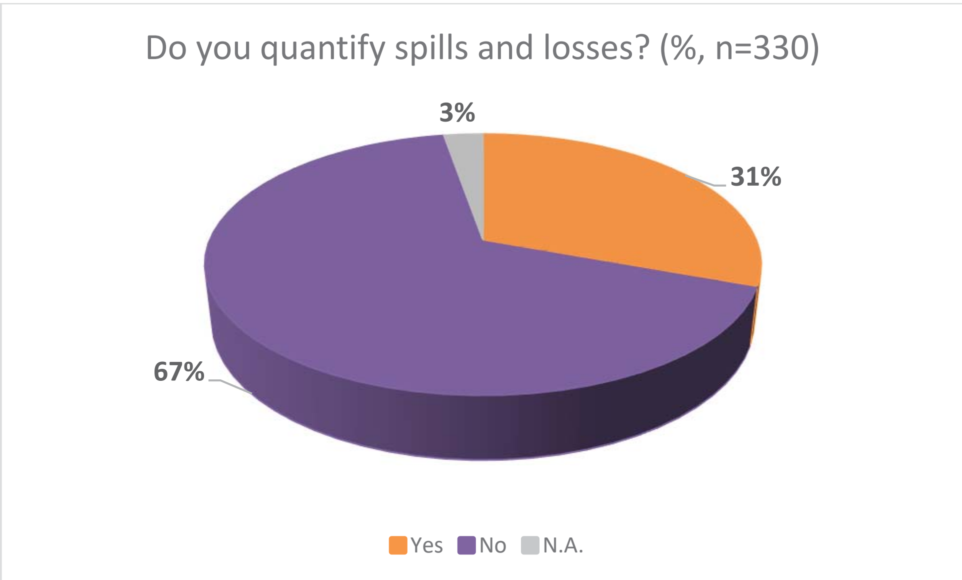

Figure 24: Quantifying pellet spills and losses[241]

[241] The data on estimated quantities of spills and losses are not reliable/exploitable for two reasons: 1) limited number of replies (36 in total, including 22 converters), and 2) it is unclear whether they indicated estimated quantities of spills or losses, hence replies show too large variations (e.g. from 0.01% to 33% for converters).

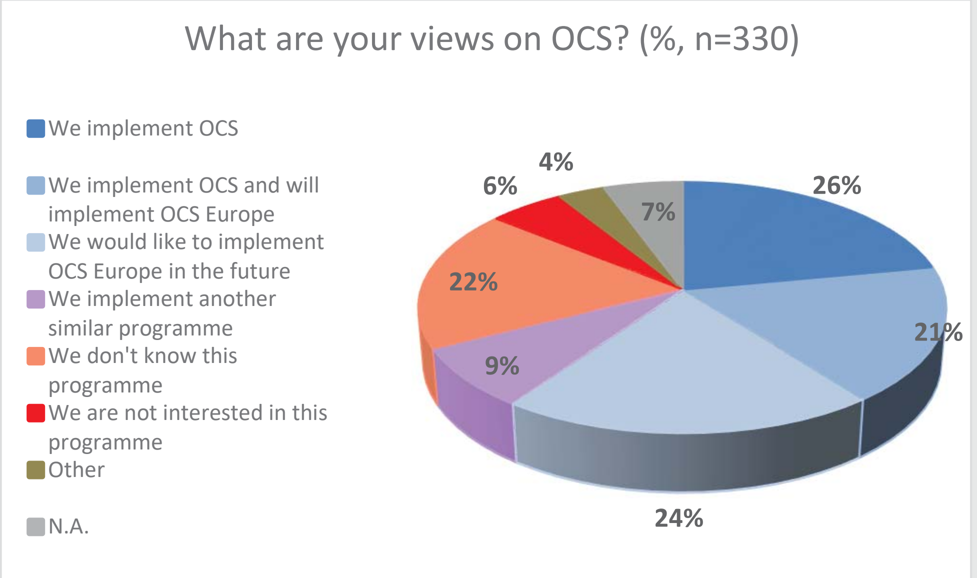

Figure 25: Views on OCS [242]

<u>Other comments by respondents</u>: Only 30 respondents submitted additional comments that can be summarised as follows. While they showed clear interest in good practices for zero pellet loss, the additional comments suggest general concern about the extra costs and burden associated with new requirements, leading to a potential disruption of the level playing field for EU companies. One respondent suggests that mandatory certification would only be acceptable to SMEs if available for free or at a reduced rate. Two respondents stress the improvement potential of packaging. Two respondents warned against classifying pellets as harmful under IMO. Two respondents plea for the OCS part of SQAS (note: the management system in place for transport) to become a recognised standard.

3.3.1 *Profile of <u>respondents</u>*

Respondents by country are shown in Figure 26. Regarding their business activity, 25 out of 28 respondents active in transport are in road transport. 41 respondents indicated an "other" activity, and out of these, 37 specified the following: 10 converters, 11 service providers (transport sector, consultancy), 8 companies from other plastics-using sectors (e.g. metal, wood, fertilisers), 3 waste operators, 2 business organisations, 1 distributor, 1 additives manufacturer, and 1 public authority (see Figure 27).

[242] The "other similar programmes" mentioned are in-house corporate programmes, ISO14001, EMAS, the IK voluntary programme 'Null Granulat Verlust' (Zero Pellet Loss), "AFNOR certification" and the implementation of the FR decree (perceived as redundant with OCS, except if OCS prove compliance)

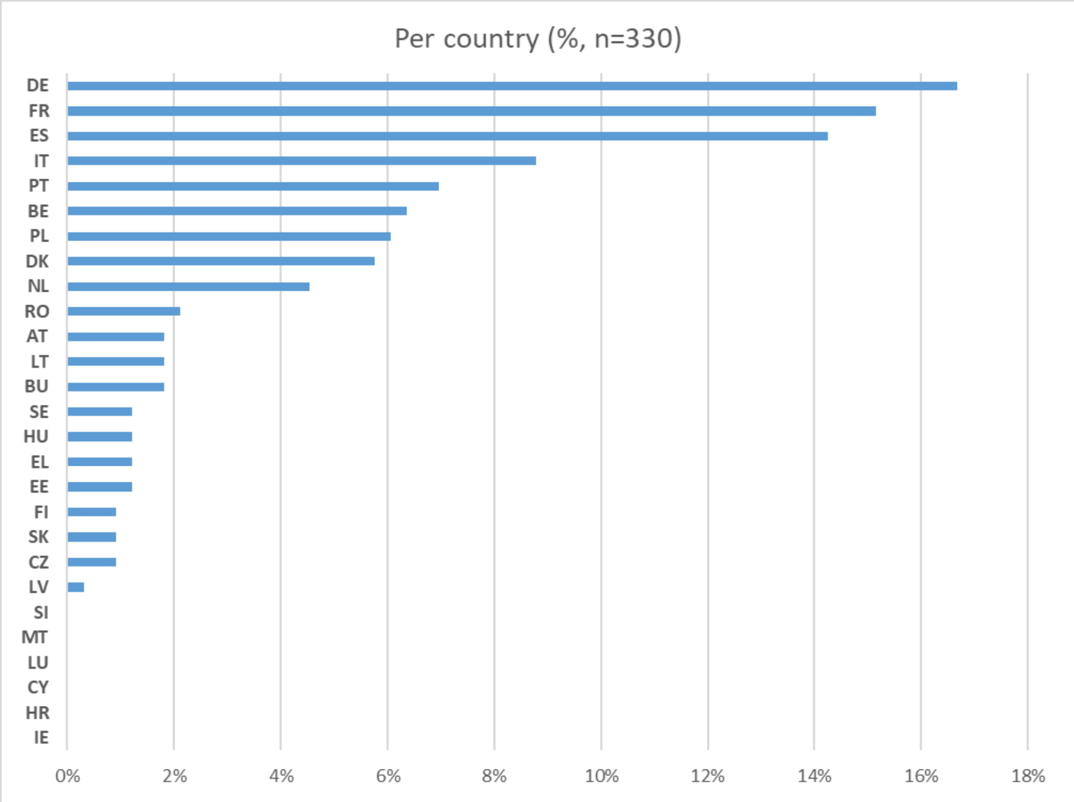

Figure 26: Respondents by country

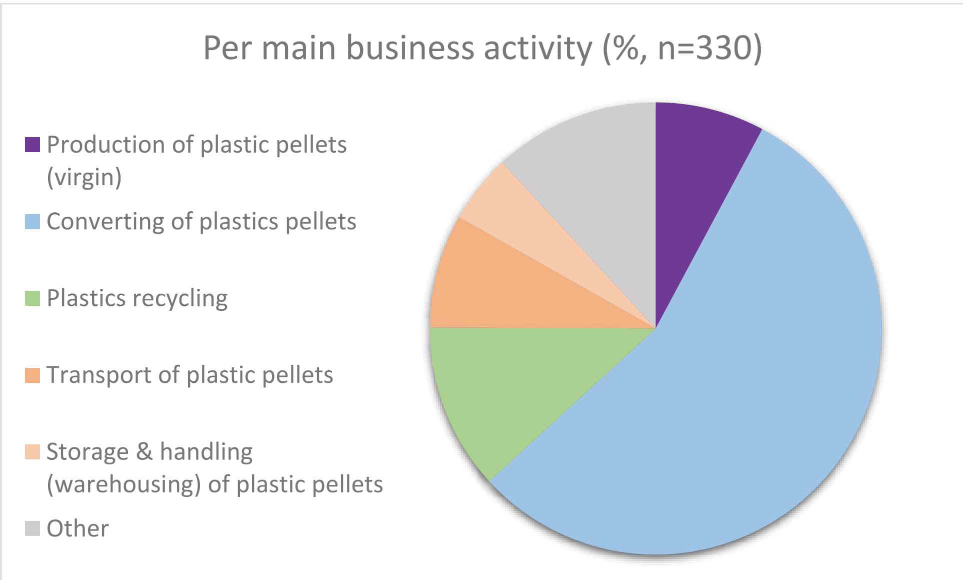

Figure 27: Respondents by business activity

Figure 28

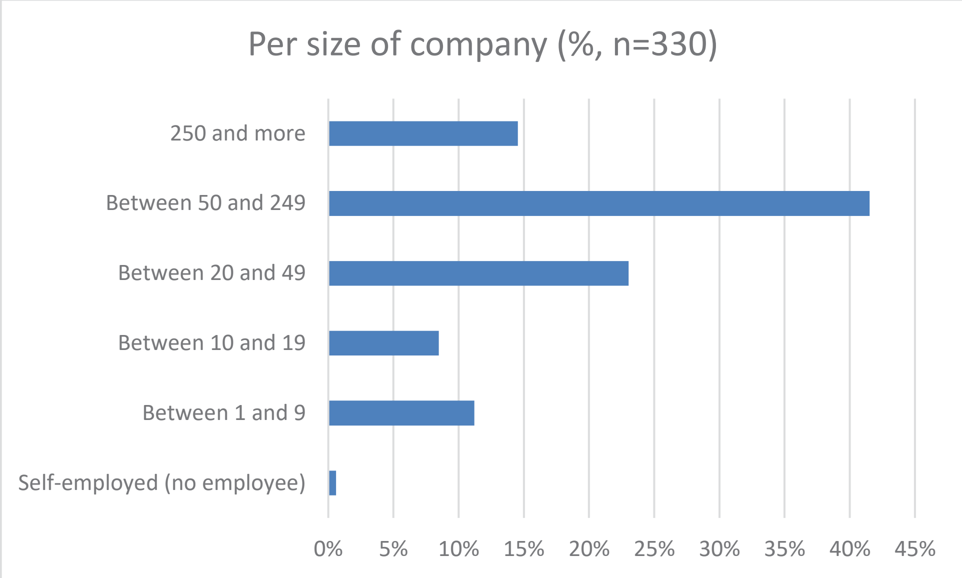

Figure 28: Respondents by company size

311 respondents indicated the annual tonnages they process, see details below in Table 65 and Table 66. Companies that process between 5 000 and 20 000 tonnes/y include 26% of micro and small companies. Companies processing over 20 000 tonnes/y include 10% of small companies.

Table 65: Average tonnages per size of company

Size of company	Number of replies	% of replies	Average tonnage	Lowest	Highest
self-employed	2	1%	0	0	0
1-9	31	10%	1140	0	15 000
10-19	29	9%	4261	0	70 000
20-49	73	23%	10 967	0	500 000
50-249	131	42%	52 240	0	3 117 977
>250	45	14%	214 728	0	4 000 000

Table 66: Declared tonnages vs. size of company

		Including				
Declared tonnage/y	**Nb of respondents**	***Self empl.***	***Micro***	***Small***	***Mid-sized***	***Large***
<1kt	122	2%	22%	43%	28%	5%
1kt<x< 5kt	63	0%	3%	44%	48%	5%
5kt <x<20kt	74	0%	3%	23%	55%	19%
> 20kt	52	0%	2%	8%	50%	40%

4 MEASUREMENT OF THE IMPACT ON SMEs

Option 1: Mandatory standardised methodology to measure pellet losses

The cost of developing a mandatory standardised methodology to measure pellet losses was estimated to be between EUR 558 000 and 1 674 000. The testing cost of one facility would be about EUR 700 to 1 500 per test which means proportionally greater costs for SMEs and micro-enterprises than for larger companies. The lower costs are the more likely ones as ongoing OCS+ work can be used as a basis.

This option will help shed light on the actual volume of losses from SMEs. In the targeted SME consultation conducted by the Commission in January-February 2023 (see above), a standardised methodology to assess pellet spills and losses was mentioned by 51% of respondents as a support measure that could best help them to take action to reduce pellet losses.

66% of plastics converters are micro-enterprises and they account for only 4% of the quantities of converted pellets. While there is no data on the relationship between pellet loss and company size, it is likely that micro-enterprises do not account for a significant share of these losses. However, the costs for smaller companies would be more significant. In the targeted SME consultation, the cost of monitoring the quantities of pellet spills and losses was estimated to be 19 man/days/year. Nevertheless, according to REACH restriction, they would still have to report the pellet losses and having a standardised methodology could simplify the reporting.

Option 2: Mandatory requirements to prevent and reduce pellet losses in a new EU law

The introduction of a mandatory certification scheme for the pellet supply chain as proposed under the policy Option 2 would have a higher cost impact for micro-enterprises and other SMEs processing plastic pellets. It would impose concrete obligations on SMEs involved at different steps of the pellet supply chain, from production to compounding to converting to transport and recycling. These obligations would be the following:

- Conducting site risk assessments to document pellet handling activities and identify the risk of spills and losses and their potential impacts. The assessment should identify high-risk areas and pathways to the external environment and include measures, equipment and procedures for prevention, containment, handling and clean-up.
- Setting up internal procedures with a zero-pellet loss objective:
  - Define roles and responsibilities and routines in case of a pellet spill/loss incident;
  - Identify appropriate steps to prevent the reoccurrence of pellet spill/loss incidents;
  - Roles and procedures for informing the competent regulatory bodies;
  - Instructions for managing the clean-up, the use of clean-up equipment and disposal of the pellets after an incident in order to prevent impact on the environment; and
  - Guidance for good cleaning.
- Employee training and accountability for spill prevention, containment, clean-up and disposal, including written procedures.
- Regular auditing and performance reporting covering the following aspects:
  - effectiveness of the procedures to avoid spills and potential losses into the environment;
  - set intervals to carry out the audits;
  - management of any change in the operations of the facility;

- compliance with the routine inspection plan inside and outside its physical boundaries and its effectiveness;
- estimation of the amount of pellets lost per year to track progress towards the objective of zero pellet loss;
- training and or competence of the internal auditors;
- independence of the internal auditors;
- actions for non-conformities identified in the audits; and
- records of the audits.

The findings of the targeted SME consultation run by the Commission in January-February 2023 indicate a cost between 100 000 and 130 000 EUR/plant on average, with large variations depending on the company's business operations and past investments. This might indeed be the case for the larger firms. This impact assessment calculates the costs for micro-enterprises to around 4 000 EUR, and 113 000 for the large plants, equally based on figures coming from the converting industry, formed by many SMEs. Lighter requirements for the smaller firms are proposed.

Option 3: Improved packaging for the transport of pellets

A measure on improved packaging for the transport of pellets means potentially high extra costs. First, the currently used plastic bags should be replaced by more resistant holders; second, the automated filling unit of the manufacturing chain would likely need to be adapted or replaced. Contrary to the cheap price of plastic bags, IBC Container's pricing ranges from EUR 165 up to 4500[243] while HDPE barrels cost EUR 13 to 40[244] depending on their specifications e.g. size, material, type of opening.

In the targeted SME consultation conducted by the Commission in January-February 2023 (see above), the cost of "using airtight, puncture-resistant and environmentally-sealed packaging to store and transport pellets" was estimated at 50 man/days/year and 50 914 EUR/year, corresponding to an average 318 EUR/tonne processed/year. The cost was found to be considerable for companies processing less than 1 000 tonnes, as well as for micro- and small enterprises, and still significant for larger companies.

Option 4: EU/national targets to reduce pellet losses

Once a methodological standard for pellet loss assessment is available, an EU (or national) reduction target for pellet losses could be set, e.g. as an absolute maximum quantity of pellets losses or a maximum percentage of the processed quantities. Both scenarios imply costs and impacts comparable to option 2, as similar prevention and mitigation measures would be implemented.

5 MINIMISING NEGATIVE IMPACTS ON SMEs

Phased implementation

Phased implementation with a longer implementation period for some companies may give them more time to adapt and align their compliance actions and investments with their normal business

243 www.ibctanks.com/chemical
244 www.hasdrums.com.sg

activities. The costs are slightly reduced where companies have more flexibility to build compliance into their normal investment cycle.

They could potentially choose to operate their existing facility until the compliance deadline before replacing it, but the longer-term benefits would be the same.

Size-related exemptions and derogations

Exemptions or derogations could be applied based on:

- the number of employees;
- the annual processing capacities;
- the turnover;
- the EU definitions of micro- and small enterprise[245]; and
- a combination of these criteria.

The targeted SME consultation, conducted by the Commission in January-February 2023, suggested a degree of correlation between company size (micro, small, mid-sized or large) and processing capacities. The processing capacities tend to increase with size:

- micro-companies who responded to the SME targeted consultation indicated an average capacity of 1 309 tonnes
- Small companies: 9 446 tonnes
- Mid-sized companies: 50 126 tonnes
- Large companies: 197 245 tonnes

However this correlation between size and tonnages is not perfect: in each size category, there are companies, including micro and small, that indicated processing capacities above 1 000 or even 5 000 tonnes per year, and some large companies indicated small tonnages (see above).

The targeted SME consultation suggested that the processing capacity of companies (in tonnes per year) is a key criterion to assess the impact of extra costs related to pellet management on the profitability. The consultation showed a disproportionate burden and considerable relative costs for micro and small companies, as well as companies with processing capacities below 1 000 tonnes of plastic materials per year.

Respondents estimated the total combined costs for implementing all measures at EUR 106 404 on average. Assuming a selling price per tonne of plastic material between EUR 800 and 1 800, then the costs would account for more than 3% of turnover for companies processing less than 1 900-4 400 tonnes per year.

In the SME targeted consultation, respondents with capacities below 1 000 tonnes accounted for a third of all respondents, but only 0.02% of all declared capacities. Respondents with capacities below 5 000 tonnes accounted for 55% of respondents, but only 1.3% all declared capacities.

As a reply to his SME targeted consultation, lighter requirements for micro-enterprises from the scope of the mandatory certification scheme are part of the preferred option. Marginal quantities of pellets

[245] https://single-market-economy.ec.europa.eu/smes/sme-definition_en

could be excluded from the scope. The French decree on plastic granulates[246] follows a similar logic where the operators processing less than 5 tonnes of pellets per year are excluded.

The targeted SME consultation also showed that mandatory monitoring of quantities of pellet losses and mandatory audit would be the least acceptable measures. Lighter requirements can be proposed for micro-enterprises involved in the production, storage, transport, storage and converting. Also small enterprises would be required to comply with less demanding requirements and could be given special assistance.

Financial support
In the targeted SME consultation, conducted by the Commission in January-February 2023, the lack of financial resources was mentioned by 48% of respondents as a barrier preventing companies from taking action to reduce pellet losses. Financial support came first as a support measure that could best help respondents to take action to reduce pellet losses (mentioned by 52% of respondents). The burden on SMEs could be reduced if Member States provide financial support to certain enterprises (e.g. micro-enterprises and other SMEs) to help them meet regulatory requirements.

In particular, EU state aid rules allow for:

- state aid with no prior notification to the Commission ("block exemption") covering up to 50% of consultancy costs in favour of SMEs, 60-70% of training costs, 50-60% (100% in case of competitive bidding complying with the conditions set out in Article 36(9)) of extra investment costs for improving environmental protection beyond Union standards in force or in the absence of Union standards or to comply with Union standards that have been adopted but are not yet in force at the latest 18 months before their entry into force [247] – the latter two options seem especially relevant as the preferred option envisages that requirements for smaller companies could be less demanding or apply at a later date.
- state aid subject to prior notification to the Commission[248] covering up to 50-70% of extra investment costs for projects preventing or reducing pollution in the absence of Union standards or going beyond Union standards as well as complying with Union standards adopted but are not yet in force at least 18 months in advance[249].

The financial support can be direct (e.g. loans or support programmes) or indirect (e.g. reduced fees). This approach would reduce compliance costs for SMEs but increase costs for Member States, depending on the specific measures adopted.

Non-financial support
The Commission and/or the Member States could provide some other support. In the targeted SME consultation, lack of staff/time and lack of information on risks and solutions were mentioned as barriers preventing action to reduce pellet losses by respectively 55 and 50% of respondents. Coherently, measures to improve information on pellet management (including a standardised methodology to assess spills and losses, information and training materials, training courses and

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[246] Décret n° 2021-461 du 16 avril 2021 relatif à la prévention des pertes de granulés de plastiques industriels dans l'environnement

[247] Commission Regulation (EU) No 651/2014 ("General Block Exemption regulation"), in particular Article 18 on consultancy in favour of SMEs, Article 31 on training aid and Article 36 on investment aids for environmental protection, including climate protection.

[248] Member States may notify to the Commission a scheme (e.g., a national aid measure for SMEs), in which case it would in principle not be necessary to notify aid for each individual project supported under the scheme.

[249] Guidelines on State aid for climate, environmental protection and energy 2022, C/2022/481, Section 4.5 on Aid for the prevention or reduction of pollution other than greenhouse gases.

workshops) came second as support measure that could best help respondents to take action to reduce pellet losses.

Such support could take the form of advisory services to SMEs. For example, a project could be supported by the Commission which would:

1. develop SME-specific guidance and training materials and tools to help compliance with the new legal requirements. It is essential that these materials and tools are first tested with SMEs, before being rolled out, to ensure they are clear and relevant to SMEs;
2. deliver advisory services, e.g. through the Enterprise Europe Network and/or in cooperation with the relevant business organisations, to help SMEs understand the new legal requirements and prepare for compliance; and
3. establish a help desk/expert pool (5-6 contact persons with in-depth expertise of the new legal requirements and the compliance solutions) to assist first-level advisers and deal with more difficult questions or issues.

Such support can be open to larger companies but SMEs should be the primary targets, as they have fewer resources to understand and implement abatement technologies. This option would however incur costs for the competent authorities and/or the Commission (a first estimated budget could be around EUR 1 Million for a first project covering points 1 to 3 above).

Annex 13:
Prodcom codes used to quantify pellet production, export and import into the EU in 2020

Item	PRODCOM code
Linear polyethylene having a specific gravity < 0,94, in primary forms	20161035
Polyethylene having a specific gravity < 0,94, in primary forms (excluding linear)	20161039
Polyethylene having a specific gravity of >= 0,94, in primary forms	20161050
Ethylene-vinyl acetate copolymers, in primary forms	20161070
Polymers of ethylene, in primary forms (excluding polyethylene, ethylene-vinyl acetate copolymers)	20161090
Expansible polystyrene, in primary forms	20162035
Polystyrene, in primary forms (excluding expansible polystyrene)	20162039
Styrene-acrylonitrile (SAN) copolymers, in primary forms	20162050
Acrylonitrile-butadiene-styrene (ABS) copolymers, in primary forms	20162070
Polymers of styrene, in primary forms (excluding polystyrene, styrene-acrylonitrile (SAN) copolymers, acrylonitrile-butadiene-styrene (ABS) copolymers)	20162090
Polyvinyl chloride, not mixed with any other substances, in primary forms	20163010
Non-plasticised polyvinyl chloride mixed with any other substance, in primary forms	20163023
Plasticised polyvinyl chloride mixed with any other substance, in primary forms	20163025
Vinyl chloride-vinyl acetate copolymers and other vinyl chloride copolymers, in primary forms	20163040
Polymers of halogenated olefins, in primary forms, n.e.c.	20163090
Polyacetals, in primary forms	20164013
Polyethylene glycols and other polyether alcohols, in primary forms	20164015
Polyethers, in primary forms (excluding polyacetals, polyether alcohols)	20164020
Polycarbonates, in primary forms	20164040
Polyethylene terephthalate in primary forms having a viscosity number of >= 78 ml/g	20164062
Other polyethylene terephthalate in primary forms	20164064

Unsaturated polyesters, in primary forms (excluding liquid polyesters, polyacetals, polyethers, epoxide resins, polycarbonates, alkyd resins, polyethylene terephthalate)	20164080
Polyesters, in primary forms (excluding polyacetals, polyethers, epoxide resins, polycarbonates, alkyd resins, polyethylene terephthalate, other unsaturated polyesters)	20164090
Polypropylene, in primary forms	20165130
Polymers of propylene or of other olefins, in primary forms (excluding polypropylene)	20165150
Polymers of vinyl acetate, in primary forms (excluding in aqueous dispersion)	20165250
Polymers of vinyl esters or other vinyl polymers, in primary forms (excluding vinyl acetate)	20165270
Polymethyl methacrylate, in primary forms	20165350
Acrylic polymers, in primary forms (excluding polymethyl methacrylate)	20165390
Polyamide -6, -11, -12, -6,6, -6,9, -6,10 or -6,12, in primary forms	20165450
Polyamides, in primary forms (excluding polyamide -6, -11, -12, -6,6, -6,9, -6,10 or -6,12)	20165490
Polyurethanes, in primary forms	20165670
Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	20165920
Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	20165945
Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	20165950
Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	20165955
Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	20165960
Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	20165965
Reclaimed rubber in primary forms or in plates, sheets or strips	22191000
Other compounded rubber, unvulcanised, in primary forms or in plates, sheets or strip	22192019

Annex 14:
Other sources of microplastics identified but not retained

1 ALL IDENTIFIED SOURCES

At the beginning of the analysis, relevant sources of microplastic releases were identified through literature review, stakeholder workshops and consultations. The table below summarizes the results of this exercise as of December 2022.

Table 67: Compilation of sources of microplastics

Source	Quantity (tonnes/year) EU
Paints	231 000 – 863 000
Tyres	360 000 – 540 000
Pellets	52 140 – 184 290
Road markings (included in paints)	94 358[a] according to Eunomia (2018) (20 000 according to EA study)
Artificial turfs (with granules)	18 000-72 000
Textiles	1 649 – 61 078
Geotextiles	6 000-19 750*
Brake pads	53 000
Detergent capsules	4 140 – 5 980
Fishing gear	478 – 4 780
Biobeads[b]	1442
Marine paints[c] (included in paints)	1 194 - – 5 970 according to Eunomia (2018) (probably grossly underestimated, EA study estimated 223 000)
Agricultural plastics	1 000 [d]
Shoe soles (data for Denmark)	100-1 000 [e]. (5.6%[e] of the country's total yearly microplastics emissions)
Indoor and outdoor building materials of plastic (data for Denmark)	80-480 (2.9%[e] of the country's total yearly microplastics emissions)
Cooking utensils and scouring pads (data for Denmark)	40-380 (2.2%[e f] of the country's total yearly microplastics emissions)
Cast rubber playground surfaces (data for Sweden)	16 (0.12% - 0.15%[g] of the country's total yearly microplastics emissions)
Artificial grass (data for Sweden)	2.4 (0.022% – 0.017%[g] of the country's total yearly microplastics emissions)
City Dust	Not quantified in Europe
Telephone poles and railway sleepers	Not quantified
Shipping	Not quantified
Cooling water	Not quantified

Plastic balls used in soft gun games	Not quantified
Macroplastics	Not quantified

*: This figure is probably a factor 10 too high, see the section on geotextiles (annex 15) for more explanation.

a: Extrapolated from German data,[250] neglecting the fact that not all Member States use sludge as a fertilizer (Germany represents 14% of agriculture production in the EU in value and emits 8380 tonnes of microplastics from sewage sludge, so 8380/0.14 = 59 857 tonnes).

b: UK data is thought to represent EU data given that the uptake of Biobeads for waste water treatment in the EU is limited.

c: Recent study suspects a gross underestimation of marine paints emissions to the environment, to the point of questioning the 80/20 ratio of microplastics emissions coming from land or water sources.[251]

d: Extrapolated from German data[250] (Germany represents 14% of agriculture production in the EU in value, and uses 139 tonnes of mulching plastics, so 139/0.14 = 1000 tonnes).

e: Calculated using the mean emission of microplastics for that source and the mean total microplastics emission for Denmark: 9 700 tonnes per year.[252]

f: Emissions from textile clothes are included in the estimation but should be included in the textile emissions, the quantities released thus are lower than in the table.

g: Calculated using total microplastics emissions of 10 437 – 13 457 tonnes per year in Sweden[253]

In Table 67, the results are summarised and ranked according to their contribution to EU microplastics pollution. The emissions are not given in g per capita because it would not be a good metric since citizens' habits and industry practices vary widely in the EU. The “ranking” provides information on the place in the emission hierarchy of microplastic emissions for each source using the higher estimate of the said contribution to get a worst-case scenario analysis.

The following sources were not retained in our analysis due to a lack of sufficient information being available.

2 SOURCES NOT RETAINED FOR ANALYSIS

2.1 Fragmentation of ‘macro’ plastics in the environment

In Europe, nearly 26 million tonnes of plastic waste is produced each year[254]. Substantial bibliographical evidence exists on the large accumulation of debris in European seas, sea floors, and coasts. Different environmental factors such as radiation, heat and mechanical stress lead to the

[250] Nabu.De, 2021, https://www.nabu.de/imperia/md/content/nabude/konsumressourcenmuell/210521-fraunhofer_oekopol_studie_plastik_landwirtschaft.pdf. Accessed 15 Oct 2021.
[251] Turner, Andrew. "Paint Particles In The Marine Environment: An Overlooked Component Of Microplastics". Water Research X, vol 12, 2021, p. 100110. Elsevier BV, doi:10.1016/j.wroa.2021.100110. Accessed 14 Oct 2021
[252] Lassen, C., S. Foss Hansen, K. Magnusson, F. Norén, N. I. Bloch Hartmann, P. Rehne Jensen, T. Gissel Nielsen and A. Brinch, Microplastics - Occurrence, effects and sources of releases to the environment in Denmark, 2015
[253] "Mikroplast Från Gjutet Gummigranulat Och Granulatfria Konstgräsytor". Ivl.Se, 2021, https://www.ivl.se/publikationer/publikationer/mikroplast-fran-gjutet-gummigranulat-och-granulatfria-konstgrasytor.html. Accessed 14 Oct 2021.
[254] EU Plastics Strategy, 2018 (https://environment.ec.europa.eu/topics/plastics_en).

fragmentation of larger plastic objects or macroplastics.[255] The resulting microplastics are referred to as secondary microplastics, as opposed to primary microplastics which are plastics manufactured deliberately in micron-scale sizes.

Maritime plastic litter (including fishing nets), mismanaged plastic waste and macroplastics, and discarded plastics, can therefore be sources of microplastics due to weathering, photolysis, abrasion or microbial disintegration. Indeed, in principle, all macroplastics sooner or later degrade into microplastics.

The fragmentation of macroplastics results in a continuous increase of secondary microplastics in the environment. In addition to the environmental factors, the fragmentation rate also depends on the type and composition of macroplastics. Fragmentation must be taken into account when assessing the long-term presence of microplastics in the environment.[256]

There is still an important distinction to be made. Macroplastics, when found in the environment, can fragment in pieces and ultimately end up as microplastics. In this case, it is first the macroplastic that is discarded into the environment, and therefor policies aiming at reducing discarding these macroplastics should prevail.

It is also possible that microplastics are released directly, for instance due to the abrasion of the use of larger plastics, or due to mishandling (e.g. of pellets). This is called the **unintentional releases of microplastics**, which is the focus of this analysis.

Combating the issue of macroplastics that are littered or found in the environment requires upstream policies preventing them from being thrown into the environment, and then solutions to remove those already in situ. Similarly, the issue of macroplastics' degradation should be handled before they degrade into microplastics as existing solutions to remove microplastics are very complex and costly. Macroplastic pollution is dealt with by various existing and forthcoming policy instruments so macroplastics as a source of microplastics fall outside of the scope of this IA.

Currently, the following EU-level actions target macroplastic pollution:

- The Plastic Bags Directive (Directive (EU) 2015/720), an amendment to the Packaging & Packaging Waste Directive, targets the use of lightweight plastic bags which have a wall thickness below 50 microns. Member States are required to adopt measures either reducing the annual consumption of lightweight plastic carrier bags or preventing these bags from being provided free of charge.
- The Single-Use Plastics Directive (Directive (EU) 2019/904) targets macroplastic pollution by ensuring that single-use plastic products, for which more sustainable alternatives are available and affordable, cannot be placed on the market. It also applies to products made from oxo-degradable plastic and fishing gear containing plastic. Specific targets on single use plastics include a 77% separate collection target for plastic bottles by 2025, increasing to 90% by 2029, and incorporating 25% of recycled plastic in PET beverage bottles from 2025, and 30% in all plastic beverage bottles from 2030.

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[255] Gomiero, A., Pierluigi S. & Fabi, G., 'From Macroplastic to Microplastic Litter: Occurrence, Composition, Source Identification and Interaction with Aquatic Organisms. Experiences from the Adriatic Sea', 2018 (https://www.intechopen.com/chapters/63956).

[256] Gomiero, A., Pierluigi S. & Fabi, G., 'From Macroplastic to Microplastic Litter: Occurrence, Composition, Source Identification and Interaction with Aquatic Organisms. Experiences from the Adriatic Sea', 2018 (https://www.intechopen.com/chapters/63956).

- The Waste Framework Directive (Directive (EU) 2008/98) establishes the waste hierarchy, placing the priority on waste prevention. Plastics fall within the scope of this Directive and Member States were required to set up the separate collection of plastics in order to ensure 50% of this waste stream was prepared for re-use and recycling by 2020.
- The EU Water Framework Directive (Directive 2000/60/EC) and the Marine Strategy Framework Directive (Directive 2008/56/EC) are also of relevance to macroplastic pollution as they should prevent litter from entering the marine environment. The MSFD also comprises regular monitoring and assessments of marine litter (including macro- and microlitter) in the marine environtment, putting in place measuses to achieve or maintain the good environmental status.
- From 1 January 2021, new EU rules apply also to shipments of plastic waste, including exports from the EU, imports into the EU and intra-EU shipments. These rules should help cut down on pollution by ensuring plastic waste is only traded if parties have proved they are able to deal with it properly.
- In March 2022, the EU was instrumental in the adoption of a resolution for negotiations on a legally binding global agreement. This agreement will establish an international instrument to prevent plastic pollution throughout the entire lifecycle. The EU is committed to ensuring this instrument focuses on upstream measures.
- On 30 November 2022, the Commission made a proposal for a new Packaging and Packaging Waste Regulation. By revising the existing Packaging and Packaging Waste Directive, the Commission hopes to reduce the generation of packaging waste, with a particular focus on plastic-containing packaging.
- The Port Reception Facilities Directive (EU) 2019/883) deals with waste coming from ships.

2.2 Sewage sludge

The microplastics emitted by sewage sludge are not generated by the sludge itself but accumulated there from other sources. Most of microplastics emitted in households (textile microplastics during washing and personal care product microbeads in majority) and those released on urban roads (tyre and brake pad wear particles, pellets when accidents have occurred) end up in wastewater treatment plants to undergo treatment before release to the environment. Indeed, there, microplastics will be separated from the inlet stream and caught in the sewage sludge. The microplastics quantities in the sludge are significant (it was estimated that 8380 tons of microplastics are released yearly from the use of sewage sludge as fertilizer in Germany alone) and are toxic due to the biofilms that develop on their surface since they are in contact with a high concentration of organic matter, microorganisms and bacteria within the sludge.

Since sewage sludge is used as fertilizer and that Germany represents 14% of the EU's total agricultural production (in value), an estimation of the total amount of microplastics emitted from sludge spreading as fertiliser in Europe is: 8380/0.14 = 59857 tons/year. However, this is likely an overestimate since not all countries spread sludge to fertilise their crops and that in countries where they do, the agricultural method differ and so may require different quantities of sludge to be spread. It is estimated that about half of sludge from urban wastewater treatment ends up on agricultural land.

However, the microplastics emitted by wastewater sludge are not generated by the sludge itself but rather released by it after having been accumulated there from other sources. This makes wastewater sludge a sink of microplastics and so the best way to reduce emissions of microplastics from sludge is through preventing microplastics from reaching the wastewater treatment plant altogether. Hence, sewage sludge is considered a pathway and not a direct source of microplastics.

Moreover, there is already a legislation regulating sewage sludge application in agriculture – the Sewage Sludge Directive. The issue of microplastics will be dealt with by the future revision of the Sewage Sludge Directive and also the UWWTD.

2.3 Brake Pads

The impact of brake pads is difficult to assess because of the impossibility of distinguishing them from other particles. Indeed, they are emitted at the same time as tyre wear particles, road wear particles, and road marking particles. Moreover, they are smaller particles mostly emitted to the atmosphere[112], rendering them even harder for the sample and thus quantify. Given the quantity of microplastics emitted by brake pads and their potential adverse effects on human health, and the uncertainties on the scale of the emitted quantities, it is recommended to have further research into microplastics emitted from brake pads in order to have more reliable numbers before further action can be undertaken. Further, the increasing penetration rate of electric vehicles will dramatically mitigate emissions from brake pads and disks. Electric vehicles, in fact, have a regenerative breaking system recovering the kinetic (when slowing down) and gravity (when going downhill) energy, recharging the battery. An average EV, used on a mix path, recovers between 15 and 25% of energy in this way. Brake pads usually last 4 times more in electric vehicles, compared to internal combustion ones and disks usually last even more than the vehicle itself.

2.4 Artificial / synthetic turf

Artificial / synthetic can be divided into two categories:
- Artificial turfs containing infill material;
- Artificial turf not containing infill materials (can also be called artificial grass); the same material is used as artificial grass with and without the granulate infill material.

Synthetic turf is typically used in regions with rainy or extremely dry climatic conditions.

Microplastics from infill material: In order to keep the synthetic fibres in an upright position and provide the desired elasticity of the field, granulates are often used as infill. This practice is typical for synthetic football and synthetic rugby pitches.

The total emission from microplastics generated from artificial turfs was between 18,000-72,000 tons per year. As per the ECHA dossier dated 11th June 2020, 16,000 tons of microplastics are released per year from artificial rubber granules used as infill in synthetic turf sport pitches. The dossier states that these are the largest contributors at European level in terms of both quantities of intentionally added microplastics used and released to the environment. The Commission proposal for a restriction on intentionally added microplastics includes a ban for the use of granular infill in artificial sport surfaces, with a transitional period of 6 years. The proposal is currently being discussed in the REACH Committee and could be adopted in the first half of 2023, after a positive vote in the Committee and the scrutiny by Council and Parliament. Since infill material is an intentionally added microplastic is out of the scope of this assessment.

Microplastics released from wear and tear of artificial grass fibres and granulates: Besides the infill material itself, which is a source of releases of primary microplastics, secondary microplastics may be formed from wear and tear of the artificial grass fibres with a typical straw length of 3-6 cm. The synthetic grass mostly consists of plastic fibres attached to a perforated polypropylene or polyester fabric. A latex-based glue is applied to the fabric, which is then cured. Infill is used between the fibres in order to stabilise the fibres as well as to achieve the desired functionality.

Wear and tear from the granulates may also occur. The use of ethylene-propylene-diene-rubber (EPDM) for playgrounds, school grounds and sports facilities is also increasing, and their wear and tear may also release microplastics.

Very little information was found regarding these sources of microplastics.

2.5 Cast rubber surfaces for playgrounds

These surfaces are used to cover playground areas in outdoor facilities, schools and running tracks. They are made of rubber granules made of either newly manufactured ethylene-propylene-diene-rubber (EPDM) or recycled SBR from old tyres and bonded with a polyurethane-based adhesive.

Very little information was found regarding these sources of microplastics.

Table 68: Comparison of microplastic releases from different sources

Surface	Emissions (g/m^2*year)	Tons/year
Artificial grass with granules	98	6.9 km2 * 98g / m2/ year = 676 tons / year
Artificial grass without granules	0.4-20	0.451 km2 * 5.3g / m2/ year = 2.4 tons / year
Cast rubber surfaces	0.6-48	1.2 km2 * 13.4g / m2/ year = 16 tons / year
Roads (5500 – 13000 AADT)	56	8 190

Source: Swedish Environment Protection Agency

Hence, artificial grass and cast rubber surfaces should not be priorities of the Commission further studies. However, the Swedish environment agency points out that extremely emitting cast rubber surfaces (up to $48g/m^2$*year) are low hanging fruits to reduce microplastic releases from these surfaces and that they should be banned to remove the most polluting surfaces.

Artificial turfs containing granulate infill materials should also not be a priority for the Commission either since they will be tackled already by the REACH restriction. However, it should be kept in mind that the restriction is addressing the releases from the artificial infill, not from the artificial grass.[257]

Table 69: Microplastic releases from wear and tear of artificial grass

Study	Findings
(OSPAR, 2017)	4-6% of fibre release per year. Out of which 0.1-1% is released to surface water. Estimated release to surface water: 3-42 tons/year for OSPAR countries.
(Ryber et al., 2019)	Not identified.
(UN Environment, 2018)	Considered of low importance at global level as the artificial turfs are likely to be more common in northern countries.

** OSPAR 2017 and EC/Eunomia 2018 consider the Denmark data unrealistic as the average life of the turf is approximately 10 years.

[257] Annex XV addition to REACH Regulation

2.6 Fishing Gear

Fishing gear is a big source of marine litter. The microplastic pollution from fishing gear is a result of:

- Lost or abandoned fishing gear and its subsequent degradation; and
- Weathering of in use fishing gear.

Since fishing gear is a macroplastic already being addressed by the SUP and Fishing Gear Directive and Port Reception Facilities Directives, it should not be addressed in this study.

Table 70: Microplastic releases from wear and tear of fishing gear

Study	Findings
(EC/Eunomia, 2018)	478-4,780 tons/year in the EU. The report notes that "this estimate is highly speculative, and both the loss rate and the fishing net data are very uncertain at this stage".
(OSPAR, 2017)	Not quantified.
(Ryber et al., 2019)	Identified but not quantified due to lack of data.
(UN Environment, 2018)	Considered important source but could not quantified due to lack of data.

2.7 Agriculture plastics

Plastics are widely used in the agricultural sector, and found in applications such as silage bales, bags and horticultural foil. As in any sector, there is some loss of material. Weathering and abrasion might generate small plastic particles from agricultural plastics in use. The particle may be lost to the soil environment or be transported with the wind. The most likely pathway of releases of plastics from the agricultural sector is the generation larger pieces of plastics. Such larger pieces might fragment to smaller pieces generating microplastics in the environment.

The proportion of conventional plastic mulch films that are typically left remaining is not known (figures in the range of 5-25% are often quoted, but the root of these have no direct link back to a published scientific study). There is no demonstrable link between common practice resulting in a particular proportion being left on the field. It is also unclear what is achievable if best practice is employed and to what extent technological improvements in field removal machinery could achieve. Anecdotal evidence suggests thicker films will result in less residue, but further study is required to determine the exact thickness (and therefore strength specification) that would be required.

A recent study[258] calculates that if 5-25% mulch film remaining in the fields is averaged across the EU, the annual use of 83,000 tonnes of mulch film would result in 4,750 -20,750 tonnes of conventional plastic remaining on agricultural land every year. Several Member States have already established a collection scheme for these plastics, or are in the process of doing so.

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[258] Eunomia, 2021. Circabc (europa.eu)

Table 71: Microplastic releases from wear and tear of agriculture plastics

Study	Findings
(EC/Eunomia, 2018)	Identified but not quantified.
(OSPAR, 2017)	Not identified.
(Ryber et al., 2019)	Identified but not quantified.
(NABU, 2021)[23]	556 tons/year of plastics for Germany, reduced to 139 tons/year for microplastics.
(UN Environment, 2018)	Considered of medium importance but could not be identified due to lack of data.

The amount of microplastics emitted from the agricultural sector is not well quantified, however, the recent German study indicates that 139 tons of microplastics are emitted yearly in Germany. This number is to be put in the European context; Germany's agriculture represents 14 % Europe's total production in value in 2019. (A worst-case scenario would be 1 000 tons per year).

The small and uncertain quantity of microplastics released by the European agriculture associated with its low toxicity may not be significant from unintentional microplastic release perspective.

2.8 City Dust

City dust is a generic name given to several sources that are grouped together because their individual contribution is small, but they account together for a considerable amount of losses as per some recent studies. While the UN Environment, study refers to data from IUCN report for calculating the microplastics generation through city dust, the definition of the city dust varies.

One of the reasons of city dust as a main contributor of microplastic pollution in global studies and not in the European studies could be attributed to the fact that the losses related to city dust are driven by population number and regions most associated with this number are Africa, China, India.

Table 72: Microplastic releases from city dust

Study	Findings
(Eunomia, 2018)	City dust is mentioned in the long list of microplastic sources and includes indoor dust and road dust only.
(OSPAR, 2017)	Mentioned as tyre dust, no quantification found.
(Ryber et al., 2019)	Global emissions 500 000 tons/year.
(UN Environment, 2018)	Global emissions 650 000 tons/year.

City dust is not a single identified source of microplastics but rather a collection of sources and cannot be tackled as a single entity. Therefore, to reduce city dust amounts, the efforts could be better focused on individual sources composing the city dust such as tyre wear particles, textile fibres, combustion engine particles, etc.

Indoor and outdoor building materials of plastic (Floorings, pipes, roof coverings, garden plastic furniture)

Plasticised as well as hard polyvinyl chloride (PVC) makes up the majority of the plastic building materials subject to deterioration and weathering. The main sources are believed to be flooring, roofing and gutters

While indoor microplastics releases typically go to the municipal sewage system, the outdoor parts are likely to release to the soil, surface water and urban run offs (entering the municipal sewage system and/or going direct to the local environment).

Table 73: Microplastic releases from indoor and outdoor building material of plastics

Study	Findings
(EC/Eunomia, 2018)	Mentioned in the long list of microplastic release source. No quantification found.
(OSPAR, 2017)	Not identified.
(Ryber et al., 2019)	Included in city dust.
(UN Environment, 2018)	Included in city dust.

Although containing flame retardants and other such toxic chemicals, given the lack of reliable information on the quantity of emissions from these sources, these sources may not need to be explored further.

2.9 Shoe soles

Soles of footwear are typically made of PVC, polyurethane or synthetic rubber. During wear microplastics particles are formed. The only finding that quantifies this source is Denmark 2015. The EC/Eunomia (2018) report refers to the same data.

Table 74: Microplastic releases from wear and tear of shoe soles

Study	Findings
(EC/Eunomia, 2018)	Identified and quantified only for Denmark.
(OSPAR, 2017)	No mention was found except in case of release from shoes after use of artificial turf.
(Ryber et al., 2019)	Included in city dust.
(UN Environment, 2018)	Included in city dust.

The data on the quantities emitted by shoe soles is too scarce and too uncertain to enable further analysis.

2.10 Cooking utensils and scouring pads

Wear and tear in tools, scouring pads and plastic clothes used in kitchens and bathrooms may cause a release of microplastics directly discharged to sewage.

Table 75: Microplastic releases from cooking utensils and scouring pads

Study	Findings
(EC/Eunomia, 2018)	Kitchen utensils identified in the long list of microplastics.
(OSPAR, 2017)	Not identified
(Ryber et al., 2019)	Included in city dust.
(UN Environment, 2018)	Included in city dust.

The main issue related to microplastic releases from kitchenware are the PFAs emitted from non-stick pans because of their toxicity. A potential solution to reduce the danger represented by these emissions could be to enforce a ban of these substances from kitchenware. The lack of information on the potential released quantities of microplastics makes it difficult further analysis.

2.11 Additional sources identified through stakeholder interactions

Telephone poles and railway sleepers

Plastic substitutes to the wooden or concrete telephone poles and railway sleepers were introduced in 2009. Microplastic releases from railway sleepers might exist especially from wear and tear but have not yet been quantified.

No information on quantities of microplastic release from these sources were found. Researchers at the Dutch RIVM are investigating the microplastic releases and will publish their results, thus if railway sleepers appear to be a significant source of microplastics, it can be considered.

Shipping

Shipping of goods by cargo worldwide is increasing and shipping activities incur losses of containers to the sea the 3-year average container loss for the period 2017 – 2019 was 779 containers. These containers can then release their content to the environment, thus (when containing plastics goods which is often the case) increasing the amount of plastic waste in the oceans. These plastic emissions although leading to an increase in the quantity of plastics in the sea are not microplastics directly, the microplastics will be emitted after the weathering of these plastic waste at sea under the conjugated effects of abrasion, salt water and UV.

As these are not microplastics resulting from the use phase of the materials nor are they manufactured as microplastics, this source was not assessed in this study. Moreover, legislative instruments are already in place to limit these emissions. This issue will be addressed with the transport of pellets.

Cooling water

No quantification of the emissions could be found and only one mention of cooling water as a source of microplastics was found in the scientific literature. Moreover, the Industrial Emissions Directive will tackle any emissions from the cooling water since it is an industrial effluent. **This leads to the conclusion the emissions are limited and that there is already a legislative framework in place.**

Plastic balls used in soft gun games

Microplastics from airsoft guns were mentioned in one article as having been identified in microplastics sampled on a beach. However, there does not seem to be a big amount of these specific microplastics released into the environment especially since users of these recreational guns are aware of the potential harm that plastic beads may have on the environment and so the industry and the users are shifting towards biodegradable pellets.

Given the lack of data combined with the expected low quantity of microplastics emitted from this source as well as the industry and players' shift towards biodegradable pellets, this source may not be relevant to explore further.

Biobeads

Biobeads or biological aerated flooded filter (BAFF) media are pellet like materials used in wastewater treatment plants for tertiary treatment. The losses occur because of failures of steel mesh retainers and because of continuous leaks (one the main manufacturer mentions 1% per year as a possibility but that if operated correctly there should be no losses). It uses polystyrene beads which are already known to cause microplastic pollution.

From the information provided by the Cornish Plastic Pollution Coalition, the European biobead pollution seems to be concentrated in the UK, it is possible that this specific type of BAFF medium is mostly used there. The emissions at that country's level may require action but they are no longer under the Commission's jurisdiction. In any case, these amounts would not justify launching a study in the near future, however, given the fact that biobeads bear a biofilm, there is a potential health risk letting them be released. Being emitted from pathways s (wastewater treatment plants) it should be possible to tackle these emissions with already in place legislative tools such as the Wastewater Treatment Directive or the Industrial Emissions Directive.

EUROPEAN
COMMISSION

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PART 3/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Combatting microplastic pollution in the European Union

Accompanying the document

Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on preventing plastic pellet losses to reduce microplastic pollution

{COM(2023) 645 final} - {SEC(2023) 346 final} - {SWD(2023) 330 final} - {SWD(2023) 333 final}

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Annex 15:
Preliminary analysis of the main sources of microplastic emissions

This Annex reflects the initial analytical work that was undertaken while developing this impact assessment. While six major sources of unintentional releases of microplastic were identified (paints, tyres, pellets, textiles, detergent capsules and geotextiles), pellets were the only source retained for further legislative action in this impact assessment. The preliminary analysis showed that subject to further analysis of cost-effectiveness, and the impacts of alternatives, **existing or forthcoming legislative instruments were better suited to tackling microplastic releases from paints, tyres, textiles, detergent capsules and geotextiles**. This Annex outlines the preliminary analysis of these five sources in view of guiding any future analysis.

1 THE ORIGINALLY IDENTIFIED SOURCES OF MICROPLASTIC EMISSIONS

A UN Environment study[1] identified as many as 74 sources for the release of microplastics (both primary and secondary microplastics) into the environment. Depending on the literature source, the importance and share of sources contributing to the unintentional release of microplastics vary widely. Microplastics are released in different stages of the product life cycle, such as production, transport, use, and end-of-life. Regarding industrial sources, the plastic and textile industries are considered to be the major contributors.

It is to note that the present monitoring data lacks harmonization of sampling and analytical methods, and data is difficult to compare. Different approaches were used to estimate the emissions from sources because of the heterogeneity of the available data or data unavailability. Several studies have indicated tyres, textiles and pellets as the main sources of the unintentional release of microplastics[2]. Further desk research and stakeholder consultation[3] pointed to three additional sources, as the preliminary analysis estimated them as main sources of unintentional releases of microplastics:

- Paints, probably the largest emitter, including also road markings and marine paints;
- Geotextiles;
- Detergent capsules (comprising laundry and dishwater capsules).

For pellets, textiles, detergent capsules and geotextiles, reliable estimates were not available on the quantity of material or for the microplastic emission rate, and therefore researchers have estimated

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1 UN Environment (2018): Mapping of global plastics value chain and plastics losses to the environment with a particular focus on marine environment

2 Germany (2014) Sources of microplastics relevant to marine protection, Report for Federal Environment Agency.
Norway (2014) Sources of microplastic pollution to the marine environment, Report for Norwegian Environment Agency.
Denmark (2015): Occurrence, effects and sources of releases to the environment in Denmark, Report for The Danish Environmental Protection Agency.
Sweden (2016): Swedish sources and pathways for microplastics to the marine environment, Report for Swedish Environmental Protection Agency
OSPAR (2017): Assessment document of land-based inputs of microplastics in the marine environment
Eunomia (2018): Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not Intentionally added in) products: Final report.
Ryberg et al. (2019): Global environmental losses of plastics across the value chains. Resource, conservation and Recyling.

3 A dedicated website https://microplastics.biois.eu was maintained to ensure constant interaction with stakeholders

varying emission levels. A range of possible emissions scenario was provided for these four sources, which varies significantly for some sources such as textiles.

For tyres, on the other hand, in the absence of data, a modelling approach was used for estimating the potential microplastic emissions, resulting in an average figure. On the basis of the uncertainty of the input data and the modelling parameters, an uncertainty factor of about 20% was applied to calculate the upper and lower ranges. For paints, a confidence interval for the micro-plastic leakage to the environment was estimated using a Montecarlo approach. The first step is to set confidence intervals for the input parameters. Since the data availability surrounding plastic losses from paint is scarce, a qualitative approach rather than a data-driven approach is used to set the intervals on the input parameters[4]. Ultimately, the 95% confidence interval for the total paint micro-plastic leakage to the environment in EU-27 is 231 - 863 kt a year. Estimated releases from these six sources are captured in Table 1.

Table 1: Estimated releases from the six sources of unintentional microplastics release to the EU environment

Source	Quantity (tonnes/year), 2019*
Paints	231 000 – 863 000 (average 482 000)
Tyres	360 000 – 540 000 (average 450 000)
Pellets	52 140 – 184 290
Textiles	1 649 – 61 078
Geotextiles	6 000 – 19 750
Detergent capsules	4 140 – 5 980
TOTAL of the selected six sources	654 929 – 1 674 098 (90-93% of total emissions)
TOTAL of all sources	729 087 – 1 808 198

(*) Estimations based on the supporting study for this Impact Assessment

Other sources were also considered and summarised in Annex 14. It also includes further information on each of these other sources that we did not retain in the analysis because they were considered as microplastics coming from the intentional use of microplastics added to products or due to a lack of sufficient information.

2 INTRODUCTION TO THE PRELIMINARY ANALYSIS OF THE FIVE SOURCES

In this chapter, we present the preliminary analysis undertaken for five of the originally identifiedmajor sources: tyres, textiles, paints, detergent capsules and geotextiles. These sources were analysed by identifying measures to tackle the following two interlinked problem areas:

- **The negative environmental and (potential) health impacts associated with the unintentional releases of microplastics into the environment from the five sources into the environment.** Most of the problems are associated with microplastics in general,

[4] Paruta et al. (2022) Plastic Paints the Environment, EAEnvironmental Action 2022, ISBN 978-2-8399-3494-7

irrespective of their source. Specific impacts are explained when discussing the most relevant sources.

➢ **Insufficient data / information on unintentional microplastics releases from five sources.** There is an absence of comprehensive information on the unintentional releases of microplastics from different sources (thus a high uncertainty). While existing information might be sufficient to take action in some cases, also in line with the precautionary principle, in other cases more information and research is needed in order to understand the sources of microplastics and their impacts so that effective policies can be designed.

Although microplastics is an active field of research and the number of publications on microplastics has increased rapidly in recent years, a standardised procedure for identifying/quantifying microplastics from different sources is still lacking. Investigations are generally conducted using different methods, covering differing particle sizes and expressed in different units that cannot be converted, overall making it difficult to compare results across studies. Hence, the reported abundance of microplastics and respective sources in the environment have high variability and may differ by several orders of magnitude.

Data Uncertainties

This IA identifies, **for each of the five sources**, different uncertainties and data gaps that are explained in more detail in the baseline of this Annex. Some salient features include:

Tyres: Several factors influence the release of Tyre Wear Particles (TWP) into the environment, e.g. tyre material and design (which consists of many components), road composition, and driving behaviour. Analysing tyre abrasion in environmental samples is challenging, and an interpretation of the analytical data should reflect the external conditions. Additionally, reproducible quantification of particles in the environment depends on the laboratories' sampling and analytical techniques, where weaknesses and knowledge gaps exist. The ongoing work to develop a harmonised test method and standard to measure TWP emissions should help. In addition to uncertainties with the overall emission factors for tyre abrasion, there is also a lack of data on the mix of tyres currently in use and how they vary in terms of abrasion rates. A number of studies have demonstrated significant variation in abrasion rates between different tyre models and types both across different categories (i.e. tyre sizes and types) as well as within categories.

Textiles: the uncertainty of the microplastic estimations is high. In the baseline, they vary between 2 058 and 74 111 t per year in the EU. The data quality is low for production and wearing life-cycle stages. There is no data for the end-of-life. The uncertainty comes from the limited data to quantify microplastic emissions and not from the baseline extrapolation.

Paints: Some uncertainties and data gaps exist relative to market statistics of paint sold per paint sector and the plastic content within it. For wear and tear losses, the lifetime of the paint system is not a subject that is systematically researched and assessed, but its assessment is key in order to determine microplastic pollution during the use phase of the object.

Detergent capsules: The estimated amount of potential microplastic losses through capsules to the environment bears several uncertainties. The principal uncertainty results from the fact that this source relates to a water soluble and biodegradable polymer. There is a lack of information on the composition of PVOH and related mixtures used for detergent capsules due to trade secrets and the subsequent lack of data on whether all PVOH-based grades are fully degradable in all environmental media.

Geotextiles: There are several uncertainties and data gaps, in particular concerning the quantities installed and for which application they are used, along with the related microplastic emissions. Depending on the application, geotextiles do not represent the same microplastic emission potential, e.g., geotextiles used to stabilise the soil during road construction are not exposed to UV, air, or abrasion in the same way as geotextiles used for coastal protection. However, limited data is available.

Table 2: Problem evolution and objectives of EU actions

Problem area	How would the problem evolve without action?	Why is action needed at the EU level?	Objectives for remediation
Tyres	The trends show an increase in tyre wear emissions, with increases of around 20-30% expected by 2030. Whilst a test method for measuring TWP emissions is under development, this alone will not necessarily drive any reductions.	Type approval testing for tyres with a standard on tyre abrasion is foreseen and then needs to be implemented at a European and international level to ensure harmonisation of tyre quality and characteristics. EU action is required to set limits also for tyre abrasion in order to limit the emissions of microplastics from tyres, as well as to ensure a consistent implementation of measures and to avoid distortions in the market and between Member States.	To reduce emissions from tyres through actions targeted at the tyres themselves as well as other factors impacting emissions.
Textiles	The trends show an increase in microplastic emissions from textiles, around 22% expected by 2030.	EU action is required to improve the understanding of microplastic emissions over the life cycle of synthetic textiles. EU action will also ensure a consistent implementation of measures and avoid distortions in the market and between Member States.	To improve the knowledge base and bridge the data gaps through better source characterisation. To reduce microplastic emissions from textiles through actions targeted at the life-cycle (production, washing, etc.) of textiles.
Paint	Paint is the key to asset protection as it extends objects' lifetime. How polymer-based paint is used, though, is the source of microplastic pollution in the environment. Without action, the business-as-usual scenario is a never-ending accumulation of microplastic pollution in all environmental compartments.	In order to prevent microplastic emissions from paints, mandatory action is needed to make sure that measures are applied in different sectors which use paints. Action at EU level would create a coherent framework from which every Member state will benefit.	To improve the knowledge base and bridge the data gaps through better source characterisation. To reduce microplastic emissions from paints and incentivise the development of new technologies for paint application, maintenance and capture.
Detergent Capsules	The general increase in the use of PVOH and related blends in detergent capsules could raise concerns regarding their possible emissions in wastewater. There is a lack of data on whether all available PVOH-based grades are fully degradable in all environmental media.	EU action would ensure a consistent implementation of measures to tackle microplastic release from detergent capsules and create a coherent framework from which every Member state will benefit.	To improve the knowledge base and bridge the data gaps through better source characterisation. To ensure that PVOH does not cause any adverse environmental impacts, the objective of the remediation is to actively reduce the release of PVOH into the European environment.
Geotextiles	The geotextiles market is seeing significant growth (expected to grow by 2.5 times by 2029 compared to	An EU-wide action on tackling microplastic emissions from geotextiles will ensure deeper insight into the problem and	To improve the knowledge base and bridge the data gaps through better source characterisation.

Problem area	How would the problem evolve without action?	Why is action needed at the EU level?	Objectives for remediation
	2019). This would result in a significant release of microplastics (particularly from coastal erosion and river margins applications).	create a coherent framework from which every Member state will benefit.	The reduction of microplastic emissions from geotextile use.

3 RELEVANT LEGISLATION FOR REDUCING MICROPLASTIC EMISSIONS & ONGOING INITIATIVES

The following legislation and ongoing initiatives were identified as relevant to the reduction of microplastic emissions. This overview aims to provide insight into the EU's and Member States' current approach to microplastics and point to any regulatory gaps. This section only contains the legislation relevant to the five sources discussed and not to pellets. The legislation relevant to pellets, such as the REACH restriction, is explained in Annex 6 of this IA on legislation related to pellets.

Several EU policies and instruments (waste management, air quality, industrial emissions legislation, tyre labelling, motor vehicle type approval legislation) affect or could affect directly or indirectly the generation and release of microplastics in the environment. The Fertilising Products Regulation contains a provision on 'Controlled Release Fertilisers' targeting microplastic releases used for fertilisers. But none of these has already taken decisive action.

3.1 Ecodesign for Sustainable Product Regulation

In March 2022, the European Commission adopted a proposal[5] for Regulation establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC. This proposal is the cornerstone of the Commission's approach to more environmentally sustainable and circular products. The proposal builds on the existing Ecodesign Directive[6], which only covers energy-related products.

This proposal will set **harmonised rules on environmental sustainability** for products, including textiles and paints, to make them more durable, reliable, reusable, upgradable, reparable, easier to maintain and refurbish, and energy and resource-efficient. A preliminary assessment of the products to be included in the first Working Plan for the ESPR is currently ongoing. Textiles, detergents, tyres and paints may be part of the working plan in the framework of the ESPR proposal – this is to be determined at a later stage. The implementation of the ESPR is expected to include information and performance requirements on products at the source of microplastic release and using the corresponding testing and measurement method.

The Implementing Regulation on **eco-design for washing machines and washer-dryers**[7], adopted in 2019, recognises the need to consider, in the next review of the Regulation foreseen by 2025, the feasibility of new requirements for reducing micro-plastics in the water outlet, such as filters.

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5 European Commission, Commission Proposal for a Regulation establishing a framework for setting eco-design requirements for sustainable products and repealing Directive 2009/125/EC, COM(2022)142 final, 2022.

6 See Energy label and ecodesign (europa.eu)

7 Commission Regulation (EU) 2019/2023 of 1 October 2019 laying down ecodesign requirements for household washing machines and household washer-dryers pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Commission Regulation (EC) No 1275/2008 and repealing Commission Regulation (EU) No 1015/2010, OJ L 315, 5.12.2019, pp. 285-312.

3.2 Tyres labelling and EURO 7

In the recent revision of the Tyre Labelling Regulation[8], the co-legislators agreed to empower the Commission to adopt delegated acts in order to include parameters or information requirements for tyre “abrasion and mileage” (as soon as a suitable method is available). The co-legislator had clearly in mind how an indicator of abrasion alone was not going to be effective in orienting consumer purchase choice, and a complementary indicator, possibly combined and highly “valued” by consumers, such as mileage, was necessary. The type approval legislation refers to the same testing methods for the same parameters and sets the minimum requirements for efficiency, safety and health protection. The Euro 7 standard adopted by EC in November 2022 has a placeholder to introduce the abrasion limits for tyres once the emissions’ measurement methodology is developed.

3.3 Construction Products Regulation

The revised Construction Products Regulation introduces the requirements for construction products, such as cement, steel, aluminium and plastics, to improve the protection of health, safety and the environment, in line with the new Ecodesign for Sustainable Product Regulation.

3.4 EU Strategy for Sustainable and Circular Textiles

The EU strategy for sustainable and circular textiles[9], adopted on 30.03.2022, sets the vision for a more sustainable textile sector by looking at the entire life-cycle of textile products and proposing actions to change how to produce and consume textiles. The Strategy identifies microplastics releases as one of the main issues to be addressed and refers to the current initiative. The Strategy also mentions that “the Commission will propose harmonised EU extended producer responsibility rules for textiles with eco-modulation of fees, as part of the forthcoming revision of the Waste Framework Directive in 2023”.

3.5 Research

Besides the policy and legislative activities, the EU is dedicating substantial resources to better understanding and combating marine litter (including microplastics) through a number of projects funded by the LIFE, EMFF/EMFAF, Horizon 2020 and Horizon Europe Programmes or other projects, including enlargement neighbourhood funding and regional (e.g. Interreg) funding.

3.6 Member state and international actions on microplastics

Several EU member states have implemented measures to tackle microplastic emissions, particularly in recent years. If most of these measures are aimed at banning intentionally added microplastics (such as in cosmetics) or single-use plastics, there are examples of initiatives taken on unintentionally released microplastics that are presented in

[8] Regulation (EU) 2020/740 of May 2020

[9] European Commission, Commission Communication – EU Strategy for Sustainable and Circular Textiles, COM(2022)141 final, 2022.

Table 3.

Table 3: Selected actions in Member States

Countries	Sources	Measure
France	Textiles	Mandatory requirement for all new washing machines to be equipped with microfiber filters by January 1st 2025.[10]
Denmark	Microplastics	Monitoring program of Danish Marine Strategy including monitoring of marine litter, analyses of microplastic in sediments, as well as analyses of macro and microplastics in stomachs of two fish species.[11]
Netherlands	Microplastics	Research program on mitigation measures to avoid microplastic emissions from pellets, tyres, textiles and paints. Investigation on the supply chain by January, mainly on spills. Developing a plan with a focus on small companies.[12]
Sweden	Microplastics	Research program in 2017 to identify the main sources of microplastic emissions in Sweden.[13]

Similarly, outside of the EU, several countries have started actions against microplastic emissions, which are summarised in Table 4.

Table 4: Selected international actions

Countries	Sources	Measure
Chile	Microplastics	National Strategy for Marine Waste and Microplastics Management, launched in 2021, with the objective for sustainable plastic waste management throughout their life cycle, preventing and reducing the discharge of plastic waste in aquatic ecosystems.
Commission for Environmental Cooperation (CEC)	Microplastics	Transformation of recycling and solid waste management in North America" brings Mexico, Canada, and the US together to accelerate the adoption of circular economy and sustainable management practices regarding materials (plastics and microplastics) in North America.
UK	Microplastics	The UK government commissioned research projects to better understand the issue of microplastics losses from tyres and clothing. A Rapid Evidence Review has been commissioned to gather the evidence to progress approaches to more consistent definition, sampling and assessment methodologies for monitoring and reporting microplastics in water. Collaboration is also ongoing with the water industry to establish methods to detect, characterise and quantify microplastics in waste water and evaluate the removal efficiency of treatment processes.

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[10] LOI n° 2020-105 du 10 février 2020 relative à la lutte contre le gaspillage et l'économie circulaire (1) [Law n°2020-105 of 10 February 2020 related to the fight against waste and the circular economy (1)], Journal official "Lois et Décrets" no. 0035 du 11 février 2020 [JORF] [Official journal "Laws and Decrees" no. 0035 of 11 February 2020], 11 February 2020, Fr.

[11] Ministry of Environment and Food of Denmark; Microplastics: Occurrence, effects and sources of releases to the environment in Denmark, Environmental project No. 1793, 2015

[12] Dutch Government, Policy Programme on (micro) plastics – European Marine Strategy Framework Directive, 2020 (https://g20mpl.org/partners/netherlands).

[13] Swedish Government, 'Microplastics', 2022 (https://www.naturvardsverket.se/amnesomraden/plast/om-plast/mikroplast/).

Countries	Sources	Measure
Australia	Textiles	The National Plastics Plan 2021 announced that the Australian Government will work with industry to phase in microfibre filters on new residential and commercial washing machines by 1 July 2030[14]
Canada	Textiles Research	Under the Zero Plastic Waste strategy, Canada is implementing a comprehensive approach to reduce plastics pollution, which includes investing in science to close research gaps on macro and microplastics. The government provided funding to support research on microfibre release occurring during washing, to design dedicated test methods and to develop sampling methods for microfibres in laundry effluent and wastewaters.
Norway	Tyres, Textiles, Turfs	The Norwegian Climate and Environment Ministry commissioned a review on microplastics pollution, which includes measures to target wear and tear of vehicle tires and textiles and losses from artificial turfs. Norway has implemented speed limits to reduce local air pollution caused by road dust will likely also reduce microplastic emissions.
USA (Connecticut)	Textiles Research	Development of research programs, awareness-raising campaigns and best consumer practices to reduce microfibre shredding and microplastics emissions during laundering House Bill 5360 (2018) to target microfibres emitted during laundering. The bill mandated further research on microfibres, awareness-raising initiatives and the development of best consumer practices and industry efforts to prevent microfibre shedding.
USA (California)	Textiles	Microfiber bill AB 129: development of a standard methodology to assess the efficiency of microfiber filtration in washing machines Bill AB 1952 (under preparation): launch of a pilot program on microfibre filters
USA (New York)	Textiles	New York State proposed Assembly Bill A01549 in 2018. This would require the following labelling for all products containing more than 50% synthetic material: “This garment sheds plastic microfibers when washed”.
USA (NASA)	Monitoring	Using a new technique relies on data from NASA’s Cyclone Global Navigation Satellite System (CYGNSS), a constellation of eight small satellites that measures wind speeds above Earth’s oceans and provides information about the strength of hurricanes, the NASA team looked for places where the ocean was smoother than expected given the wind speed, which they thought could indicate the presence of microplastics. Then they compared those areas to observations and model predictions of where microplastics congregate in the ocean.

3.7 Industry initiatives

Selected voluntary initiatives are presented in Table 5.

[14] Australian Government, ‘National Plastics Plan 2021’, 2021 (https://www.agriculture.gov.au/sites/default/files/documents/national-plastics-plan-2021.pdf).

Table 5: Selected voluntary initiatives (Industry and NGO)

Name	Sources	Details
Microfibre Consortium	Textiles	Development of practical solutions for the textile industry to minimise microfibre release to the environment from textile manufacturing and product life cycle.
Voluntary Cross Industry Agreement	Textiles	Several industry associations (International Association for Soaps, Detergents and Maintenance Products, Comité International de la Rayonne et des Fibres Synthétiques, European Outdoor Group, Euratex and the Federation of the European Sporting Goods Industry) have formed a voluntary Cross Industry Agreement. The partnership aims to contribute to the development of international standardised test methods to identify and quantify microfibres, share information on the progress of research, knowledge gaps, options and priorities and support and participate in industrial research for the development of feasible and effective solutions
Clothing Industry initiative	Textiles	Patagonia, Arc'teryx, REI and MEC and MetroVancouver commissioned Ocean Wise's Plastic Lab to investigate microfibers, the tiny textile particles that shed from garments over their lifetime.
Tire Industry Project	Tyres	This project, launched by 11 major tyre manufacturing companies under the umbrella of the World Business Council of Sustainable Development (WBCSD), aims to identify and implement feasible measures in order to reduce the impact of the life cycle of tyres on the environment, also in the context of microplastics pollution. [15]
European Tyre and Road Wear Particle Platform	Tyres	The European Tyre and Rubber Manufacturers Association (ETRMA) initiated this multi-stakeholder platform aimed to facilitate research, encourage stakeholder cooperation and knowledge-sharing and explore mitigation options to reduce TRWP pollution.
European Tyre and Rime Technical Organization (ETRTO)	Tyres	ETRTO is working on assessing the feasibility and accuracy of a standard test method for the tyre abrasion rate to propose to the European Commission.
Plastic soup foundation	Textiles Cosmetics	With their Beat the Microbead app, one can scan all your personal care and cosmetic products for yourself to see if they contain plastic ingredients. Their Ocean Clean Wash campaign additionally raises awareness about microfibers and the relationship between clothes and plastic in the ocean.
Race for Water Odyssey	Microplastics	Raise awareness about microplastics[16]
Rethink plastic alliance	Microplastics	Awareness raising, policy lobbying
Seas at Risk	Microplastics	Awareness raising, policy lobbying

[15] https://tireparticles.info/our-research
[16] https://www.raceforwater.org/en/news/microplastics/

3.8 Multilateral Actions

In March 2022, the second session of the 5th United National Environment Assembly unanimously adopted resolution 14: End Plastic Pollution: towards an international legally binding instrument[17] (hereafter referred to as the resolution). The preamble to the resolution highlights that "plastic pollution includes microplastics". This inclusion indicates that the intergovernmental negotiating committee (INC) will have to consider how to address microplastics in a forthcoming global agreement.

In May 2019, the Conference of the Parties to the Basel Convention adopted a decision by which it amended Annexes II, VIII and IX of the Convention in relation to plastic waste. A Plastic Waste Partnership was created with the aim, among other things, to significantly reduce and eliminate the discharge of waste plastics and microplastics in the environment. The OECD Council Recommendation on Water calls for Adherents to prevent, reduce and manage water pollution from all sources while paying attention to pollutants of emerging concern, such as microplastics. UNEP's Clean Seas campaign raises awareness on microplastics, such as on cigarette filters, textiles and cosmetics.

4 PROBLEM DEFINITION BY SOURCE

4.1 Problem definition for tyres

Tyre wear is caused by the friction process between tyres and the road surface. Accordingly, tyre wear is emitted wherever and whenever vehicles travel. From the point of origin, it can either be transported directly into the three environmental compartments (soil, air, water) or indirectly through remobilisation and deposition. Most tyre wear is initially deposited on or near the road surface. The finer fractions (PM2.5 and PM10) can be transported much further by airborne drift[18]. As exhaust emissions of particular matter continue to decline due to legislation such as Euro 6, the contribution that tyre wear and other non-exhaust emissions make to total PM emissions from road transport are increasing significantly. For example, in the UK, non-exhaust emissions (i.e. particles from brake wear, tyre wear and road surface wear) have been estimated to contribute around 60% and 73% (by mass) of primary PM2.5 and PM10 emissions, respectively, from the road transport sector (and 7.4% and 8.5% of total primary UK PM2.5 and PM10 emissions, respectively)[19]. In the EU, non-exhaust PM, emissions from brake, tyre or road wear, have all increased and become the dominant transport emission source for PM10 (since 2012) and PM2.5 (since 2018)[20].

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[17] United Nations Environment Assembly, Resolution – End plastic pollution: towards an international legally binding instrument, UNEP/EA.5/Res.14, 02.03.2022.

[18] Air Quality Expert Group, Report for UK Department for Environment, Food and Rural Affairs, Scottish Government, Welsh Government, and Department of the Environment in Northern Ireland, 'Non-Exhaust Emissions from Road Traffic', 2019 (https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf).

[19] Air Quality Expert Group, Report for UK Department for Environment, Food and Rural Affairs, Scottish Government, Welsh Government, and Department of the Environment in Northern Ireland, 'Non-Exhaust Emissions from Road Traffic', 2019 (https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1907101151_20190709_Non_Exhaust_Emissions_typeset_Final.pdf).

[20] Vanherle, K. et al., 'ETC/ATNI Report 5/2020: Transport Non-exhaust PM-emissions. An overview of emission estimates, relevance, trends and policies', *Eionet Portal*, 2021 (https://www.eionet.europa.eu/etcs/etc-atni/products/etc-atni-reports/etc-atni-report-5-2020-transport-non-exhaust-pm-emissions-an-overview-of-emission-estimates-relevance-trends-and-policies).

4.1.1 Pathways to the environment and the scale of their impact

The impact of tyre wear on individual environmental compartments and the organisms living there is not sufficiently understood. However, there are already many studies that have estimated the total emissions of tyre wear for a region or country. These have typically been developed by combining activity rates (generally vehicle kilometres) with emission factors (i.e. the rate of microplastic release per vehicle kilometre), sometimes disaggregated by road and/or vehicle type, although other approaches have also been taken. A comprehensive literature review on tyre wear has been prepared by Baensch-Baltruschat et al.[21] This provides estimates of the mass losses of the tyres. In some cases (e.g., in Sundt et al.), the calculated TWP (total) is supplemented by the polymer shares (polymer).

Table 6: Annual tyre wear emissions for different countries and regions from Baensch-Baltruschat et al.[22] supplemented by Hann et al.[23] and ETRMA.[24][25][26]

Country	Tyre wear emissions in total (referring to tyre tread) tonnes/years	Calculation method	Emission Factor applied	Remarks	Reference
EU28	572,157		own data		(ETRMA, 2018)
EU28	503,586	b	k		(Hann, 2018)
EU28	1,327,000	b		Estimates based on EU Registered LDV and HDV X Total vehicle km derived from data of Germany / no differentiation of road type	(Wagner, 2018)
Germany	61,000	b	own data	Derivation of EF is not explained	(Baumann, 1997)
Germany	111,420	b	i		(Hillenbrand, 2005)
Germany	60,000-111,000	c			(Essel, 2014)
Germany	133,000	b	i		(Wagner, 2018)

[21] Baensch-Baltruschat, B. et al., 'Tyre and road wear particles – A calculation of generation, transport and release to water and soil with special regard to German roads', *Science of the Total Environment*, Vol. 752, 2021, Elsevier BV.

[22] Baensch-Baltruschat, B. et al., 'Tyre and road wear particles – A calculation of generation, transport and release to water and soil with special regard to German roads', *Science of the Total Environment*, Vol. 752, 2021, Elsevier BV.

[23] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

[24] Data provided by the European Tyre & Rubber Manufacturers Association (ETRMA) in: Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

[25] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

[26] Data provided by the European Tyre & Rubber Manufacturers Association (ETRMA) in: Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

Country	Tyre wear emissions in total (referring to tyre tread) tonnes/years	Calculation method	Emission Factor applied	Remarks	Reference
Germany	75,200	b	j		(Baensch-Baltruschat, 2020)
Germany	98,400		k		(Baensch-Baltruschat(b), 2020)
Germany	125,188	b			(Kole, Wear and Tear of Tyres in the Global Environment: Size Distribution, Emission, Pathways and Health Effects, 2019)
Denmark	6514 – 7660	b	l	Recalculation of data estimated by Lassen et al. 2015	(Kole, Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. , 2017)
Denmark	4200 – 6600	d			(Lassen, 2015)
Denmark	7310	d			(Kole, Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. , 2017)
France	37 646	d			(Unice, 2018)
Seine River basin (FR)	13 804	e			(Unice, 2018)
Italy	50 000	n/a			(Milani, 2004)
Netherlands	15452 (total)	b	n		(Sherrington, 2016)
Netherlands	7726 (polymer)	b	n		(Sherrington, 2016)
Netherlands	17300 (only tyre wear)	b	o		(Verschoor, 2016)
Netherlands	15030	b	p		(Kole, Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. , 2017).
Netherlands	8768 (corrected for amounts trapped in open pore road surface)	b	p		(Kole, Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. , 2017)

Country	Tyre wear emissions in total (referring to tyre tread) tonnes/years	Calculation method	Emission Factor applied	Remarks	Reference
Norway	7500 (total)	b	l, m		(Sundt, 2014)
Norway	4500 (polymer)	b	l, m		(Sundt, 2014)
Norway	9600 (total)	f			(Sundt, 2014)
Norway	5700 (polymer)	f			(Sundt, 2014)
Norway	7100 (total)	b	l,k		(Vogelsang, 2020)
Norway	4300 (polymer)	b	l,k		(Vogelsang, 2020)
Sweden	13000	b	q		(Magnusson, 2016)
Great Britain	38000 – 75000	d			(UK, 1999)
Great Britain	42000 – 84000	d		Update of data given by EA UK	(Kole, Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment. , 2017)

A Own calculation, data source for number of inhabitants: total Europe (Eurostat, 2020), others (CIA, 2018).
B Estimation based on emission factors and total vehicle km.
C Data based on (Gebbe, 1997) and WDK (Association of German Rubber Manufacturing Industry, reporting year 2005)
D Estimation based on consumption of tyres and abrasive loss (weight loss during use).
E Derived from data for entire France based on population density and lengths of urban and rural roads in the Seine river basin
F Estimation based on the number of tyres collected for retreading and weight loss during use.
G Estimation based on the number of registered vehicles, life expectancy of tyres and loss during life time
H Extrapolated from the emission data for DEU, DNK, GBR, ITA, NLD, NOR, SWE, AUS, BRA, CHN, IND, JPN, and USA, and the world's number of vehicles
I Emissions factors compiled by (Hillenbrand, 2005)
J Emissions factors compiled by (Gebbe, 1997)
K Emission factors by (Deltares-TNO, Emissieschattingen Diffuse bronnen Emissieregistratie. Remslijtage., 2016).
L (Luhana, 2004)
M (Anonymus, 2012)
N (Deltares-TNO, Emissieschattingen Diffuse bronnen Emissieregistratie. Remslijtage. , 2014)
O (Klein, 2015) (Dutch Pollutant Release and Transfer Register).
P Van Duijnhove et al. (2014)
Q (Gustafsson, 2008)
R (Aatmeeyara, 2009)
S Unified EF: 50 mg/km.

The total amount for the EU28, as shown in the table, is in the range of about 500 000 – 1 300 000 t/a (with the UK included). If the amount of emissions from the UK is excluded, according to Kole

(2017)[27], the emissions from the EU27 based on these studies would be about 460,000-1,220,000 t/a (a specific quantification has been developed for this study and is described later in in the baseline. Where tyre wear ends up in the environment is the subject of current research. The tyre wear mapping study[28] has calculated the input pathway after more direct emission of tyre wear for Germany and selected regions in a comprehensive model. According to this, in Germany as a whole, tyre abrasion is emitted in approximately 57% in urban areas, 43% to open spaces and forests. Direct input into water bodies is only 0.4%, but indirect input from precipitation drainage must be considered.

The tyre wear deposited on the road surface can be flushed into surface waters via the road runoff after precipitation, depending on the sewer system. Figure 1 shows the two possible sewer systems “separate system”, where the road runoff is discharged directly into a surface water body, and the “combined sewer system”, where the road runoff is discharged to a wastewater treatment plant. During heavy rainfall events, the combined sewer system may be overloaded and drain directly to a surface water body by means of a sewer overflow. Figure 2 shows volume flows based on the example of Berlin and shows that about 78% of precipitation water is discharged untreated into surface waters. The discharge via the sewer overflow amounts to 7% (15 million m³) and thus represents a pathway that also needs to be taken into account.[29] Sustainable drainage systems can be an efficient measure to reduce emissions from tyre wear into the surface water, but such systems are mainly used on motorways due to the space required. Further measures are discussed later in this section. WWTP is not seen as a sink because microplastics from tyre wear will typically end up in sludge which is either applied to fields as fertiliser and thus contributes to microplastic accumulation in the soil, or it is incinerated or landfilled.

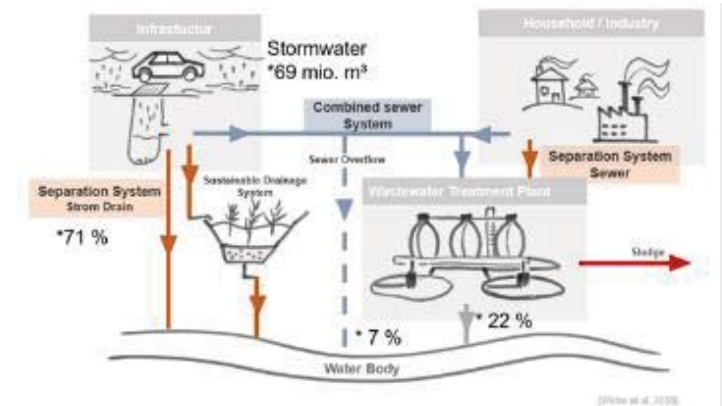

Figure 1: Volume shares of storm water in separations system and combined sewer system in Berlin[30]

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[27] Kole, P.J., Löhr, A.J., Van Belleghem, F.G.A.J. and Ragas, A.M.J., ‘Wear and Tear of Tyres: A Stealthy Source of Microplastics in the Environment’, *International Journal of Environmental Research and Public Health*, Vol. 14, No. 10, 2017.

[28] German Federal Ministry of Traffic and Digital Infrastructure (BMVI), ‘Schlussbericht 19F2050A-C: TyreWearMapping: Reifenabrief – ein unterschätztes Umweltproblem?’ [Final report 19F2050A-C: TyreWearMapping: Tyre abrasion – an underestimated environmental problem?], 2021 (https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/kompetenz/prozesse/tyrewearmapping-schlussbericht.pdf), De.

[29] TyreWearMapping - Digitales Planungs- und Entscheidungsinstrument zur Verteilung, Ausbreitung und Quantifizierung von Reifenabrieb in Deutschland. Final report 19F2050A-C

[30] Wicke, D. et al., ‘Projekte: Relevanz organischer Spurenstoffe im Regenwasserabfluss Berlins (OgRe)’ [Project: The relevance of organic trace substances in Berlin stormwater runoff], organischer Spurenstoffe im Regenwasserabfluss Berlins. Hg. v. Kompetenzzentrum Wasser Berlin. Kompetenzzentrum Wasser Berlin.

Baensch-Baltruschat et al.'s study defines the total release of tyre and road wear particles in Germany. Up to 20% of tyre abrasion was estimated to enter surface waters depending on the sewer systems. According to Baensch-Baltruschat et al., 74% ends up in the soil, which is within the range of the studies[31,32] (49% - 85%). There is a lack of data on how microplastics behave once they enter soil and surface water and the extent to which degradation occurs.

Figure 2: Releases of microplastics from tyre wear into the environment for Germany[33]

4.1.2 Factors affecting the scale of the problem

This section discusses the key parameters influencing tyre wear, building on the problem drivers identified in the figure above. A comprehensive overview of the key parameters influencing tyre wear, according to Boulter et al.[34] presented in figure below.

Tyre characteristics
- Size (radius/width/depth)
- Tread depth
- Construction
- Tyre pressure and temperature
- Contact patch area
- Chemical composition
- Accumulated mileage
- Set-up (*e.g.* tracking, toe-in and camber)

Vehicle characteristics
- Vehicle weight and distribution of load
- Location of driving wheels
- Engine power
- Power/unassisted steering
- Electronic braking systems
- Suspension type and condition

Road surface characteristics
- Material: bitumen/concrete
- Texture pattern
- Texture wavelength - micro/macro/mega
- Porosity
- Condition, including rutting and camber
- Road surface wetness
- Silt loading of road surface
- Surface dressing

Vehicle operation
- Speed
- Linear acceleration
- Radial acceleration
- Frequency and extent of braking and cornering

Figure 3: Influences on the emission factor of tyre wear

Possible influencing variables are divided into driving behaviour, tyre, road surface and vehicle characteristics. From a technical measurement point of view, it is very difficult to evaluate the individual influencing factors separately. The RAU project "Tire wear in the environment" has

31 Unice et al., Characterizing export of land-based microplastics to the estuary – Part II: Sensitivity analysis of an integrated geospatial microplastic transport 250odelling assessment of tire and road wear particles, 2018

32 Hann, S., Sherrington, C., Jamieson, O., Hickman, M., Kershaw, P., Bapasola, A., & Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products. Report for DG Environment of the European Commission, 335.

33 Baensch-Baltruschat, B. et al., 'Tyre and road wear particles – A calculation of generation, transport and release to water and soil with special regard to German roads', *Science of the Total Environment*, Vol. 752, 2021, Elsevier BV.

34 Boulter, P. G. „A Review of emission factors and models for road vehicle non-exhaust particulate matter." Project Report PPR0065, Department for the Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government, and the Department of Environment in Northern Ireland, 2006

identified the factors (Figure 4) that influence tyre wear[35]. According to this, road topology and driving behaviour have the most significant influence on tyre wear emissions. The road topology describes the road layout and can be divided into different driving situations such as curves, intersections, slopes and straight roads etc. Changing the topology (e.g. increasing the curve radius) is certainly not technically feasible on a large scale. But a reduction of the permitted maximum speed could be an agreed adjustment here. In addition, hot spots can be identified with the description of the topology so that specific measures, such as the treatment of road runoffs or optimised road cleaning, can be implemented. The driving behaviour can be described, for example, by acceleration behaviour. An aggressive driving behaviour (high accelerations) leads to more tyre wear than a moderate driving behaviour (low accelerations).

Also, the project team carried out road dust studies that underlined the influence of road topology. In the local investigations, traffic lights, curves, gradients and straight roads were considered and compared. In the analysis of the road dust samples, increased SBR (styrene-butadiene rubber) contents were found at the locations of curves and traffic lights.

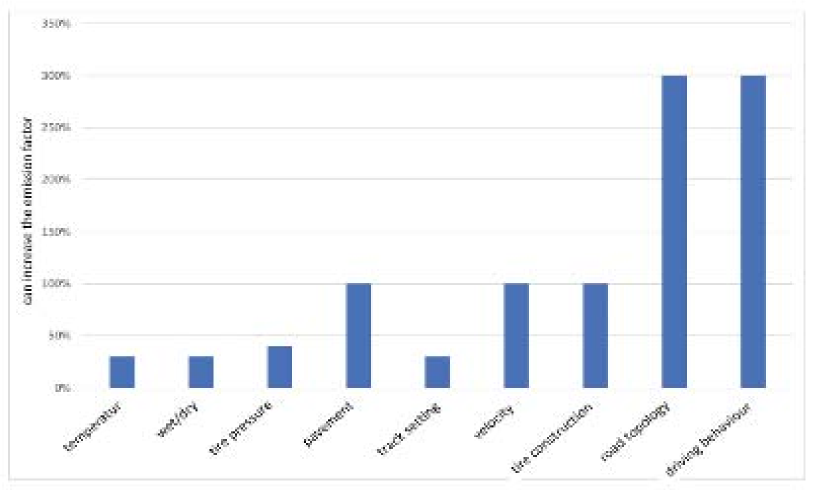

Figure 4: Factors influencing the formation of tyre wear and maximum influence[36]

Development in transport volume and mode of transport

In the OECD report[37], a reduction of PM10 emissions from road traffic by 251 approx. 40 % from 2000 to 2014 was determined (Figure 5). However, the decrease is only caused by exhaust emissions; the emissions from non-exhaust (tyres, brakes, roads) remained constant. With further internal combustion engine vehicles (ICEVs) optimisation and progressive replacement of ICEVs by electric vehicles (EVs), a further reduction in exhaust emissions can be expected, and the non- exhaust emissions will become the main source of PM10 emissions in road traffic.

[35] Barjenburch, M. and Venghaus, D., ‘Präsentation: Reifenabrieb in der Umwelt’ [Presentation: Tyre abrasion in the environment], Abschlusskonferenz "Plastik in der Umwelt" [Conference "Plastic in the environment"], 2021 (https://bmbf-plastik.de/sites/default/files/2021-05/Session-B_Venghaus_RAU.pdf).

[36] Barjenburch, M. and Venghaus, D., ‘Präsentation: Reifenabrieb in der Umwelt’ [Presentation: Tyre abrasion in the environment], Abschlusskonferenz "Plastik in der Umwelt" [Conference "Plastic in the environment"], 2021 (https://bmbf-plastik.de/sites/default/files/2021-05/Session-B_Venghaus_RAU.pdf).

[37] OECD, *Non-exhaust Particulate Emissions from Road Transport: An ignored environmental policy challenge*, 2020, OECD Publishing, Paris.

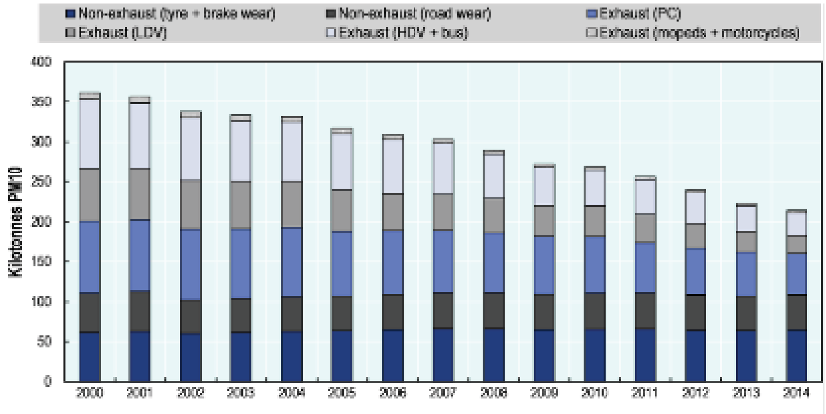

Figure 5: Annual PM emissions from road transport, EU-28, 2000-2014

A key driver of tyre wear emissions is driving mileage. It is expected that there will be a significant increase in road transport volumes over the next decades. The JRC estimates (Figure 6) show a 16% increase in passenger road transport between 2010 and 2030 and 30% for 2010-2050. Freight transport is estimated to increase by 33% by 2030 and 55% by 2050[38].

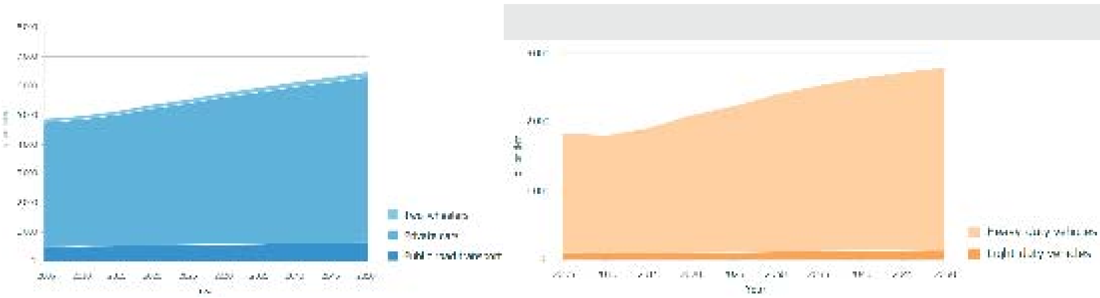

Figure 6: Estimated passenger and freight transport on roads in Europe[39]

Tyre characteristics

The influence of tyre characteristics and construction was investigated in detail by the German Automobile Association (ADAC). Under representative conditions, car tyres from various manufacturers were tested for emission factor (EF) and driving safety. A distinction was made between the three tyre types: summer, winter and all-season tyres with different tyre dimensions. Due to the limited data available, all-season tires are only listed for one dimension. Driving safety was assessed for dry and wet road surfaces and on snow for winter tyres. The figure below shows the tyre wear emissions in mg/vehicle km, as an average of all four vehicle tyres.

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38 Alonso Raposo, M. and Ciuffo, B., *The Future of Road Transport: Implications of automated, connected, low-carbon and shared mobility*, JRC116644, 2019, Publications Office of the European Union, Luxembourg.

39 Barjenburch, M. and Venghaus, D., 'Präsentation: Reifenabrieb in der Umwelt' [Presentation: Tyre abrasion in the environment], Abschlusskonferenz "Plastik in der Umwelt" [Conference "Plastic in the environment"], 2021 (https://bmbf-plastik.de/sites/default/files/2021-05/Session-B_Venghaus_RAU.pdf), De.

Figure 7: Emission factors of different tyres[40]

Figure 7 shows a significant difference in EF due to the tyre dimension. As the tyre dimension increases, it also increases the average EF. However, the scattering of the EF within a tyre dimension is particularly interesting, where the deviations between the manufacturers are up to 100% apart. A significant correlation between EF and driving safety was not observed in the study. Both low-emission tyres achieved good results in driving safety and tyres with high EF, and vice versa. The study identified tyre models in all categories that have low tyre wear and do not compromise on safety. There are data gaps in terms of the volumes of each of these tyre models that are sold each year as well as the distances driven, which, combined with the emission factors, influence overall emissions from tyres. The challenge in tyre development is to move the composition (and construction) towards higher abrasion resistance while ensuring the same driving safety. Nevertheless, as shown in the ADAC study[41], there is a large potential for tyre manufacturers to produce TWP emission-optimized tyres that also provide driving safety.

The ADAC study also highlighted the need to adopt good practices, such as shaving tyres (i.e. removing fine rubber protrusions or pins that might be left over from the production process) before putting them in the market to avoid releasing them into the environment during the first kilometres of their use. Fine rubber pins are created when the rubber is injected into the tyre mould through fine channels. Many manufacturers remove these residues in a further production step in order to return the material directly to the material cycle. However, it appears that some manufacturers do not remove the residues and directly place the tyres on the market with these rubber residues. However, it is highly uncertain exactly what proportion of tyres placed on the market include these rubber pins. They seem to be more commonplace for budget tyres than more premium brands and potentially more frequent for winter tyres where the injection channels are necessary due to the fine tread structure compared to summer tyres. Whilst it is very challenging to quantify the exact contribution that they may make to overall tyre wear emissions, some initial estimations appear to indicate that their overall impact is expected to be very low, less than 0.5% and potentially closer to 0.1% of the total wear from a tyre[42].

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[40] ADAC, 'Tyre wear particles in the environment' / 31940 RMU
[41] ADAC, 'Tyre wear particles in the environment' / 31940 RMU
[42] Personal communication with the JRC, May 2022.

In materials science and R&D, innovations are also reported, such as the use of dandelions[43] or moss[44]. One possibility would be using innovative additives such as nanotubes (TUBALL[45]), which should be effective for improved performance. However, the effect on tyre wear emission is unclear. A test method covering tyres for both light and heavy-duty vehicles is currently being developed by the European Commission through a study led by IDIADA. The study is expected to propose and validate appropriate test methods, evaluate the performance of current tyres in Europe with these methods and perform a cost-benefit analysis of possible tyre abrasion limits by third quarter of 2022. The results of the project will allow the inclusion in the future of abrasion limits in Euro 7 emission standards for motor vehicles and their components (such as tyres) adopted in November 2022. The UNECE WP.29 established a joint Task Force between its Working Party on Noise and tyres (GRBP) and its Working Party on Pollution and Energy (GRPE) in February 2022 to develop the tyre abrasion test method and a Global Technical Regulation. This is expected by 2024.

In general, a standardized test method and limit should consider the physical properties and chemical composition of the emitted tyre wear. The physical characteristics include the emitted particle mass, number and size distribution. It is essential to prevent an increase in the potentially toxic particulate matter fraction (especially PM2.5).[46] A limit value based only on mass may lead to less tyre wear being emitted in general, but it does not reflect a shift from large/few particles to small/many particles. Furthermore, it is assumed that larger particles are better retained during emission treatment. However, the consideration of chemical composition is also highly relevant from the point of view of environmental protection. Until now, tyre manufacturers have not been required to disclose the components used. In the Emission Analytics/PEW report[47], 100 different tyres available on the European market were analysed for tyre wear rate and chemical composition. More than 400 organic components were found in an average tyre, with 49% of the organic mass consisting of often-carcinogenic aromatic and polycyclic hydrocarbons. In this study, there is a factor of 4 between the highest and lowest emitting tyre manufacturers. In order to regulate or prevent the use of environmentally harmful substances, disclosure of the ingredients by the tyre manufacturers would be recommended.

Tyres are also sold with only part of the vent spews shaved off: sometimes, even those on the tread are left there. Vent spews, also known as “tyre hairs” or “Tire hairs” (or vent sprue, nibs, or nippers), are the result of excess rubber expelled through air channels in the tyre mould (needed because of the intense heat and pressure used during curing).

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43 Continental, ‘Erste Versuchsreifen aus Löwenzahn-Kautschuk’ [First test tyres made from dandelion rubber] (https://www.continental-reifen.de/specialty/unternehmen/sustainability/taraxagum/continental-tires-dandelion-taraxagum), De.

44 Goodyear, ‘Der internationale Reifenhersteller Goodyear stellt heute auf dem Autosalon in Genf seine jüngste Mobilitätsvision für die Städte von morgen vor: den neuen Konzeptreifen „Oxygene“, der dazu beiträgt, dass urbane Mobilität in Zukunft sauberer, komfortabler, sicherer und nachhaltiger wird’ Kautschuk’ [International tire manufacturer Goodyear is presenting its latest mobility vision for the cities of tomorrow at the Geneva Motor Show today: the new concept tyre "Oxygene" will help make urban mobility cleaner, more comfortable, safer and more sustainable in the future], 2018 (https://www.goodyear.eu/de_de/consumer/why-goodyear/geneva-motor-show.html), De.

45 OCSiAl, ‘TUBALL: Revolutionary Carbon Nanotubes for the Tyre Industry’, 2017 (https://ocsial.com/de/news/-tuball-revolutionary-carbon-nanotubes-for-the-tyre-industry-/).

46 ETRMA (in Hann et al. 2018)

47 Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions

Vehicle characteristics

A shift of passenger vehicles from internal combustion engine vehicles (ICEVs) to electric vehicles (EVs) is assumed[48], whereby the influence of EVs on tyre wear emissions is controversially discussed. The absolute vehicle weight of an EV may increase when directly comparing the same vehicle model available as ICEVs and EVs due to the weight of the batteries. In this case, tyre wear emissions will also increase. It is expected that future development of the batteries (higher energy density for the same weight or volume) might decrease this weight difference

Another factor to consider is the engine power or drive torque. EVs bring full torque to the road already at start-up. Although efficient traction control (anti-slip control) is possible, there is still a higher point-to-point power transfer. The negative influence on tyre wear emissions due to engine power has been studied, among others, in Gebbe et al[49]. In the OECD report[50], the focus is on airborne non-exhaust particulates, with EVs classified into light weight (driving range up to 160 km) and heavy weight (driving up to 480 km or more). The OECD report's assessment shows:

- Light weight: 11-13% less non-exhaust PM2.5 and 18-19% less PM10 than ICEVs;
- Heavy weight: reduce PM10 by only 4-7% and increase PM2.5 by 3-8% relative to conventional vehicles.

There is a trend towards heavier vehicles and with bigger wheels and tyres, which has a negative effect on tyre wear emissions. A market share analysis by the International Council on Clean Transportation (ICCT)[51] shows the significant development of demand for Sport Utility Vehicles (SUV) in Europe over the last 20 years. Since EV variants are also offered for these SUV models, a decline in the trend is not expected.

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48 Venghaus et al. 2021 RAU - "Reifenabrieb in der Umwelt" Abschlusskonferenz "Plastik in der Umwelt" (20./21.04.2021)

49 Gebbe et al., 'Quantifizierung des Reifenabriebs von Kraftfahrzeugen in Berlin' [Quantification of tyre wear of motor vehicles in Berlin], *Technische Universität Berlin* [*Technical University of Berlin*], 1997, De.

50 OECD, 'Policies to reduce microplastics pollution: Focus on textiles and tyres', 2021 (https://www.oecd-ilibrary.org/environment/policies-to-reduce-microplastics-pollution-in-water_7ec7e5ef-en).

51 The International Council on Clean Transportation, 'European vehicle market statistics: Pocketbook 2021/22', 2021 (https://theicct.org/wp-content/uploads/2021/12/ICCT-EU-Pocketbook-2021-Web-Dec21.pdf). Diaz et al. 2020 European vehicle market statistics 2020/21

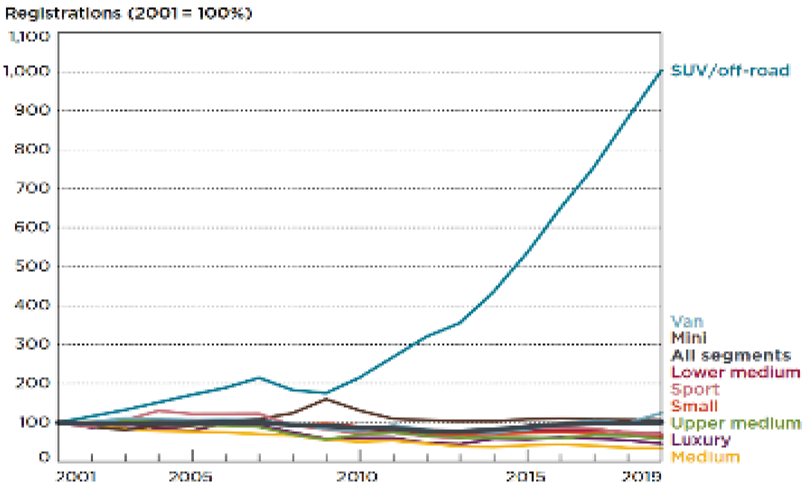

Figure 8: Passenger car registrations by vehicle segment[52]

Road surface characteristics

Although porous asphalt can have a negative impact on the tyre wear emission rate, porous asphalt is seen as a positive influence due to its retaining effect.[53] In order for the retaining to be effective, regular cleaning of the road surface is needed. The use of this asphalt is currently planned primarily for motorways. The use of rubber asphalt also needs to be considered. Although the addition of tyre material results in a reduction potential of CO_2 emissions and noise and contributes to the recycling process of waste tyres, it also improves the temperature properties and fatigue resistance of the asphalt.[54] Nevertheless, it must be critically examined whether additional tyre material from the asphalt is emitted into the environment during the use phase.[55]

Collection and treatment of road run-off is a challenge, especially in urban areas. Due to the high investment costs, no significant use is assumed without regulatory intervention. There is also a crossover with some elements of the Urban Wastewater Treatment Directive.

Vehicle operation

Speed limits (motorways) are under discussion because of their impact on exhaust emissions. Germany is the only country in the EU27 without a general speed limit. Whether a speed limit will be introduced is currently the subject of political discussions. According to the UBA, a speed limit could reduce CO_2 emissions by 6.7% at 120 km/h and 13.8% at 100 km/h.

In several Member States, there is a growing tendency to limit speed in urban areas for both safety and environmental reasons (in particular, for air quality and climate change reasons). For example,

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[52] Ibid.

[53] European Tyre and Road Wear Particles (TRWP) Platform, 'Way Forward Report', 2019 (https://www.etrma.org/wp-content/uploads/2019/10/20200330-FINAL-Way-Forward-Report.pdf).

[54] Wang, Q.Z. et al., 'Waste Tire Recycling Assessment: Road Application Potential and Carbon Emissions Reduction Analysis of Crumb Rubber Modified Asphalt in China', *Journal of Cleaner Production*, Vol. 249, 2020, Elsevier BV.

[55] Bhashyam, S.S. et al., ‚Microplastics in the marine environment sources, impacts and recommendations', *Research@THEA*, 2021.

Spain has introduced a 30 km/h speed limit in urban areas for roads with one lane in each direction. Similarly, Paris implemented a general speed limit of 30 km/h in 2021.

The significance of an urban speed limit of 30km/h in Germany and its federal states in terms of tyre abrasion emissions has been investigated by the TyreWearMapping project[56]. With the physical model, a reduction of about 50% was calculated for both passenger cars and heavy-duty vehicles, considering 50 km/h as the maximum permitted speed in urban areas.[57]

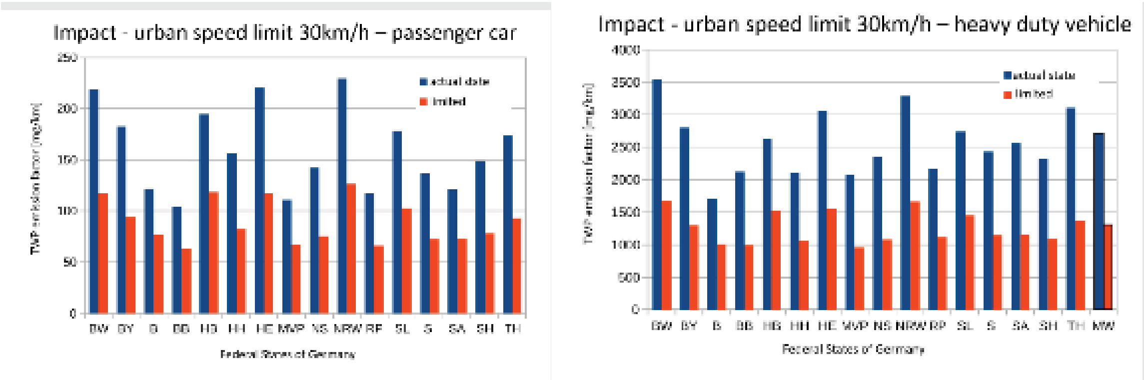

Figure 9: Impact – urban speed limit 30 km/h

An increase in the proportion of autonomously driving vehicles could have a reducing effect on tyre wear emissions. Autonomous driving makes it possible to optimise the flow of traffic and thus reduce braking and starting manoeuvres and moderate the driving style, for example.[58] Moreover, autonomous driving is expected to have vehicles move more smoothly and calmly. The development of the share of fully autonomous driving vehicles, for which the impact is most effective, in the total number of autonomous vehicles is shown in the following figure.[59]

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[56] German Federal Ministry of Traffic and Digital Infrastructure (BMVI), 'Schlussbericht 19F2050A-C: TyreWearMapping: Reifenabrief – ein unterschätztes Umweltproblem?' [Final report 19F2050A-C: TyreWearMapping: Tyre abrasion – an underestimated environmental problem?], 2021 (https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/kompetenz/prozesse/tyrewearmapping-schlussbericht.pdf), De.

[57] German Federal Ministry of Traffic and Digital Infrastructure (BMVI), 'Schlussbericht 19F2050A-C: TyreWearMapping: Reifenabrief – ein unterschätztes Umweltproblem?' [Final report 19F2050A-C: TyreWearMapping: Tyre abrasion – an underestimated environmental problem?], 2021 (https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/kompetenz/prozesse/tyrewearmapping-schlussbericht.pdf), De.

[58] Center of Automotive Management 2021 https://auto-institut.de/automotiveinnovations/emobility/elektromobilitaet-in-europa/

[59] Center of Automotive Management 2021 https://auto-institut.de/automotiveinnovations/emobility/elektromobilitaet-in-europa/

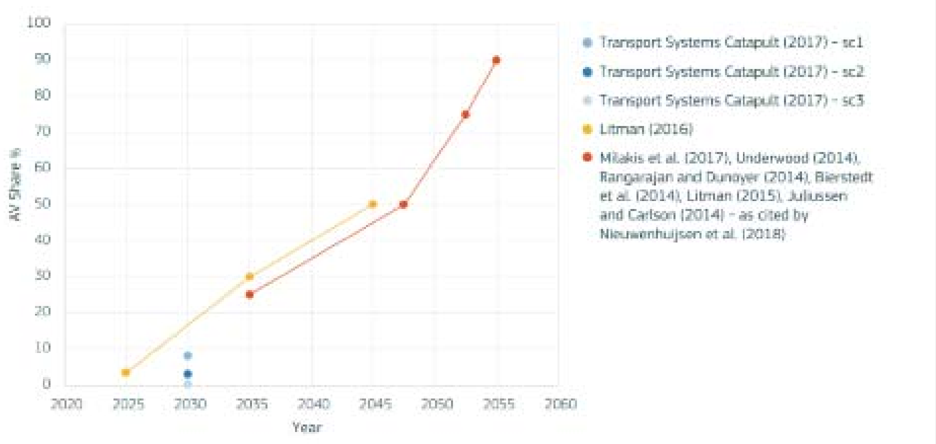

Figure 10: Range of sales projections for AVs (fully automated) until 2055 (as% of AV of total vehicles sold) (sc=scenario)

Other factors

On-board information on driving behaviour or awareness campaigns (e.g. "deadly dust"[60] initiated by the tyre wear collective and how&how) can positively influence driving behaviour or even reduce vehicle kilometres in general. Furthermore, on board tyre pressure monitoring systems (TPMS), which warn drivers when tyre pressure is dangerously low, can also help to reduce microplastic emissions as tyre pressure is an important factor in abrasion rates. Such systems are currently calibrated from a safety perspective but could be adapted to also optimise for tyre wear.

The alignment of the wheels can also play an important role in tyre wear as well as tyre lifetime. Directive 2014/45/EU on periodic roadworthiness tests[61] sets minimum requirements (and frequencies) for periodic testing of road vehicles which includes specific technical elements that are to be covered. These include wheels and their alignment. However, the requirements for checks on wheel alignment are indicated to be "…*not considered essential in a roadworthiness test*", so may not be applied uniformly across the EU.

4.2 Problem definition for textiles

Most scientific papers discuss the unintentional release of microplastics from textiles used in clothing with a focus on the emission of microplastics during the use phase and, more specifically, on textile washing. Due to the lack of data on microplastic emissions from polycotton (used in household and professional textiles/furnishing), and the amount of polyester contained in the polycotton blend, no estimation could be made. According to the first approximations made by RDC Environment, microplastic emissions from professional textiles would represent less than 5% of the emissions from clothing. The focus is, therefore, on the **microplastic emissions of clothing from households**.

It is known that synthetic textiles are prone to release microplastics in water during washing because of abrasion. The water is then treated in WWTP. According to the Swedish Environmental Protection Agency, most of the microplastic (around 98%) is removed from water in WWTP and retained in

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[60] How & How and The Tyre Collective, 'Deadly Dust Campaign, 2020 (https://how.studio/work/deadly-dust).
[61] European Parliament and Council of the European Union, Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC, OJ L 127, 29.4.2014, pp. 51.

sewage sludge[62]. About half of the sewage sludge is then spread on agricultural land[63], used in soil production, or incinerated. However, microplastic releases can occur during the entire lifetime of textiles, including production, wearing, washing, drying and end-of-life. Consequently, the fibres may not only enter the environment via WWTP discharges but also via airborne emissions, landfill leakages, etc. Fibrous microplastics have been found in freshwater, seas, soils, air and remote ice and polar regions[64]. The figure below presents the different pathways followed by unintentionally released microplastics from textiles.

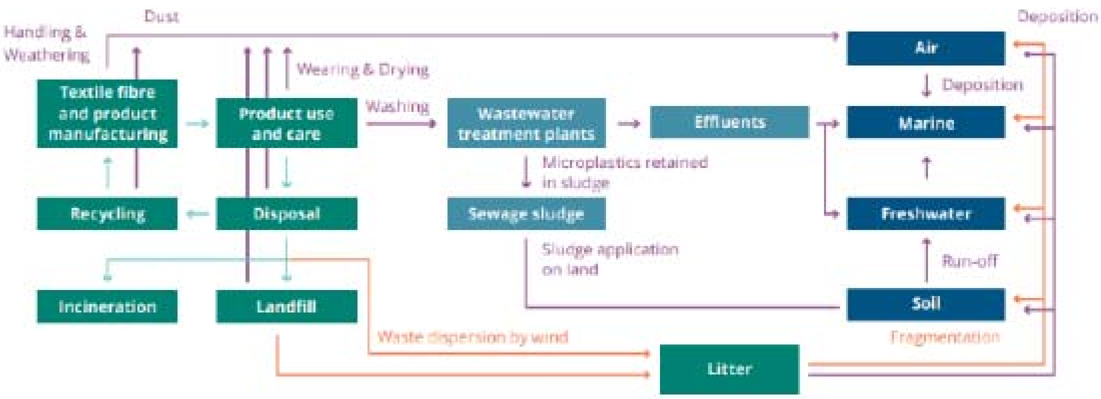

Figure 11: Emission pathways for secondary microplastics from synthetic textile in the air, water and soil (ETC/WMGE, 2021)

4.2.1 Factors affecting the scale of the problem

Three general problem drivers impact the unintentional release of microplastics from textiles:

- Increase in production and use of synthetic textiles;
- Regulatory failure as the microplastic release from textiles is an externality;
- Lack of knowledge and practice (for consumers and producers).

These general problem drivers can be divided into several specific problem drivers, discussed further.

Increase in production and use of synthetic textiles

Since microplastics from textiles are emitted during production as well as during use, an increase in production necessarily implies a bigger release of microplastics from textiles. More intensive use of textiles, such as an increasing washing frequency, will also lead to more microplastic emissions.

<u>Problem driver 1: Increase in demand for textiles</u>

Between 1996 and 2012, there was a 40% growth in the number of clothes purchased per person in the EU[65]. This trend is expected to increase in the future, as at a global level, the consumption of

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[62] Magnusson et al. (2017) Swedish sources and pathways for microplastics to the marine environment, Report for Swedish Environmental Protection Agency.
[63] When sewage sludges are applied to soil, the microplastics end up back in the environment and can be washed away by rain. Some sludge is also incinerated.
[64] Zhang, Y-Q., et al., 'Microplastics from textile origin – emission and reduction measures', *Green Chemistry*, No. 15, 2021.
[65] ETC/WMGE, 'Textiles and the environment in a circular economy', 2019 (https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/textiles-and-the-environment-in-a-circular-economy/).

clothing and footwear is expected to increase by 63% between 2019 and 2030. This increase in textiles consumption leads to an increase in textiles production, thus increasing microplastics emissions from textiles (both from production and in use). In practice, this increase in consumption is accompanied by a decrease in the number of uses per piece[66,67]. A higher renewal rate also means more textiles being thrown away and more emissions at the end-of-life stage, especially if the textiles are recycled (shredding can cause a lot of microplastic emissions[68]).

Several factors and drivers explain the increase in textile consumption, including production trends based on low-cost and fast fashion, a respective decrease in the price of clothing, the increasing affluence of consumers, and further trade liberalisation. Beyond the increase in textiles consumption, the growing population in Europe also implies an increase in the use of textiles. This will lead to more microplastic emissions in the air (because of wearing and drying) and water (because more washing cycles will be performed). According to OECD statistics, the EU population is expected to increase by 1.3% by 2030[69]. The European Commission has recently adopted the EU strategy for sustainable textiles[70]. As summarised by Interreg Europe[71], "the new strategy sets out the vision and concrete actions to ensure that by 2030 textile products placed on the EU market are long-lived and recyclable, made as much as possible of recycled fibres, free of hazardous substances and produced in respect of social rights and the environment. Moreover, consumers will benefit longer from high-quality textiles -fast fashion should be out of fashion- and economically profitable re-use and repair services should be widely available." Regarding microplastics, the European Commission plans to address the unintentional release into the environment by a set of prevention and reduction measures at the different life-cycle stages.

Problem driver 2: Increase in use of plastic as raw materials for textiles

The figure below shows the evolution of the split of world fibre production[72] between 1980 and 2030. Synthetic fibres represent 75% of total fibres in 2020, a share that will reach 85% in 2030 (with 70% for polyester alone).

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66 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) [German Agency for International Cooperation], 'Study for the German Federal Ministry for Economic Cooperation and Development (BMZ): Circular Economy in the Textile Sector', 2019 (https://www.adelphi.de/de/system/files/mediathek/bilder/GIZ_Studie_Kreislaufwirtschaft_Textilsektor_2019_final.pdf).

67 European Environment Agency (EEA) (2019) Textiles and the environment in a circular economy

68 RDC Environment assessment based on experts' estimates literature review

69 OECD, 'Population projections: evolution forecasts of EU (28 countries) population between 2021 and 2030', 2022 (https://stats.oecd.org/Index.aspx?DataSetCode=POPPROJ#).

70 European Commission, Commission communication - EU Strategy for Sustainable and Circular Textiles; COM(2022)141 final, 2022.

71 Interreg Europe, 'New EU Strategy for sustainable and circular textiles', 2022 (https://www.interregeurope.eu/news-and-events/news/new-eu-strategy-for-sustainable-and-circular-textiles#:~:text=The%20new%20strategy%20sets%20out,social%20rights%20and%20the%20environment).

72 Yang Qin, M. (2014). Global fibres overview. Tecon OrbiChem: Synthetic Fibres Raw Materials Committee Meeting at APIC 2014.

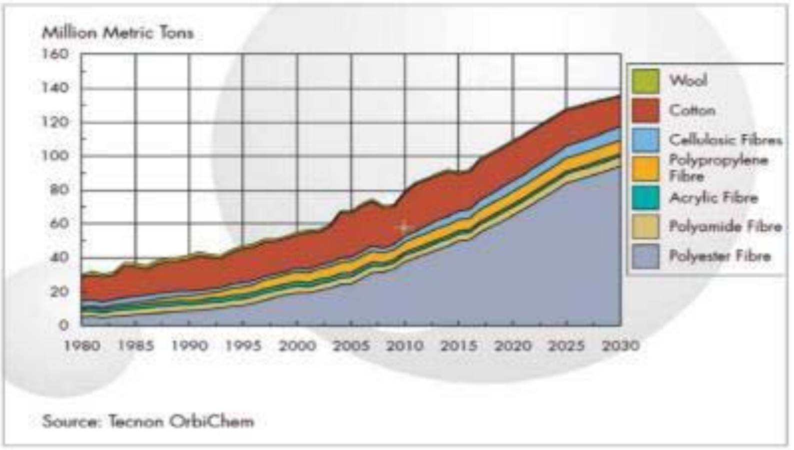
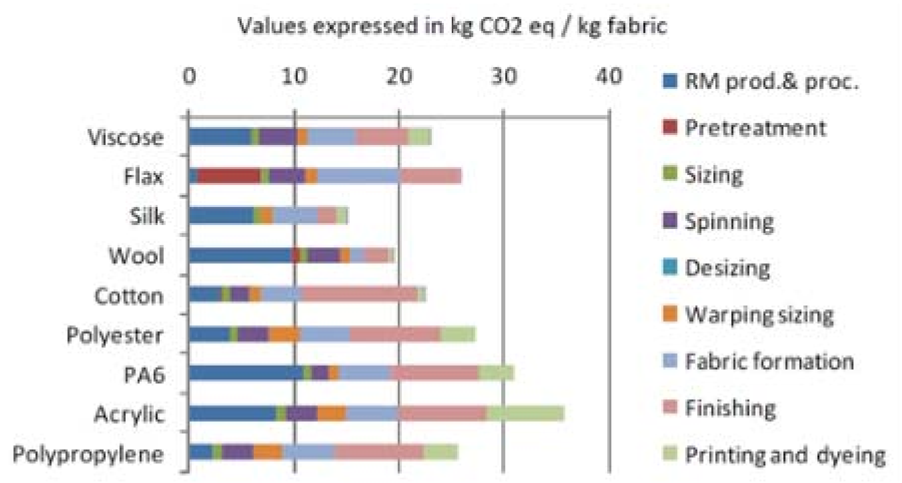


Figure 12: World fibre production per fibre between 1980 and 2030

According to Fibre2Fashion[73], the increase in the use of synthetic fibres will probably continue for the next few decades because of the relatively low cost of synthetic fibres compared to natural fibres and the availability of raw materials. Viscose staple fibres are an alternative to cotton fibres because of their physiological performance. Cellulose fibres have specific properties that make them difficult to substitute with petroleum-based synthetic fibres. Given the limited production of cotton fibres, the share of viscose is likely to increase to cover the increase in textile consumption and the increase in population. In terms of environmental impact, the CO2 equivalent of producing viscose staple fibre is similar to that of cotton fibre. However, the impact on ecosystem diversity is better in the case of cotton, see next figure.



[73] Fibre2Fashion, 'Man-made fibres driving growth', 2017 (https://www.fibre2fashion.com/industry-article/7895/man-made-fibres-driving-growth).

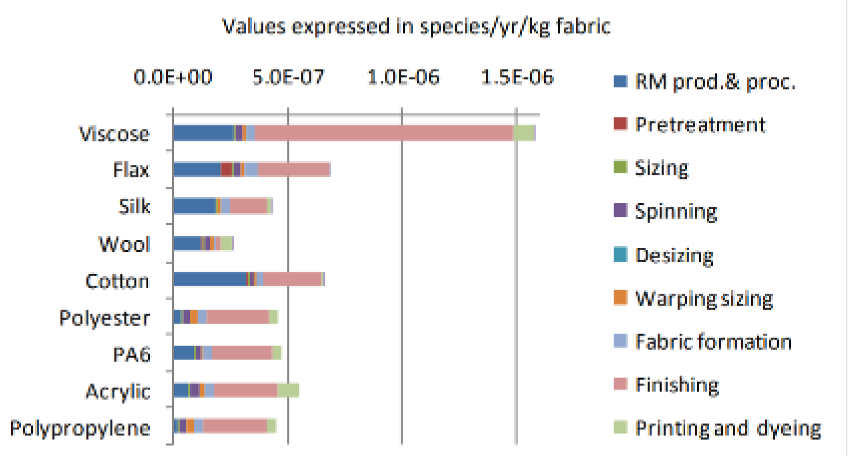


***Figure 13: Environmental impact of fibre production processes*[74]**

Problem driver 3: Increase in textile washing frequency

According to AISE, the average amount of washing cycles in the EU is staying relatively stable at around 3.5 washes a week per household (a slight decrease was observed between 2008 and 2017, followed by a slight increase between 2017 and 2020), as well as the average load, which remains around 80%. However, the capacity of the average washing machine sold in the EU has been increasing: while in 2004, 97% of washing machines sold in the EU had a capacity of less than 6 kg, in 2014, 60% of them had a capacity of 7 kg or more. This means that there is an average increase in the quantity of textiles washed per washing cycle and thus an increase in textile washing frequency.

Regulatory failure as the microplastic release from textiles is an externality

Problem driver 1: No eco-design requirements on the unintended release of microplastics

No eco-design requirement is currently defined at the production level to reduce microplastic emissions from textiles. Furthermore, no document or information has been developed to guide producers on this matter, which is not tackled in the main guides. For instance, the BREF (Best Available Techniques Reference Document) for the Textiles Industry developed under the Industrial Emissions Directive groups microplastic emissions with TSS (Total Suspended Solids), and does not provide specific solution or guidance for reducing microplastic emissions during the production phase[75]. The Textiles BREF mentions that there is currently a lack of information about microplastic emissions[76].

The implementation of eco-design criteria is limited by knowledge gaps and the lack of standardised measurement methods to quantify microplastic emissions. These methods are currently under development and could be used in the future to set a threshold on microplastics released from textiles.

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[74] JRC, Environmental Improvement Potential of textiles (IMPRO Textiles), January 2014. (https://publications.jrc.ec.europa.eu/repository/handle/JRC85895)

[75] JRC, 'Best available techniques (BAT) Reference Document for the Textiles Industry', 2023 (https://eippcb.jrc.ec.europa.eu/sites/default/files/2023-01/TXT_BREF_2023_for_publishing%20ISSN%201831-9424_final_1_revised.pdf).

[76] Textiles BREF "In conclusion, at the time of drafting this document, there was little information available as to the emissions of microplastics to water from textile production facilities, in terms of emissions actually monitored and therefore in terms of the significance of these emissions."

However, as shown in figure below, nearly 80% of textiles consumed in Europe are imported and produced outside of Europe. Regulation at the producer level would then require developing an international approach and commitment. In addition, to effectively enforce ecodesign measures and avoid barriers to free trade inside the EU as a result of the implementation of national measures, ecodesign measures should be implemented at the EU level. The European Commission proposed a new Ecodesign for Sustainable Products Regulation (ESPR) in 2022. This framework aims to set ecodesign requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects. Textiles are identified as a priority in this framework.[77]

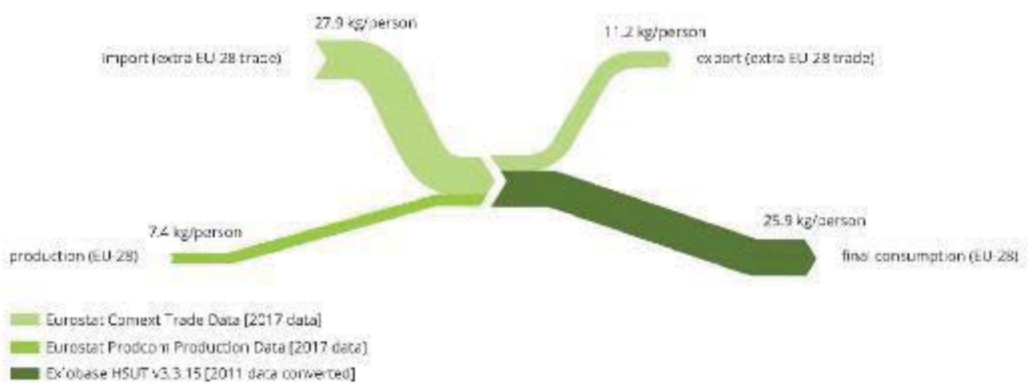

Figure 14: Overview of the import, export, production and consumption flows of textile products, EU, 2017, kg per person[78]

Problem driver 2: No legal requirements to prewash textiles

High microplastic emissions occur during pre-washing due to loose fibres resulting from the manufacturing process. No prewashing step is required at the producer level before selling the textiles. A pre-wash step could be added during production to specifically remove microplastics and must be associated with the obligation of having a proper wastewater treatment plant. This could also be an ecodesign requirement. Currently, pre-washing can be done by consumers to eliminate certain chemical residues before wearing clothes.[79] With the goal of eliminating pre-washing for consumers, the pre-wash should cover both functions: removing microplastics and removing chemical residues.

Problem driver 3: No legal requirements for washing machines and tumble dryers to reduce the release

In France, a law was approved in February 2020 mandating that, as of January 2025, all washing machines sold in France be equipped with a filter for synthetic microfibres. An amendment to this

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77 European Commission, Commission Proposal for a Regulation establishing a framework for setting eco-design requirements for sustainable products and repealing Directive 2009/125/EC, COM(2022)142 final, 2022.

78 ETC/WMGE, 'Textiles and the environment in a circular economy', 2019 (https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/textiles-and-the-environment-in-a-circular-economy/).

79 Time, 'Why You Should Always Wash New Clothes Before Wearing Them', 2019 (https://time.com/5631818/wash-new-clothes/).

law was adopted in June 2021, enabling the implementation of other technologies[80] (alternative to filters) such as capturing bags or absorbing balls to reduce microplastic emissions from washing.[81]

The use of filters in washing machines was also studied in Sweden, but there does not appear to be any such initiative in other EU countries.[82] Ecodesign requirement on washing machines and tumble dyers could also facilitate the use of filters. However, particular attention should be paid to how consumers handle the filters. If they are eventually washed or rinsed in a sink, there will be no decrease in microplastic release.

Problem driver 4: Very costly to invest in end-of-pipe wastewater treatment (including preventing microplastics in sludge)

Most wastewater treatment plants contribute to reducing microplastic concentration in water efficiently. However, decreasing the amount of microplastics in sludge is more challenging. Almost half of this sludge is usually spread on soil, which leads to microplastic releases into the soil. Implementing an additional treatment step to treat sludge would be costly, and there do not yet appear to be commercially available techniques to do so effectively.

Lack of knowledge and practice

There is a lack of knowledge and practice, both at the consumer and producer level. At the consumer level, the awareness is low, and there is no communication or guidance on how to reduce releases, while at the producer level, there is a lack of knowledge on eco-design measures and how to improve manufacturing processes in order to reduce emissions.

Problem driver 1: No or limited awareness among consumers

There is very limited awareness of the microplastics issue among consumers. According to a survey in the US in July 2020, 57% of the population had never heard of microplastics before. It means that the aware public represents around 40% of the population. About 50% of those who do know about microplastics have learned about them in the past year[83]. According to this study, around 30% of US consumers think microplastics need to be addressed urgently.

Problem driver 2: No guidance to consumers on how to avoid or reduce unintentional releases

Information on how to reduce microplastic emissions from household washing machines is available online for consumers already aware of the issue. Several websites list the different existing options available for consumers (laundry bags, balls or filters, and general information on washing).[84,85] However, this information is directed to an aware public (representing around 40% of the population,

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[80] Alternatives to the filters.

[81] Sénat français [French Senate], Amendement n°2143 au projet de loi relatif à la lutte contre le dérèglement climatique [Amendment n°2143 to draft legislation on the fight against climate change], 10.06.2021 (http://www.senat.fr/amendements/2020-2021/667/Amdt_2143.html), Fr.

[82] Australia also announced its intention to "Work with the textile and whitegoods sectors on an industry-led phase-in of microfibre filters on new residential and commercial washing machines by 1 July 2030".

[83] The Nature Conservancy and Bain & Company, 'Toward eliminating pre-consumer emissions of microplastics from the textile industry', 2021 (https://www.bain.com/globalassets/noindex/2021/tnc_bain_white_paper_eliminating_microplastics.pdf).

[84] The New York Times, 'Your Laundry Sheds Harmful Microfibers. Here's What You Can Do About It', 2021 (https://www.nytimes.com/wirecutter/blog/reduce-laundry-microfiber-pollution/).

[85] Irish Examiner, 'Green washing: How to reduce microplastic in your laundry', 2022 (https://www.irishexaminer.com/property/homeandgardens/arid-40951550.html).

see section above). At the same time, there is no or limited communication on this issue to the general public. If filters become mandatory or more widely used, particular attention should be paid to how consumers handle the filters or other devices to avoid microplastic releases. If they are eventually washed or rinsed in a sink, there will be no effect on overall microplastic emissions.

Problem driver 3: Lack of knowledge on eco-design measures and how to improve manufacturing processes in order to reduce emissions among producers

At the producer level, no or few technical solutions are defined. The implementation of eco-design criteria is limited by knowledge gaps and sometimes contradictions in the literature, as well as the lack of standardised measurement methods to quantify and compare microplastic emissions. At this stage, it is hard for producers to efficiently change the design of their textiles to reduce microplastic emissions.[86]

Producer voluntary initiatives reported so far are limited in terms of market shares; some examples of initiatives include the following:

- TextileMission project[87]: project carried out with several partners such as Adidas AG (retailer of sporting goods) and VAUDE Sport GmbH & Co (retailer of mountain equipment). The main work areas are the microplastic output of marketable textiles, retention capacity of different cleaning or purification steps in wastewater treatment plants, sustainability aspects of alternative materials, biodegradable materials and new cutting and processing possibilities, and production and testing of prototypes.
- Cross Industry Agreement (CIA)[88]: voluntary collaboration for the prevention of microplastic release into the aquatic environment during the washing of synthetic textiles of five European industry associations representing the global value chain of garments and their associated maintenance, namely AISE, CIRFS, EOG, EURATEX and FESI
- Patagonia (retailer of outdoor equipment and clothing)[89]: the company initiated two studies. The first study focused on measuring the amount of microfibers that come off the products in the wash (and comparing them to lower-quality items). The objective of the second study is to understand better the fibre and fabric characteristics that lead to microfiber release and to develop a rapid test method to assess the potential of fabrics to shed during laundering. Both studies are conducted to enable the research and development of new materials.

4.3 Problem definition for paints

Generally, paints are made from the following components: pigments (absent in the case of varnishes), solvents (organic solvents and/or water), various additives and a binder. With few exceptions (e.g., pure mineral paint, which contains inorganic binders), the binder is a polymer, most commonly a synthetic resin, which binds all the other ingredients together and influences durability, and flexibility, and it is responsible for the general mechanical properties of the film (*Bierwagen et al., 2017*). Common binders are alkyls and epoxies, but paint might also contain polyurethanes, polyesters, polyacrylates and polystyrenes (*C. Gaylarde et al. 2021*). After the paint has been applied,

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[86] Opting for natural fibres would stop microplastics emissions but would also increase other environmental impacts (CO_2 emissions, land use, etc.).
[87] TextileMission, Project: Microplastics of Textile Origin - A Holistic View: Optimized Processes and Materials, Material Flows and Environmental Behavior, 2017-2021 (https://bmbf-plastik.de/en/joint-project/textilemission).
[88] Euratex, 'Cross Industry Agreement' (https://euratex.eu/cia/).
[89] Patagonia, 'An update on microfiber pollution', 2018 (https://www.patagonia.com/stories/an-update-on-microfiber-pollution/story-31370.html).

the solvents (and/or water) evaporate, leaving binder, additives and pigments behind, forming the solid content.

The majority of paint formulations do not contain microbeads as an ingredient[90]; however, due to their resin content, paint particles (dried together with additives or in liquid form as polymers) are considered as microplastic[91]. Out of the 52 Mt of paint produced globally in 2019, 19.5 Mt are synthetic polymers[92], representing 5% of total world polymer production (*368 Mt - PlasticsEurope, 2020*). Paint has, in fact, a high polymer content - on average 37% - and can be found on a wide range of objects and infrastructures used in our society: cars, boats, indoor walls, buildings, and bridges, among others. It is not without reason, as paint delivers value by protecting objects from environmental degradation and corrosion. Thus, by increasing the lifetime of objects, paint eliminates the need for frequent replacement or maintenance that would otherwise be necessary, with the associated environmental impacts. But since paint is often applied on exterior surfaces to protect them from wear and tear and corrosion, it should come as no surprise that paint lost during the application, wear and tear, or removal will eventually find its way to the environment.

Many studies have already pointed out that paint particles are part of the increasingly important microplastic source in our oceans. Ingredients of the paint binders such as polyurethanes, polyesters, polyacrylates, polystyrenes, alkyls and epoxies have been increasingly identified in environmental samples all over the globe[93],[94],[95],[96],[97],[98], highlighting the importance of better assessing the contribution of paint to plastic pollution.

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90 Microbeads are intentional added microplastics which are covered by the REACH restriction: European Chemicals Agency, Bakcground Document to the Opinion on the Annex XV report proposing restrictions on intentionally added microplastics, 2020 (https://echa.europa.eu/documents/10162/b56c6c7e-02fb-68a4-da69-0bcbd504212b).

91 Verschoor, A. et al., ‘Emission of microplastics and potential mitigation measures: Abrasive cleaning agents, paints and tyre wear’, Dutch National Institue for Public Health and the Environment, 2016 (https://rivm.openrepository.com/bitstream/handle/10029/617930/2016-0026.pdf?sequence=3)

92 Market research from MarketsandMarkets Research Private Limited

93 Turner, 2021, Paint particles in the marine environment: An overlooked component of microplastics, https://doi.org/10.1016/j.wroa.2021.100110)

94 Dibke et al. Microplastic Mass Concentrations and Distribution in German Bight Waters by Pyrolysis–Gas Chromatography–Mass Spectrometry/Thermochemolysis Reveal Potential Impact of Marine Coatings: Do Ships Leave Skid Marks? https://doi.org/10.1021/acs.est.0c04522

95 Schell, T., Hurley, R., Buenaventura, N. T., Mauri, P. V., Nizzetto, L., Rico, A., & Vighi, M. (2022). Fate of microplastics in agricultural soils amended with sewage sludge: Is surface water runoff a relevant environmental pathway?. Environmental Pollution, 293, 118520;

96 Turner, A., Ostle, C., & Wootton, M. (2022). Occurrence and chemical characteristics of microplastic paint flakes in the North Atlantic Ocean. Science of The Total Environment, 806, 150375;

97 Cardozo, A.L.P., Farias, E.G.G., Rodrigues-Filho, J.L., Moteiro, I.B., Scandolo, T.M., Dantas, D.V. (2018). Feeding ecology and ingestion of plastic fragments by Priacanthus arenatus: What's the fisheries contribution to the problem? marine Pollution Bulletin 130: 19-27;

98 Herrera, A., Ŝtindlová, A., Martínez, I,. Rapp, J., Romero-Kutzner, V., Samper, M.D., Montoto, T., Aguiar-González, B., Packard, T., Gómez, M. (2019). Microplastic ingestion by Atlantic chub mackerel (Scomber colias) in the Canary Islands coast. Marine Pollution Bulletin 139: 127-135)

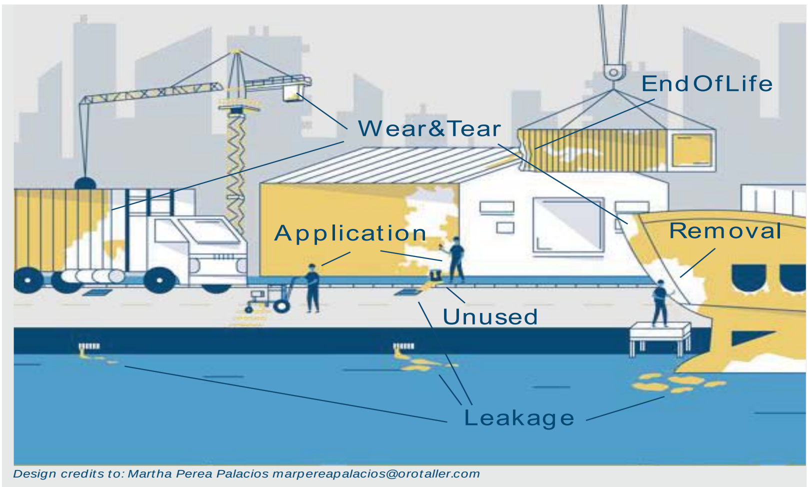

Figure 15: Different ways of microplastic release from paints

From the EA-Environmental Action analysis published in January 2022[99], a large part of the paint is mismanaged in the EU (40%) and thus leaks to the environment. The majority (63%) of this leakage occurs in the form of microplastics emitted during paint application, maintenance and wear and tear. The remaining 37% of the leakage (mostly microplastics) stems from unused paint or is associated with the end-of-life of the painted objects. The leakage occurs predominantly on land (63%) and in oceans and waterways.

If one looks in more detail, this 37% of the global leakage is the result of different forms of solid waste mismanagement and the leakage occurring directly in the ocean (e.g., through wear and tear or maintenance of commercial ships or offshore rigs), the latter accounting for 18% of total leakage.

Paint leakage is geographically ubiquitous, with leakage rates ranging from 22% in high-income North America to 50% in low and middle-income Europe. This means, for instance, that half of the paint applied in European low-income countries will eventually leak into the environment in one way or another. Because of its larger population, the highest contribution to total leakage in absolute terms comes from the Asia Pacific region (54% of total leakage).

The six paint sectors analysed in the EA's global study are architectural, marine, automotive, road markings, industrial wood and general industrial. They contribute to the total leakage with individual leakage rates ranging from 28% (automotive sector) to 74% (road markings sector). The architectural sector is the largest contributor to the total leakage (48%), and the road markings sector is the smallest contributor (2%). In terms of leakage specifically to ocean and waterways, the contribution from architectural paint is similar to that of marine or general industrial paints. EA-Environmental Action's report[100] shows that the paint industry is potentially the sector with the highest contribution to microplastics leakage to ocean & waterways (1.9 Mt/year), higher than tyre dust, synthetic textile

[99] Paruta, P., Boucher, J., Pucino, M. (2022). Plastic Paints the Environment, EA- Environmental Action, ISBN 978-2-8399-3494-7

[100] Paruta, P., Boucher, J., Pucino, M. (2022). Plastic Paints the Environment, EA- Environmental Action, ISBN 978-2-8399-3494-7

and other known sources combined (less than 1.5 Mt/year in total[101,102] . This finding does not imply that these other sources are not part of the problem, as the paint leakage identified in the EA study only adds up to the leakage from these other sources, which was already high in absolute value. To understand the reasons behind this change in the methodology, one needs to look at the previous research focusing on other sources of microplastics. Some of the previous studies on plastic leakage have included paint but under "other sources" of primary microplastic release in the environment. The contribution of paints to the total microplastic leakage was estimated to range from 9.6% to 21% in different studies (see Table 7). Although none of the studies takes into account all paint sectors and all geographies, this alone is not enough to explain the difference with the EA's assessment.

The root differences are rather that not all loss types are accounted for in previous studies, and that wear and tear and removal rates are very different. For example, the Eunomia report[103] excludes all losses due to overspray. Furthermore, most studies base their wear and tear and removal rates on an OECD report[104] or on values provided by CEPE (the association representing the interests of the coatings sector at European level)[105]. For instance, Eunomia estimates that only 0.5% of the antifouling marine paint will be lost to the environment due to wear and tear during the lifetime of the boat, even when most antifouling paint is meant to "erode" or "peel off" in order to prevent fouling on the boat hull. The EA study assumes that within 4 years, 35% of the antifouling paint will be lost and thus is an important source of microplastics release. This is a conservative estimate, as according to a paper by paint manufacturer International Paint Ltd.[106], CEPE considers all the biocide contained in the antifouling paint to be released during the antifouling coating lifetime (100% loss rate). The same paper claims that the actual emission is a factor 2.9 smaller (34% loss rate).

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[101] Boucher, J., & Friot, D. (2017). Primary microplastics in the oceans: a global evaluation of sources (Vol. 10). Gland, Switzerland: IUCN

[102] Lau, W. W., Shiran, Y., Bailey, R. M., Cook, E., Stuchtey, M. R., Koskella, J., & Palardy, J. E. (2020). Evaluating scenarios toward zero plastic pollution. Science, 369(6510), 1455-1461

[103] Hann, S., Sherrington, C., Jamieson, O., Hickman, M., Kershaw, P., Bapasola, A., & Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products. Report for DG Environment of the European Commission, 335.

[104] OECD (2009). Emission scenario document on coating industry (paints, lacquers and varnishes). OECD Health and Safety Publications, Series on Emission Scenario Documents, 22: 201.

[105] CEPE, 2021. About us. Accessed on 19/11/2021. https://cepe.org/about-us/who-we-are/

[106] Finnie (2006) Improved estimates of environmental copper release rates from antifouling products. Biofouling : The Journal of Bioadhesion and Biofilm Research

Table 7: Comparison of studies on plastic leakage from paints

Source	Geography	Sectors	Paint microplastic leakage (kt/yr)	Per capita equivalent (g/cap/yr)	Paint share of micro-plastic leakage (%)
IUCN *Boucher & Friot, 2017*	Global	• Marine • Road markings	156 (to ocean & waterways)	23 (to ocean & waterways)	10,7%
EUNOMIA *Hann et al, 2018*	EU	• Architectural • Marine • Automotive • Road markings	20 (to ocean & waterways)	40 (to ocean & waterways)	11.6%
MEPEX *Sundt, Schulze & Syversen, 2014*	Norway	• Architectural • Marine • Road markings	1.1 (to environment)	214 (to environment)	14%
UNEP *Ryberg et al., 2018*	Global	• Architectural • Marine • Road markings	640 (to environment)	84 (to environment)	21%
Swedish EPA *Magnuson et al., 2016*	Sweden	• Architectural • Marine • Road markings • General Industrial	1.8 (to environment)	186 (to environment)	9.6%
EA *Paruta et al. 2021*	Global	• Architectural • Marine • Road markings • General Industrial • Automotive • Industrial wood	1857 (to Ocean & Waterways)	267 (to Ocean & Waterways)	58%

4.4 Problem definition for detergent capsules

Industry claims that detergent capsules have revolutionised the world of household care and professional cleaning and hygiene industry within the last ten years. They afford several key advantages by being more convenient for consumers (easy and correct dosing), avoiding skin contact with active ingredients like detergent, salt and rinse aid and optimising resource use and packaging. The cornerstone of these detergent capsules relies on using a water-soluble plastic film that must be dissolved during the washing cycle. The water-soluble plastic films are mainly composed of polyvinyl alcohol (PVOH). The typical thickness for these water-soluble plastics is between 30 and 50 µm. For instance, in the case of liquid laundry detergent capsules, the volume of each liquid laundry detergent capsule is considerably lower than that of an equivalent dose of traditional detergent. Yet, it cleans the same full load of laundry. All active ingredients are contained in a single unit dose capsule, which dissolves after contact with water inside the washing machine and then releases the detergent. In addition to this convenience, the high concentration level leads to lower product amounts/job needed to be transported through the supply chain, which is a sustainability advantage by reducing CO2 emissions. Additionally, the film performs the containment function, enabling high-efficiency cleaning agents that facilitate low-temperature and low-water wash cycles (which directly improves sustainability, as a significant portion of the carbon emissions from a laundry cycle comes from the use phase of heating water). As a unit dose, precise portion control is a key feature to dispense only the quantity needed per load, effectively reducing excessive use and consumer/end-user overdosing.[107] The key enabler of this capsule is a water-soluble film, which holds the concentrated detergent solution. This film is generally based on PVOH, with polymer backbone modifications and specific performance additives such as salts (e.g., calcium carbonate) and plasticizers (e.g., glycerol). The films are developed to readily dissolve as intended in the washing process, including in sustainability-driven cold-water cycles, and meet the technical challenges of mass volume production and regulatory compliance.

The definition of "microplastics" of the REACH restriction might not be applicable to PVOH, either because it is in the form of a film (then not complying with the size limits of the definition) or because it fulfils the solubility criteria set in the restriction. However, even if PVOH is water-soluble and as such not in the scope of the REACH restriction, it may adversely impact the environment (see Rolsky[108]). Detergent capsules frequently contain multiple compartments, allowing the formulators to separate ingredients which at the elevated concentrations of liquid laundry detergent capsules would not be compatible with each other. To ensure consumer safety and avoid spillage, the film is designed not to dissolve and rupture during routine transport and handling (e. g. when touched with wet hands); to resist compression (e. g., during transport or dosing); and to trigger an aversive reaction in case of oral contact. These features are required for liquid laundry detergent capsules in the EU under Regulation (EU) No. 1297/2014 (amending the CLP Regulation (EC) 1272/2008), which was put in place to help reduce accidental exposures involving young children observed in the market. With respect to their powder analogues, these detergent capsules provide better protection against any allergic issues related to skin contact and any accident related to misuse by children.

As far as water-soluble films are concerned, more particularly related to their water-solubility feature, the use of PVOH can be expanded to other applications as a sizing and finishing agent in the textile industry and as a thickening or coating agent for paints, glues, packaging of meat, pharmaceuticals and paper and food industries. The fate of PVOH relating to these different applications remains uncertain.

With a yearly global production of 650,000 tonnes, PVOH is becoming increasingly popular, with an annual growth rate of 4% from 2018 to 2023. In Europe, the use of PVOH is estimated to be around 100 000 tonnes per year, of which 20 000 tonnes are used as protective films for detergent capsules (see further in the calculation of the baseline).[109] Other uses are papermaking, textile warp sizing, as a thickener and emulsion stabilizer in polyvinyl acetate (PVA) adhesive formulations, in a variety of coatings, and 3D printing. As aforementioned, the PVOH films can be used for all relevant products (capsules filled with detergent for the washing machine and all chemicals for the household

[107] AISE report on SOLUBLE FILMS IN SINGLE-DOSE DETERGENT PRODUCTS: Information on their purpose, technical characteristics, testing and usage (April 2022, Provided by A.I.S.E. in support of the study for the European Commission on "Microplastics pollution – measures to reduce its impact on the environment")

[108] Rolsky, C. and Kelkar, V., Degradation of Polyvinyl Alcohol in US Wastewater Treatment Plants and Subsequent Nationwide Emission Estimate', *International Journal of Environmental Research and Public Health*, Vol. 18, no. 11: 6027, 2021.

[109] Renewable Carbon, 'BioSinn – Products for Which Biodegradation makes sense', 2021 (https://renewable-carbon.eu/publications/product/biosinn-products-for-which-biodegradation-makes-sense-pdf/).

and garden, such as chlorine tablets for the garden pond). However, in the case of PVOH-based capsules, they have a direct environmental impact as these capsules are directly delivered into grey water before wastewater treatment plants.

The common way to obtain PVOH is through a hydrolytic deprotection process conducted on polyvinyl acetate (PVA). To facilitate the processability window, PVOH can also be used as blends or mixtures (PVAI, Polyviol, Alcotex, Covol, Gelvatol, Lemol, Mowiol, Mowiflex, and Rhodoviol) when used as a protective film for laundry and dish detergents[110]. For the sake of clarity, the term "PVOH types" indicates the generic composition of these protective films.

As reported by Rolsky[111], the general increase of PVOH and related blends used in capsules and others could be more and more considered as one of the most ubiquitous pollutants in wastewater. Some reports[112] highlight that when PVOH is discharged into water bodies, PVOH and related blends likely have an adverse effect on the environment. Due to its surface properties, it has been reported that PVOH's ability to foam can inhibit oxygen transfer, causing irreparable harm to aquatic life at high concentrations. In addition, PVOH can potentially adsorb dangerous chemicals or contaminants, such as antibiotics or heavy metals, at high concentrations, posing a threat to the environment and our food chains, similar to traditional polluted plastics at high concentrations.

The fate of PVOH in wastewater treatment systems[113] has been explored (using radio-labelling to have a clear follow up about the complete biodegradation), with some studies indicating the degradation of PVOH-films during the wastewater treatment process even if the complete degradation has not been established following this process. For instance, some claims have highlighted that the PVOH and related mixtures used as detergent capsules are fully biodegradable, but they require additional investigations to confirm this statement. The biodegradation of PVOH occurs under specific circumstances, which may not be present during wastewater treatment or in the natural environment (river, seas, and oceans). The PVOH biodegradation is usually conducted in the presence of oxidative bacteria in which they oxidize the tertiary carbon atoms, leading to the main endo-cleavage of PVOH molecules and ultimately to the formation of hydrolysable by-products (hydroxy ketone and 1,3-diketone). Other microorganisms such as bacteria Pseudomonas can utilize PVOH as a carbon source, and many of these processes can take place simultaneously to begin the degradation of the polymer. While several bacterial species have been documented degrading PVOH,

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[110] Julinova, M. et al., 'Water-soluble polymeric xenobiotics - Polyvinyl alcohol and polyvinylpyrrolidon - And potential solutions to environmental issues: A brief review', *Journal of Environmental Management*, No. 228, 2018, pp. 213-222.

[111] Rolsky, C. and Kelkar, V., Degradation of Polyvinyl Alcohol in US Wastewater Treatment Plants and Subsequent Nationwide Emission Estimate', *International Journal of Environmental Research and Public Health*, Vol. 18, no. 11: 6027, 2021.

[112] (a) Cole, M., Lindeque, P., Halsband, C. and Galloway, T. S., 'Microplastics as contaminants in the marine environment: A review', *Marine Pollution Bulletin*, Vol. 62, 2011, pp. 2588-2597.

(b) Li, J., Zhang, K. and Zhang, H., 'Adsorption of antibiotics on microplastics', *Environmental Pollution*, Vol. 237, 2018, pp. 460-467.

(c) Brennecke, D., Duarte, B., Paiva, F., Caçador, I. and Canning-Clode, J, 'Microplastics as vector for heavy metal contamination from the marine environment', *Estuarine, Coastal and Shelf Science*, Vol. 178, 2016, pp. 189-195.

(d) Lei, L. et al., 'Oxidative degradation of poly vinyl alcohol by the photochemically enhanced Fenton reaction', *Journal of Photochemistry and Photobiology A: Chemistry*, Vol. 116, No. 2, 1998, pp. 159-166.

(e) Sun, W., Chen, L. and Wang, J., 'Degradation of PVA (polyvinyl alcohol) in wastewater by advanced oxidation processes', *Journal of Advanced Oxidation Technologies*, Vol. 20, No. 2, 2017.

(f) Hollman, P.C.H., Bouwmeester, H. and Peters, R.J.B., 'Microplastics in Aquatic Food Chain: Sources, Measurement, Occurrence and Potential Health Risks', *RIKILT-Institute of Food Safety*, 2013 (https://edepot.wur.nl/260490).

[113] Wheatley, Q. and Baines, F., 'Biodegradation of polyvinyl alcohol in wastewater', *Textile Chemist & Colorist*, Vol. 7, No. 2, 1976, pp. 28-33.

they are present in soils and not usually in natural water compartments.[114] In the case of old sludge, the microorganisms are usually acclimatised and could effectively biodegrade these PVOH and related mixtures. Knowing that these PVOH and related mixtures used as water-soluble films can contain certain additives (e.g. salts and plasticizers), the related additives could likely modify and to some extent, inhibit their biodegradation ability.[115] To clearly demonstrate the full biodegradation of these PVOH after wastewater treatments, specific procedures and related characterization techniques must be employed, such as radiolabelling PVOH in order to follow up the ultimate fate of these PVOH types.

A recent report has highlighted that the PVOH films used for detergent capsules were shown to be potentially biodegradable in OECD screening test conditions.[116] The OECD 301 series of biodegradation tests are commonly used by manufacturers and users of these water-soluble films. They are considered stringent screening tests, conducted under aerobic conditions, in which a high concentration of the test substance (in the range of 2 to 100 mg/L) is used and ultimate biodegradation is measured by non-specific parameters like Dissolved Organic Carbon (DOC), Biochemical Oxygen Demand (BOD) and CO2 production. These tests are also used under existing EU legislation to measure the biodegradability of mixtures (surfactants under Regulation (EC) No 648/2004 on detergents) and polymers (under the recently adopted REACH restriction on intentionally added microplastics). These tests are considered stress tests for the test chemical since the system does not have an environmentally realistic ratio of a test chemical to microbes (which in an actual WWTP would be orders of magnitude higher). The inoculum is sourced from a well-operated domestic wastewater treatment plant with a diverse and robust microbial population, and no pre-exposure to the test chemical is allowed. In these studies, the test material is the sole carbon and energy source for the population of microorganisms to use and grow. Using 6 representative PVOH and related mixtures, the extent of biodegradation after 28 days was estimated at 60.4% on average, but the full biodegradation has not been demonstrated except on the basis of extrapolation models.

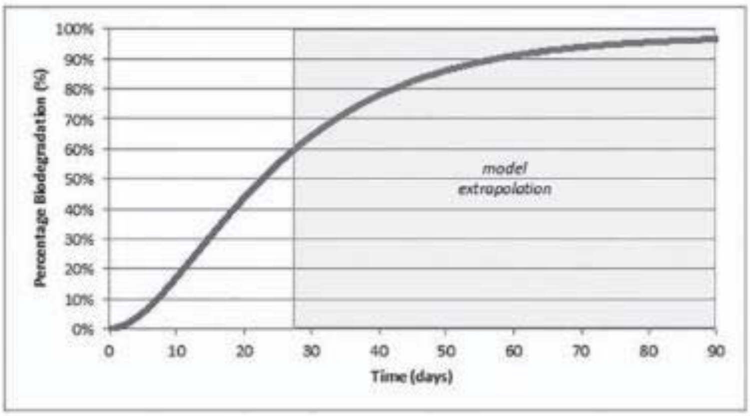

Figure 16: Model extrapolation beyond 28 days

[114] Yamatsu, A., Matsumi, R., Atomi, H. and Imanaka, T.: Isolation and characterization of a novel poly(vinylalcohol)-degrading bacterium, Sphingopyxis sp. PVA3. Appl Microbiol Biotechnol 72 (2006), 804 – 81. PMid:16583228; DOI:10.1007/s00253-006-0351-4

[115] Byrne et al., Biodegradability of Polyvinyl Alcohol Based Film Used for Liquid Detergent Capsules, *Environmental Chemistry*, (2021)

[116] Byrne et al., ‘Biodegradability of polyvinyl alcohol based film used for liquid detergent capsules’, *Tenside Surfactants Detergents*, Vol. 58, No. 2, 2021.

There are some international standards (e.g., ISO standard 14593: 1999) that can be used to demonstrate the complete biodegradation of biodegradable plastics, such as some microbial polyesters in natural aqueous compartments (marine), *i.e.*, the complete metabolisation of C-substrate into CO_2. However, the standards are commonly conducted at temperatures above room temperature and do not correspond to the real environmental situation. Therefore, PVOH removal during wastewater treatments is still in question due to a lack of comprehensive research and must be even experimentally demonstrated in some natural compartments, such as in marine conditions in which the rate of biodegradation can be slowed down due to a low temperature (e.g., 4°C in oceans).

4.4.1 Value chain of water-soluble plastics

The main actors in the value chain are:

- Detergent manufacturers
- Water-soluble plastic producers
- Water-soluble plastic processors
- Wastewater management companies

Below is a description of their respective roles.

- **Detergent manufacturers** belong to the European household care and professional cleaning and hygiene industry, particularly those manufacturing detergent capsules for laundry and dishwasher capsules. More than 1700 companies are active in the domains of soaps, detergents or maintenance products.
- **Water-soluble plastic producers** are manufacturers of virgin PVOH materials for water-soluble productions. Historically, air Products and DuPont were among the first PVOH manufacturers of PVOH, but today Kuraray (Japan) is one of the largest manufacturers of PVOH resins.
- **Water-soluble plastic processors** transform PVOH pellets by mixing them with plasticizers and salt to alter their physical properties, particularly water-solubility. Such activities are related to compounders. The major supplier in Europe is Kuraray under the brand name monosol.
- **Wastewater management companies** are treating urban and industrial wastewater with a fundamental role in ensuring public health and environmental protection by removing suspended solids, harmful bacteria, and pollutants of emerging concern. They can be of private and public bodies. Urban wastewater treatment in Europe has improved over recent decades, largely above 80% of wastewater treated since 1995.

4.4.2 Routes of water-soluble plastics loss

Related to its inherent water-solubility, the major release of PVOH and its blends as detergent capsules occur through conventional water treatments in the form of greywater from domestic, public, and industrial sources. One might not exclude that other PVOH fractions not used as detergent capsules, such as chlorine tablets, can be found elsewhere, such as in soils. In this respect, the major route of PVOH and its blends is related to water discharges of greywater from domestic, public, and industrial sources, mainly reaching most wastewater treatment plants in Europe. There are different wastewater treatment levels (primary, secondary, sludge, and disinfection) before leaving the wastewater treatment plant. The primary treatment based on mechanical treatments (stirring, filtration, etc.) and the secondary treatment based on biological actions (digestion, etc.) are compulsorily implemented in the EU and in the case of sensitive areas (coasts, etc.), additional treatments (tertiary treatments based on advanced filtration, etc.) are even considered. For instance, for discharges to sensitive waters, the wastewater treatment plant directive requires that all urban areas populated by more than 10 000 people provide primary, secondary and tertiary treatment. In a highly dense EU country such as The Netherlands, more than 90% of wastewater treatment is based on a tertiary treatment, consisting of a disinfection chamber and a filtration unit. [117] [118] [119] [120]

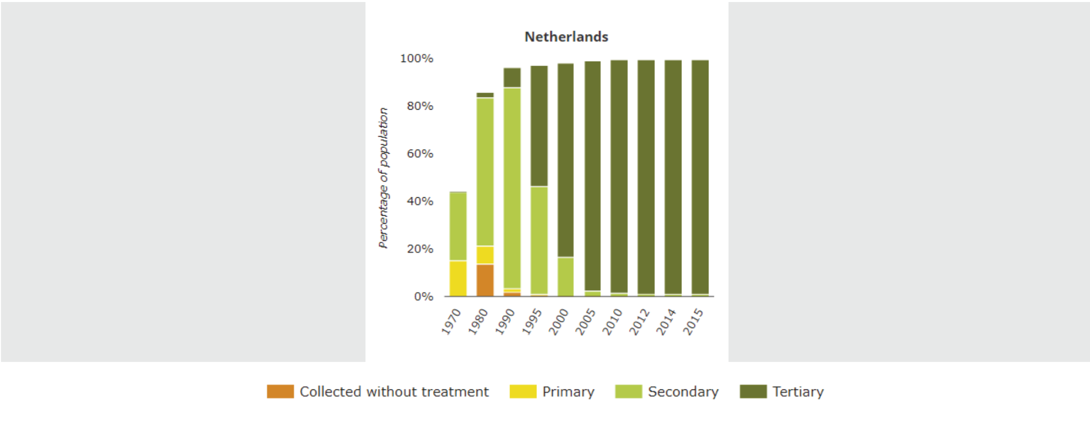

Figure 17: Collection rate of urban wastewater in the Netherlands

Related to the misuse or non-intentional release of PVOH in some natural compartments (e.g. soil), we may not exclude that all PVOH cannot reach the facilities related to wastewater treatment plants. Therefore, PVOH residues could be likely found in both treated sludge and water.

Water-soluble plastics used for detergent capsules have been recently extended to other types of more environmentally friendly resins, such as the LACTIPS company[121]. They propose a casein-based packaging film for dishwasher tabs claimed as "OK bio-degradable WATER" by the private company TÜV Austria, but are not endorsed by any CEN or ISO standard. However, at this moment, these alternatives are still unsuitable as these LACTIPS products derived from milk protein are non-VEGAN products and could not be widely accepted as water-soluble films. Another issue is related to their poor transparency as water-soluble films. Some suppliers in Germany can provide biodegradable films based on natural products (starch) with the EU Ecolabel. The EU-Ecolabel recognised the biodegradability of these products, in which the water-soluble films were a part of the overall composition.

4.5 Problem definition for geotextiles

Geotextiles are a type of geosynthetics used for various civil engineering applications. They are primarily made of polymers such as polypropylene or polyester and are mostly manufactured in two different forms woven and nonwoven. Figure 18 below shows various examples of geosynthetics.

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[117] European Environment Agency, 'Urban wastewater treatment in Europe', consulted March 18th 2022 (https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment).

[118] European Environment Agency, 'Urban wastewater treatment in Europe', consulted March 18th 2022 (https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment).

[119] European Environment Agency, 'Urban wastewater treatment in Europe', consulted March 18th 2022 (https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment).

[120] European Environment Agency, 'Urban wastewater treatment in Europe', consulted March 18th 2022 (https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment).

[121] Lactips, 'Polymère naturel et biodégradable en milieu aquatique', consulted on March 18th 2022 (https://www.lactips.com/).

Figure 18: Various samples of geosynthetics

From bottom to top: the rough black surface of high-density polyethylene (HDPE) geomembrane, white carrier nonwoven geotextile, black geonet, white nonwoven filter geotextile (folded back), black woven geogrid and a white.[122]

There is a real environmental advantage in using geotextiles as their mechanical properties enable civil engineers to significantly increase the tensile strength of soils. They are lightweight materials, so they have lower carbon emissions than equivalent concrete or metal. Furthermore, they weigh significantly less than other materials which can be used to stabilise soils, e.g., gravel and rock. As a result, the CO_2 balance when using geotextiles versus gravel or more traditional stabilising materials is in favour of geotextiles[123,124]. Indeed, rising sea levels and increasing storm strength are disrupting European coasts to a greater extent than before, and geotextiles are used for protecting coasts. Although geotextiles are, in theory, designed to withstand the harsh conditions to which they are exposed in these applications, there are examples of these geotextiles failing and not serving their intended purposes nor being removed (after use) from coastal areas where they can become hotspots for macro and microplastics emissions.

The issue seems to stem from two main factors: first, the materials may not have sufficient resistance to the environmental conditions they are exposed to (temperature variation, exposure to water, salt water, UV light, abrasion, etc.) and second, the extreme weather events such as storms which the material can be exposed to. Some autoclave tests performed in 2021[125] exhibit good life expectancies (a half-life of 330 years for mechanical properties retainment) for different geotextile types. However, the mechanical wear of the materials was not taken into account, which is unfortunate considering that mechanical wear in coastal erosion protection applications is a very destructive force.

The industry has estimated the longevity of geotextiles by studying the influence of thermal and UV ageing on the reduction in mechanical properties of the geotextiles. Their results showed that for an unexposed 1.5 mm thick HDPE geomembrane, the life expectancy for the retention of 50% of mechanical capacity could be up to 450 years, whereas it was 97 years for the exposed membranes.

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122 Müller, W.W. and Saathoff, F., 'Geosynthetics In Geoenvironmental Engineering', *Science And Technology Of Advanced Materials*, Vol. 16, No. 3, 2015.

123 Dixon, N., Raja. J., Fowmes, G. and Frost, M., 'Sustainability Aspects Of Using Geotextiles', *Geotextiles*, 2016, pp. 577-596.

124 Edana, 'Why use nonwovens in geosynthetics and civil engineering?', Consulted 6 January 2022 (https://www.edana.org/nw-related-industry/nonwovens-in-daily-life/geosynthetics-and-civil-engineering).

125 Scholz, P. et al., 'Environmental Impact Of Geosynthetics In Coastal Protection', *Materials* (Basel), Vol. 14, No. 3, 2021, pp. 634.

[126] A study indicates that the successive exposure of polypropylene geotextile to UV degradation, sea water and thermal cycle "showed the existence of relevant interactions between the degradation agents and the reduction factors obtained by the traditional methodology were unable to represent accurately (by underestimating) the degradation occurred in geotextiles."[127]

The tests performed[128] to evaluate the life expectancy of these materials emulated the thermal, radiative and chemical processes to which geotextiles are exposed. However, they did not consider the mechanical abrasion which happens when geotextiles are exposed to the outside environment. One can infer that adding mechanical abrasion to the three degradation tests discussed would reduce the life expectancy of these materials even more for the geotextiles used in harsh environments, such as when used for coastal erosion protection. The general problem drivers for the microplastic emissions from geotextiles are similar to other sources, viz. market failure, regulatory failure and information/knowledge failure.

Scale of microplastic emissions from geotextiles

Estimations of the emissions of microplastics from geotextiles are scarce, but there are no lab results or experiments conducted, except the Bai, Xue et al. experiment in China. There are several explanations for this; first of all, geotextile weathering and environmental impact because of microplastics is a newly studied subject. Moreover, in-situ sampling is extremely difficult because these materials are either directly exposed to harsh environments and water (e.g., coastal erosion protection) where any microplastic particle emitted is extremely difficult to sample from the environment, either they are buried in the foundations of roads, building, or any other large construction works where to sample any microplastics; one would need to dig up the surrounding soil. The fate of geotextiles buried underground and potential microplastic emissions are also not known.

5 BASELINE BY SOURCE

5.1 Baseline for tyres

A key driver of tyre wear emissions is driving mileage. It is expected that there will be a significant increase in road transport volumes over the next decades. The JRC estimates a 16% increase in passenger road transport between 2010-2030 and a 30% increase for 2010-2050. Freight transport is estimated to increase by 33% by 2030 and 55% by 2050[129]. Most recently, in the context of preparing the Fit for 55 Package[130], the Commission assumed the increase in passenger car transport will grow by around 30% and around 20% for road freight transport[131]. Additionally, climate change effects,

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[126] Koerner, R. M., Hsuan, Y.G. and Joerner, G.R., 'Lifetime Predictions Of Exposed Geotextiles And Geomembranes', *Geosynthetics International*, Vol. 24, No. 2, 2017, pp. 198-212.

[127] Carneiro, J.R., Almeida, P.J. and De Lurdes Lopes, M., 'Laboratory Evaluation Of Interactions In The Degradation Of A Polypropylene Geotextile In Marine Environments', *Advances In Materials Science And Engineering*, Vol. 2018, 2018, pp. 1-10.

[128] The thermooxidation tests were carried out according to method A of EN ISO 13438 and the damage suffered by the geotextile (during the degradation tests) was evaluated by tensile tests according to EN 29073-3 [33] (the method specified in EN 12226 [19] for determining the changes in the tensile properties of aged nonwoven geotextiles).

[129] Alonso Raposo, M. and Ciuffo, B., *The Future of Road Transport: Implications of automated, connected, low-carbon and shared mobility*, JRC116644, 2019, Publications Office of the European Union, Luxembourg.

[130] European Council and Council of the European Union, 'European Green Deal - Fit for 55', 2022 (https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/).

[131] European Commission, 'Policy scenarios for delivering the European Green Deal', 2022 (https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-european-green-deal_en#scenario-results).

e.g. more frequent heavy rainfall events, will exacerbate the problems linked with releases of those microplastics from urban runoff and stormwater overflows (SWO). Finally, the increasing electrification of vehicle fleet may negatively influence tyre wear emissions and abrasion since ‘electrified vehicles’ (i.e. hybrid ICE) are generally heavier compared to their conventional counterparts. Battery electric vehicles are not necessarily heavier than conventional ICE vehicles of comparable class and power, particularly the larger ones[132]. Moreover, energy density (in weight and volume) is predicted to improve, so longer-range battery electric vehicles (BEVs) are expected in the future without an increase in weight. The possible effects of the introduction of electrified vehicles on non-exhaust emissions have been summarised in a recent OECD report[133].

With regards to tyre abrasion, important improvements could be expected since the proposal for a Euro 7 Regulation includes a review clause and related empowerments in order to include tyre abrasion limits in the type approval process. An ongoing Commission study and work performed in the UN Forum for Harmonisation of vehicle regulations on tyre abrasion test method will provide the basis for a tyre abrasion standard. The Tyre Labelling Regulation[134] included the possibility of a delegated act on tyre abrasion when the standard on abrasion (and mileage) becomes available.

5.1.1 Analytical approach

It is still a challenge to collect representative environmental samples of tyre wear, whether in water, soil or air.[135] Due to a lack of reliable methodologies, measurement uncertainties and incomplete databases, no reliable results can be quantified. An analytical or a top-down approach is possible.

Analytical problems hamper the environmental monitoring of emitted TWP. Emitted TWP cannot be analysed using FTIR or Raman spectroscopy, commonly used for other microplastics. Since tyre tread and emitted TWP have a complex chemical composition and emitted TWP are difficult to separate from environmental matrices, markers are needed to detect the particles in environmental samples. In general, chemical compounds that are additives in tyre tread materials in sufficiently high concentrations are used as markers. A reliable marker should i) be specific to tyre rubber polymer, ii) be present in comparable concentrations, preferably independent of tyre brands, iii) not easily leach out or be transformed under environmental conditions and iv) be easily and precisely detectable. Typical markers used are inorganic Zn, benzothiazoles such as 2-(4-morpholinyl)benzothiazole (24MoBT) and N-cyclohexyl-2-benzothiazolamine (NCBA) (components of vulcanization accelerators), NR (natural rubber) and SBR/BR (styrene butadiene rubber/ butadiene rubber). For all markers, a sample preparation to separate emitted TWP from other particles is useful to reduce the background concentration, prevent matrices effects and concentrate emitted TWP to get a representative sample. By using thermoanalytical methods, a fractionation in several size classes is useful. The reason is that bigger particles have a high influence on the total mass, but in general, the number of particles is less than for smaller particles.[136] Furthermore, by analysing the air samples, the particle size <10µm is more relevant to evaluating health hazards.

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[132] E.g. A Tesla Model 3 LR, 4x4, 441 HP weighs 1726 kg, while a BMW 330e, 4x4 292 HP weighs 1820 kg.

[133] OECD, *Non-exhaust Particulate Emissions from Road Transport: An ignored environmental policy challenge*, 2020, OECD Publishing, Paris.

[134] European Parliament and Council of the European Union, Regulation (EU) 2020/740 on the labelling of tyres with respect to fuel efficiency and other parameters, OJ L 177, 5.6.2020, pp. 1–31.

[135] Peter Tromp et al., Presentation on the ‘Comparison and improvement of analytical techniques for quality data on TWP in the environment’, *Conference Setac Europe*, 2021 (https://globe.setac.org/tire-wear-and-microrubber-particles/).

[136] Venghaus, D. et al., Report on project RAU (Tyre abrasion in the environment) – ‘Tire Wear in the environment – RAU’, 2021, Funded by the German Federal Ministry of Education and Research (BMBF).

Top-Down approach

Based on a mileage approach, tyre abrasion emissions can be estimated theoretically. An emission factor (EF) is defined and multiplied by the distance travelled. The resulting quantity corresponds to the losses on the tyre tread and represents the emitted TWP. The EF can be made dependent on various influencing variables, which are explained below.

Quantification of emissions

By differentiating between vehicle types (motorcycle, passenger car, HDV, etc.) and road types (urban, rural and motorway), the influencing variables from Boulter et al.[137] - tyre and vehicle characteristics, road surface characterisation and vehicle operation - can be taken into account, i.e. emission factors of the vehicle types are adjusted according to the driving situation (urban/rural/motorway). Based on the methodology for determining the emission rate described above and considering influencing factors, emission factors (EF) can be determined.

The figure below shows an overview of EF from various studies[138]. It is clear that the EF for motorcycles, passenger cars and light/medium vehicles show hardly any deviations. The EF for heavy-duty vehicle (HDV) and buses, on the other hand, fluctuate strongly.

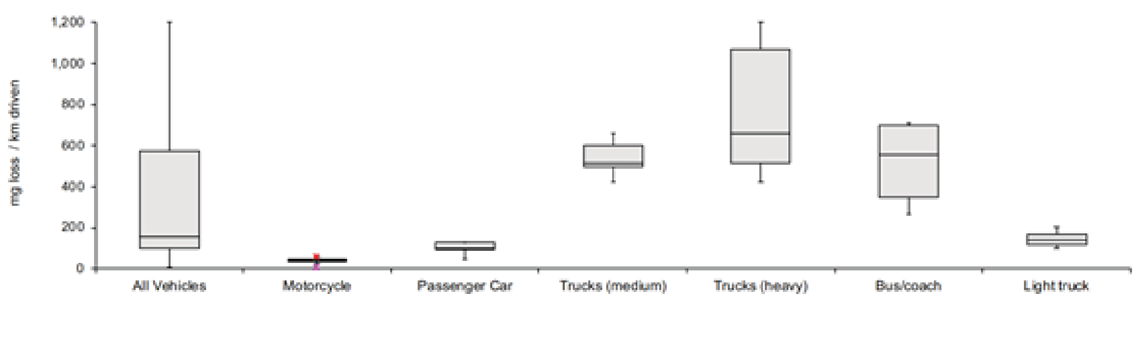

Figure 19: Emission rates according to vehicle type in various studies[139]

The EF, according to Deltares and TNO[140], has already been used several times in the calculations of the Netherlands Environmental Agency[141,142,143]. Furthermore, the EF served as a basis for the TWP

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[137] Boulter, P.G., Thorpe, A., Harrison, R.M. and Allen, A.G., 'Road Vehicle Non-exhaust Particulate Matter: Final Report on Emission Modelling', *TRL*, 2006.

[138] Peano, L. et al., 'Plastic Leak Project. Methodological Guidelines', *Quantis*, 2020 (https://quantis.com/report/the-plastic-leak-project-guidelines/).

[139] Ibid.

[140] Deltares and TNO, 'Emissieschattingen Diffuse bronnen Emissieregistratie - Bandenslijtage wegverkeer' [Emission estimates Diffuse sources Emission registration - Tyre wear road traffic], 2016 (https://docplayer.nl/22104153-Bandenslijtage-wegverkeer.html), Nl.

[141] Geilenkirchen, G. et al., 'Methods for calculating the emissions of transport in the Netherlands', *PBL Netherlands Environmental Assessment Agency*, 2020 (https://www.pbl.nl/sites/default/files/downloads/pbl-2020-methods-for-calculating-the-emissions-of-transport-in-the-netherlands-2020-4139.pdf).

[142] Verschoor, A. et al., 'Emission of microplastics and potential mitigation measures: Abrasive cleaning agents, paints and tyre wear', Dutch National Institue for Public Health and the Environment, 2016 (https://rivm.openrepository.com/bitstream/handle/10029/617930/2016-0026.pdf?sequence=3).

[143] Klein, J. et al., 'Methods for calculating the emissions of transport in the Netherlands', 2019 (https://english.rvo.nl/sites/default/files/2019/05/Klein%20et%20al%202019%20Methodology%20report%20transport%202019.PDF).

emissions calculations in numerous studies[144]. To estimate TWP emissions for the EU27, the most recent road traffic data from the Eurostat database were used (Table 8).

Taking into account the given data and assumptions, this results in an annual emission quantity of **450,000 t/a TWP** for the entire EU27 for 2020, which is at the bottom end of the range from other studies (460,000-1,220,000 t/a) discussed previously. The shares of the road sectors (urban/rural/motorway) in the total emissions can be estimated on the basis of the available mileage data. According to this, most tyre wear is emitted on urban (39%) and rural (38%) roads. The share of motorways is 23%.

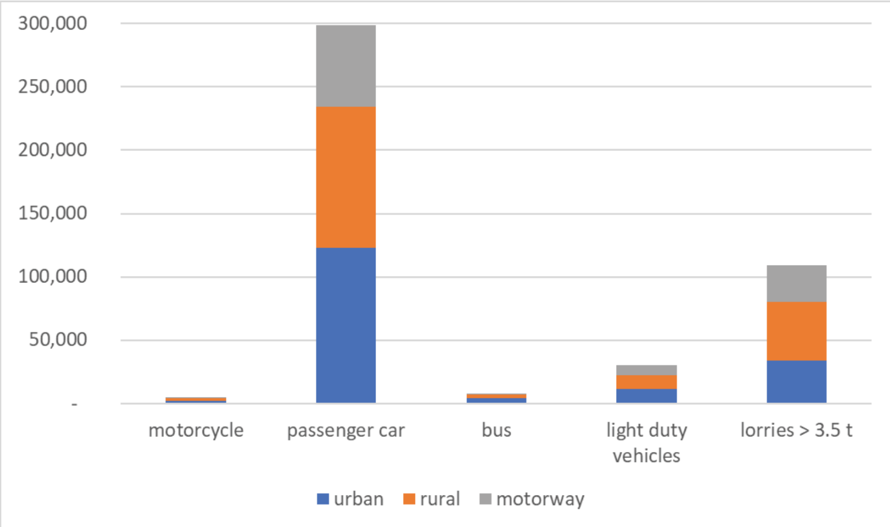

Figure 20: Annual estimated TWP emissions for the EU27, 2020

In order to develop an estimate for the final release of tyre wear (i.e. to which environmental compartments they are released), the methodological guidelines of the Plastic Leak Project[145] were used. The tool published for this project takes all input pathways into account and allows specific parameters to be adjusted. Although there are uncertainties in the data, e.g. the share of separate/combined sewer systems or the recycling of sewage sludge, it nevertheless provides information on how different measures could affect it.

The table below shows the calculated estimates for the final release of tyre wear into the environment.

Table 8: Estimation of the final release of emitted TWP

		FINAL RELEASE COMPARTMENTS					Removed from the environment
	share of roads	OCEANS (sediments and water column)	FRESH-WATER (sediments and water column)	SOILS	AIR	OTHER TERRESTRIAL COMPAR-TMENTS	
Average		2%	14%	59%	5%	9%	12%

[144] Vogelsang, C. et al., 'Microplastics in road dust – characteristics, pathways and measures', 2019 (https://www.miljodirektoratet.no/globalassets/publikasjoner/M959/M959.pdf).

[145] Quantis, 'The Plastic Leak Project' (https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/plastic-leak-project/).

Urban	39%	2%	19%	48%	5%	12%	19%
Rural	38%	0%	3%	91%	5%	5%	0%
Motorway	23%	3%	26%	38%	5%	12%	21%

The table shows that the majority of the emission is deposited in the soil (59%), which is the significant input pathway for rural roads in particular. This includes wind drifts to roadside and ditches as well as WWTP sludge agriculture and compost use. With regard to the input into the aquatic environment, urban areas and motorways are of particular importance. Other terrestrial compartments include stormwater sludge and sewage sludge listed in Eurostat as other and unknown. Sludge for incineration is evaluated as "removed from the environment". Although it can be assumed that airborne particles will deposit in the environment over time and thus contribute to the input of soil, surface waters or oceans, the intention of the pathway estimation is to identify which compartments and the living organisms in them are affected by the emission. The proportion of airborne particles is therefore set to 5%, according to Baensch-Baltruschat et al.

The baseline is the projection of emissions over the assessment period. The different factors that could potentially influence tyre wear emissions in the future have been assessed above. The following table summarises the expected effect of these factors on the tyre wear emissions. In addition to these factors, any future potential regulatory actions on abrasion rates could have a significant positive effect.

***Table 9: Key factors and their effect on tyre wear* emissions.**

Factor	Estimated Impact on TWP Emissions
Development in transport volume and mode of transport	Increase
Tyre material innovations	High effect and high potential
Road material innovations	Limited effect but high potential
Electric vehicles	Increase – depending on battery technology developments which might reduce the effect
Vehicle weight (SUV trend)	Increase
Speed limits	Decrease
Porous asphalt	Limited decreasing effect – but medium potential impact
Driving behaviour	Changes in behaviour can lead to increases (greater acceleration, sharp breaking etc.) or decreases (slower acceleration / speeds, reduced ./ smoother breaking)
Autonomous driving / connected driving	Limited decreasing effect in the short term, but medium potential impact in the longer term

For transport volumes, there are EU projections available that quantify how it is expected to evolve. In preparation of the European Green Deal Package, the Commission carried out a scenario assessment, including projections of the development of the transport sector and transport volumes. The policy scenarios assume continued transport growth. Though they include some reductions compared to the reference scenario, the increase in passenger car transport is assumed to grow by around 30% and about 20% for road freight transport[146]. It means that an increase in emissions can be expected due to the continued road transport growth.

Considering the different factors, it is difficult to quantify the expected change in emissions in the future. The increase in road traffic and the (assumed) higher weight of electric vehicles would all lead to an increase in tyre wear emissions. More restrictive speed limits, better tyres, and improved driver behaviour through autonomous driving and awareness campaigns would lead to lower emissions. The following assumptions have been made:

- It is assumed that all factors except the transport volume increase cancel each other out. For example, effects of increases in the weight of passenger cars are offset by the factors that reduce emissions such as speed etc.
- The projected increase in transport volumes by 2030 of 30% for passenger transport and 20% for freight transport lead to proportionate increases in the microplastic emissions by the respective vehicle categories.

In total, the emissions are therefore expected in the baseline to increase from around 450,000 tonnes per year to **570,000 tonnes per year in 2030**.

5.1.2 Uncertainty and data gaps

Several factors influence the release of emitted TWP into the environment, e.g. tyre material and design, which consists of many components, road composition, and driving behaviour. The analysis for the determination of tyre abrasion in environmental samples is a challenge, and an interpretation of the analytical data should be carried out, taking into account the external conditions. In general, these variables' comparison and inclusion are not explored. Additionally, reproducible quantification of particles in the environment depends on the laboratories' sampling techniques and analytical techniques. Currently, there is a knowledge gap which is a combination of sampling techniques and evaluation procedures most suitable for quantification of emitted TWP to get realistic values. This gap should be at least partially filled with the ongoing work to develop a harmonised testing method and standard.

In addition to uncertainties with the overall emission factors for tyre abrasion, there is also a lack of data on the mix of tyres currently in use and how they vary in terms of abrasion rates. Several studies have demonstrated significant variation in abrasion rates between different tyre models and types both across different categories (i.e. tyre sizes and types) as well as within categories.

5.2 Baseline for textiles

The European demand for synthetic textiles is estimated at 8 million tonnes (ETC/WMGE, 2021c), representing almost 14 % of Europe’s total plastic consumption. Between 1996 and 2012, there was a 40% increase in the amount of clothes purchased per person in the EU, and, according to the European Environmental Agency (EEA), between 1996 and 2018, clothing prices in the EU dropped by over 30 %, relative to inflation. Since 2000, Europeans have purchased more pieces of clothing but spent less money in doing so. These trends are expected to increase in the future, as at a global level, the consumption of clothing and footwear is expected to increase by 63% between 2019 and 2030. The global consumption of synthetic fibres increased from a few thousand tonnes in 1940 to

[146] European Commission, ‘Policy scenarios for delivering the European Green Deal’ (https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-european-green-deal_en).

more than 60 million tonnes in 2018, and continues to rise. Since the late 1990s, polyester has surpassed cotton as the fibre most commonly used in textiles. While the majority of synthetic textile fibres are produced in Asia, Europe stands out as the world's largest importer of synthetic fibres by trade value[147], and also produces and exports such fibres.[148] This increase in consumption leads to an increase in textiles production thus increasing microplastic emissions from textiles. In practice, this increase in consumption is accompanied by a decrease in the number of uses per piece[149]. A higher renewal rate also means more textiles being thrown away and more emissions at the end-of-life stage. Due to their low cost, synthetic materials are one of the levers of fast fashion.

The global increase in textile consumption implies a wider use of synthetic fibres, namely polyester and a consequent increase in fibre production. More than half of the global fibre production is polyester, making it the most common synthetic fibre (55 million tonnes in 2018) (Textile Exchange, 2019)[150], in with a large majority of polyester, which should represent around 70% of the total fibre production in 2030. The growing share of synthetic fibres is linked to the limited production of cotton and its relatively high price, as well as the increasing use of synthetic fibres in industries (synthetic fibres are used in a wide range of technical products: tyres, conveyor belts, reinforcement in composites, etc.).

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147 Birkbeck, C.D., *Global Governance Brief: Strenghthening international cooperation to tackle plastic pollution: options for the WTO*, The Graduate Institute of Geneva, 2020.

148 Manshoven, S., Smeets, A., Arnold, M. and Fogh Mortensen, L., 'Plastic in textiles: Potentials for circularity and reduced environmental and climate impacts', European Environment Agency and European Topic Centre on Waste and Materials in a Green Economy, Eionet report ETC/WMGE 2021/1, 2021.

149 Hemkhaus, M., Hannak, J., Malodobry, P. et al., 'Circular economy in the textile sector', study for the German Federal Ministry for Economic Cooperation and Development, 2019.

150 Textile Exchange, '2019 Preferred Fiber & Materials Report', 2019 (https://store.textileexchange.org/product/2019-preferred-fiber-materials-report/).

Table 10 sums up current microplastic emissions from synthetic textile per year in the EU. Data quality was assessed according to the number of sources and the uncertainty[151]. Not all emissions to water reach the environment. Indeed, part of the emissions to water will be captured by wastewater treatment plants. A large majority of microplastics are captured in the sludge[152]. However, in Europe, approximately 50% of all sludge are applied in agriculture as fertilizer[153]. So, due to sludge usage as fertilizer (the other half being incinerated, the microplastics are not emitted to the environment), 50% of emissions to water will reach the environment. Outside Europe, all emissions to water are considered to be emitted to the environment.

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[151] The data used for calculating the emission ranges are presented in the appendices of the supporting study for this Impact Assessment.

[152] Lares, M. et al., 'Occurrence, Identification And Removal Of Microplastic Particles And Fibers In Conventional Activated Sludge Process And Advanced MBR Technology', *Water Research*, Vol. 133, 2018, pp. 236-246, Elsevier BV.

[153] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

Table 10: Microplastic emissions from synthetic textile per year in the EU27 - 2021

	Production	Washing	Drying	Wearing	End-of-Life
Microplastic emissions per year due to EU consumption (tonnes)	[841 ; 22,704] Of which 21% happen in the EU	[635 ; 5506]	[137 ; 7501]	[37 ; 25,367]	NA
Type of emissions	Air / water	Water	Air	Air	Air / water
Data quality	Low	Medium	Medium	Low	NA
Number of sources	1	6	4	2	0

These quantifications need to be refined along with standardised measurement methods in order to understand the influence of each factor and to be able to compare data. Standardisation should specify all the experiment criteria and impose only one measurement method to compare studies with one another. However, these values already underline the need to tackle microplastic emissions and generation directly at the source.

The baseline scenario has been developed for the year 2030. The quantities of microplastics emitted per year in 2030 are estimated by taking into account the evolution of the parameters related to the general problem driver “Increase in production and use of textiles”, such as the increase in clothing consumption and the increase in the share of synthetic materials in clothing. The following table lists the parameters used to define the baseline scenario and gives their evolution between the current situation and the foreseen situation in 2030. The values for 2030 are either estimated on the basis of the literature or are assumed (details provided in “Comments” column).

*Table 11: Evolution of the parameters of the microplastic emissions from textiles between the current situation and 2030 (parameters marked with an * are used directly in the emission calculations)*

Parameter	Sub-category	Unit	Data considered in the state of the art (current value)	Baseline scenario (forecast data)	Comments
Evolution of the population					
Population *	-	million	447	449 [154]	
Households in Europe (1)	-	million households	195	198	Population increase: 1.3% [155]
Market data					

[154] Toute l’Europe.eu, ‘A quoi ressemblera l’Europe en 2030’ [What will Europe look like in 2030?], 2020 (https://www.touteleurope.eu/environnement/a-quoi-ressemblera-l-europe-en-2030/), Fr.

[155] Calculation according to OECD projections between 2021 and 2030.

Parameter	Sub-category	Unit	Data considered in the state of the art (current value)	Baseline scenario (forecast data)	Comments
Consumption of textile products *	-	million tonnes	7.4 [156]	9.0	Increase in textile production: +23% [157]
Proportion of man-made fibres in clothing sector	-	%	33.9%	38%	Assumption: 38% of man-made materials (cf. section "Increase in production and use of synthetic textiles" / problem driver 2)
Polyester *	Woven	%	8.40%	9.38%	
	Knitted	%	8.60%	9.60%	
Polypropylene *	Woven	%	0.20%	0.22%	
	Knitted	%	1.20%	1.34%	
Acrylic *	Woven	%	0.30%	0.33%	
	Knitted	%	8.40%	9.38%	
Polyamide *	Woven	%	1.50%	1.67%	
	Knitted	%	5.30%	5.92%	
Washing					
Number of washes per household (2)	-	washes a week	3.35	No change	According to 2008, 2017 and 2020 AISE data, no change in frequency[158, 159]
Average capacity of a washing machine (3)	-	kg	6.5	7	Assumption based on (JRC, 2016)
Relative load of one wash (4)	-	%	82%	-	

[156] Calculation based on the following data: 6.4 million tonnes of clothing consumed in the EU in 2015 (source: ECAP, 'Mapping clothing impacts in Europe: the environmental cost', 2017 (http://www.ecap.eu.com/wp-content/uploads/2018/07/Mapping-clothing-impacts-in-Europe.pdf)) and "40 per cent growth in the amount of purchased clothes per person in the EU between 1996 and 2012", which means 2.5% growth per year (source: ETC/WMGE, 'Textiles and the environment in a circular economy', 2019 (https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/textiles-and-the-environment-in-a-circular-economy/))
As in the EC/Eunomia (2018) report, professional textile washing – namely in hospitals or hotels – was not considered. Professional and household linens are mainly composed of cotton or polycotton (polyester/cotton blend) . Due to the lack of data on microplastics emissions from polycotton, the amount of polyester contained in the polycotton blend, no estimation could be made. According to first approximations made by RDC Environment, microplastics emissions from this source would represent less than 5% of the household emissions from clothing.

[157] Calculation based on the following data: "40 per cent growth in the amount of purchased clothes per person in the EU between 1996 and 2012" (source: ETC/WMGE, 'Textiles and the environment in a circular economy', 2019 (https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/textiles-and-the-environment-in-a-circular-economy/))

[158] AISE, 'A.I.S.E.'s pan-European habits survey 2020', 2021 (https://www.aise.eu/our-activities/information-to-end-users/consumer-research.aspx).

[159] AISE, 'A.I.S.E. Pan-European Consumer Habits Survey 2017', 2018 (https://www.aise.eu/documents/document/20180528165059-aise_consumershabitssurvey2017_summary_final.pdf).

Parameter	Sub-category	Unit	Data considered in the state of the art (current value)	Baseline scenario (forecast data)	Comments
Machine load * (3)*(4)	-	kg of textile washed per cycle	5.33	5.33	Calculation based on the average capacity of a washing machine and the relative load of one wash Note: no increase in load despite the increase in capacity.[160]
Number of washes per year * (1)*(2)	-	billion washes	34.0	34.5	Assumption: increase in the number of washes according to the population
Drying					
Number of tumble dryers in use in European households *	-	million	78.0	78.3	Assumption: increase in the number of dryers according to the population
Number of uses per year *	-	times per year	107	No change	
Average load *	-	kg	4.4	No change [161]	

The microplastic emissions per year for 2030 are presented in the following table. It should be noted that emissions of microplastics per year for the year 2030 are calculated using the following assumption, **"there is no change in the quantities of microplastics emitted per kg (kg worn, kg washed or kg dried)".** This assumption is based on the fact that the time considered is too limited to identify and implement eco-design and research & development actions as a baseline without policy measures fostering changes. No quantified data is available for microplastic emissions related to the end of life of clothing. For these emissions, the evolution of emissions (in % terms) is estimated only based on the increase in clothing consumption.

[160] European Commission, Final report - Review study on household tumble driers, 2019 (https://www.applia-europe.eu/images/Library/Review_study_on_tumble_dryers_06-2019.pdf).
[161] Ibid.

Table 12: Evolution of the quantities of microplastics emitted per year (tonnes/year)

Emissions	Data estimated in state of the art (current value)	Baseline scenario (forecast data)	Evolution	Comments
Production in Europe (emissions to air and water)	159 - 4293	217 - 5869	+ 37%	Emissions in Europe. Evolution estimates based on the increase in textile consumption and increase in the share of synthetic materials
Production outside Europe (emissions to air and water)	682 – 18 411	932 – 25 172	+ 37%	Emissions outside Europe. Evolution estimates based on the increase in textile consumption and increase in the share of synthetic materials
Use phase – wearing (emissions to air)	37 – 25 367	42 – 28 438	+ 12%	Increase due to the increase in the share of synthetic materials and population growth
Washing (emissions to water)	635 - 5506	714 - 6223	+ 12%	Increase due to the increase in the share of synthetic materials and the evolution of washing habits
Drying (emissions to air)	137 – 7501	153 – 8410	+ 12%	Increase due to the increase in the share of synthetic materials and population growth
End-of-life (emissions to air and water)	No quantified data	No quantified data	+ 37%	Evolution estimates based on the increase in textile consumption. The evolution of the emissions linked to the end of life corresponds to an overestimation because no stock is considered.

The evolution of microplastic emissions varies between +12% and +37%, depending on the type of emissions considered. Among the four parameters used to define the baseline scenario, the most influencing parameters are:

- Increase in the consumption of clothing (for production and end of life)
- Increase in the share of synthetic materials (for wearing, washing and drying).

Note: According to CircularInnoBooster Fashion and Textile project, second-hand clothing accounts for 2% of the total weight of the fashion and luxury goods sector in the world[162]. This figure is expected to grow by 15 to 20% over the next five years. At present, the market for second-hand clothes is still limited. The use of second-hand clothes makes it possible to: reduce the consumption of new clothes and therefore reduce production (thus avoiding microplastic emissions at this stage). On the other hand, studies[163, 164] show that microplastic emissions during care increase with the age of the garment. Thus, emissions could increase during washing.

[162] CircularInnoBooster Fashion and Textile project, 'Second-hand fashion, a new impetus for clothing consumption', 2021 (https://circoax.eu/second-hand-fashion-a-new-impetus-for-clothing-consumption).

[163] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.

[164] Textile Mission, 'Textiles Mikroplastik reduzieren - Erkenntnisse aus einem Interdsziplinären Forschungsprojekt' [Reducing textile microplastic emissions: Insights from an interdisciplinary research project], 2021 (https://textilemission.bsi-sport.de/fileadmin/assets/Abschlussdokument-2021/TextileMission_Abschlussdokument_Textiles_Mikroplastik_reduzieren.pdf), De.

The following figures show the evolution of microplastic emissions between 2021 and 2030 for the min and max values. In Figure 21, the microplastic emissions are expressed in tonnes/year. In Figure 22: the emissions are represented relative to 2021 emissions (i.e. 2021 = 100%). Microplastic emissions increase by +25% or +21% depending on whether the min and max thresholds are considered. There is not enough data to estimate what is the most plausible between min and max. The average microplastic emissions were used to quantify the impact of the policy measures.

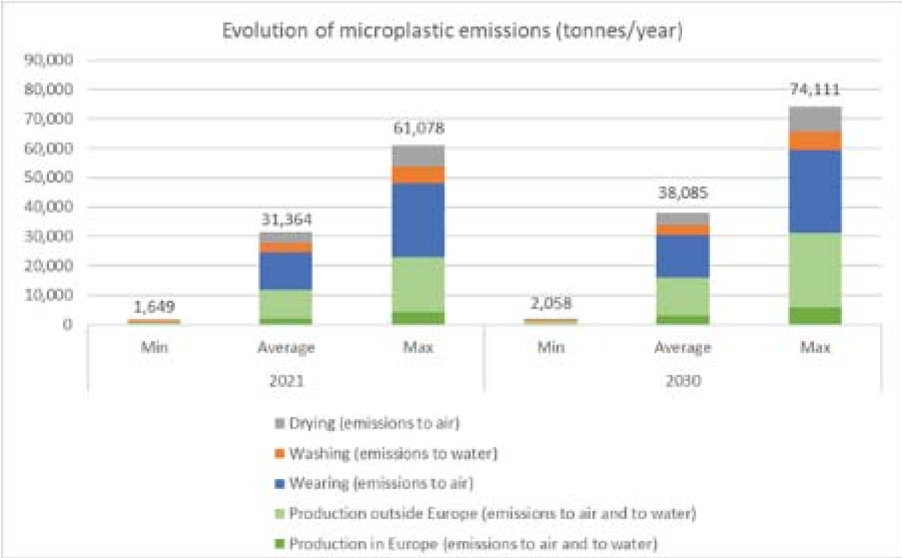

Figure 21: Evolution of microplastic emissions between 2021 and 2030 (in tonnes/year)

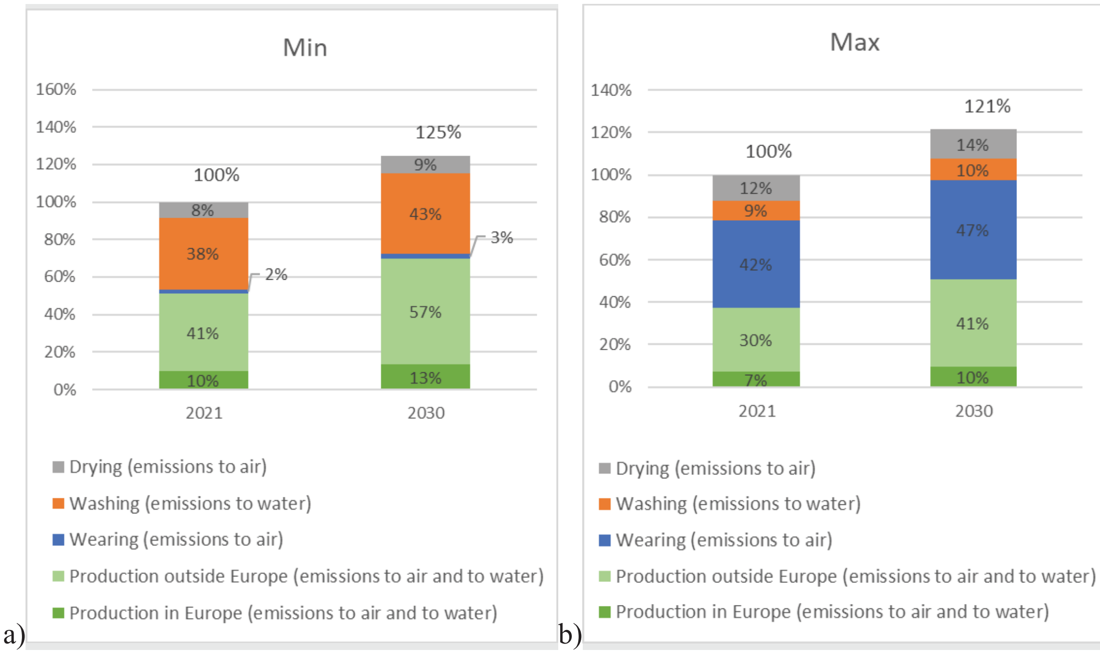

Figure 22: Evolution of microplastic emissions between 2021 and 2030, a) for min thresholds, b) for max thresholds

5.2.1 Uncertainty and data gaps

The uncertainty of the microplastic estimations is high. In the baseline, they vary between 2,058 and 74,111 t per year in the EU. The data quality is low for production and wearing life-cycle stages.

There is no data for the end-of-life. The uncertainty comes from the limited data to quantify microplastic emissions and not from the baseline extrapolation (see following table).

Table 13: Microplastic emissions from synthetic textile per year in the EU27 - 2021

	Production	Washing	Drying	Wearing	End-of-Life
Microplastic emissions per year due to EU consumption (tonnes)	[841 ; 22,704] Of which 21% happen in the EU	[635 ; 5506]	[137 ; 7501]	[37 ; 25,367]	NA
Type of emissions	Air / water	Water	Air	Air	Air / water
Data quality	Low	Medium	Medium	Low	NA
Number of sources	1	6	4	2	0

These quantifications need to be refined along with standardised measurement methods in order to understand the influence of each factor and to be able to compare data. Standardisation should specify all the experiment criteria and impose only one measurement method to compare studies with one another. No quantified data is available for microplastic emissions related to the end of life of clothing. The following figure shows the evolution of microplastic emissions between 2021 and 2030 for the min and max values. There is not enough data to estimate what is the most plausible between min and max. The average microplastic emissions were used to quantify the impact of the policy measures.

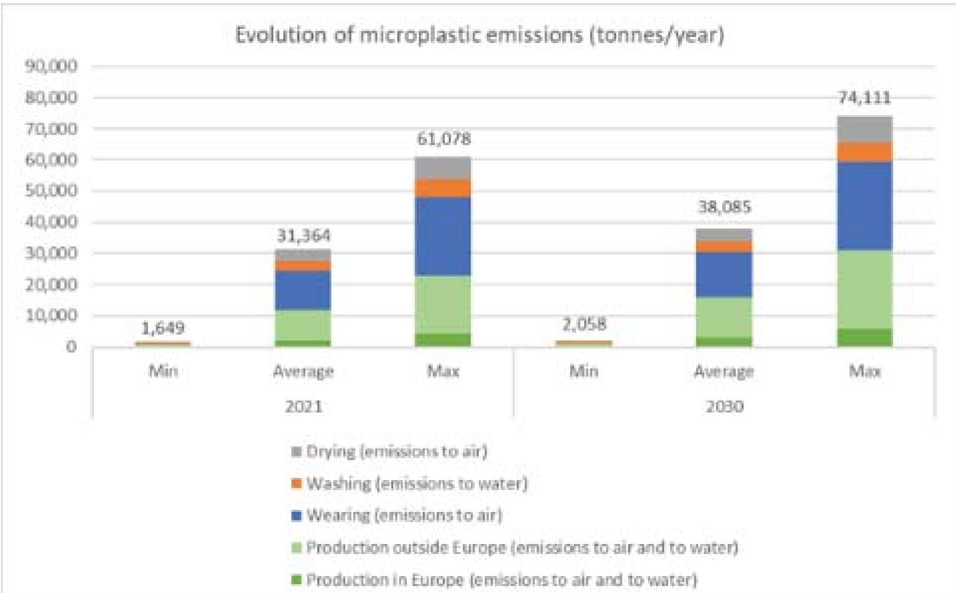

Figure 23: Evolution of microplastics emissions between 2021 and 2030 (in tonnes/year)

5.3 Baseline for paints

Out of the 52 Mt of paint produced globally (in 2019), 19.5 Mt are plastic polymers[165]. This represented 5% of the total global polymer production that year. Paint has a high plastic content - on average, 37% - and can be found on a wide range of objects and infrastructures used in our society: cars, boats, indoor walls, buildings, and bridges, among others.

According to data provided by Statista, citing Kusumgar, Nerlfli & Growney as sources (but without precise reference), paint volumes have grown steadily from 2009-2021, with yearly growth rates of 4%-9%. If we perform a linear fitting of this past trend and extrapolate it to 2030, we can expect that globally 27 Mt of plastic polymer will be used in paint.

The results presented hereafter are an extract from the global EA assessment Paruta et al., 2022. The analysis focuses on paint microplastic release to the environment during the application, wear and tear, removal of paint or handling of the painted object when it reaches its end of life.

It is important to highlight that loss rates are poorly documented both in the scientific and grey literature; therefore, an accurate assessment is not feasible at the moment. The following sections present an estimate of the order of magnitude of the paint leakage to determine whether paint represents a significant contribution to the total plastic leakage. To navigate through this data-scarce environment, expert assumptions have been used for some of the model parameters.

The first thing to estimate is the paint demand by sector. Figure below shows the way plastic polymers were used across the different paint sectors in EU-27 in 2019. The architectural sector ranked first with 42% of the total input, followed by the automotive and marine sectors with 17% and 15%, respectively.

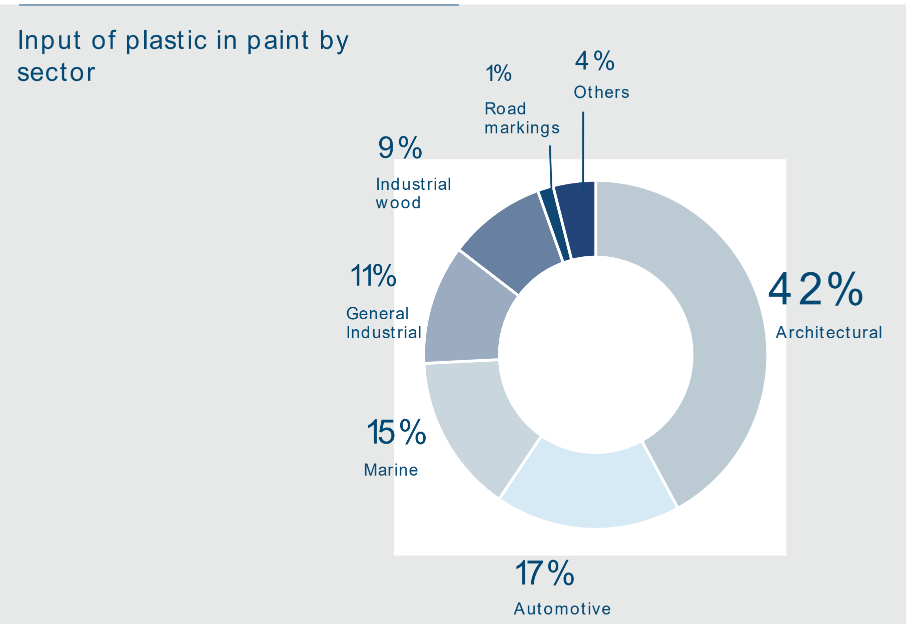

Figure 24: Yearly input of plastic in paint by sector for EU-27, data for 2019.

The total amount of plastic content of paint used in 2019 in the EU was 2,326 thousand tonnes, of which 628 kt/year leaked into the environment. The majority of this leakage was in the form of

[165] Market research from MarketsandMarkets Research Private Limited

microplastics, for a total of 482 kt/year, of which 298 kt/year was leaked to the ocean and waterways and 145 kt/year to land. Despite the uncertainties arising from the leakage calculation, it is clear from this study that the majority of applied paint does not benefit from proper management during maintenance or end-of-life.

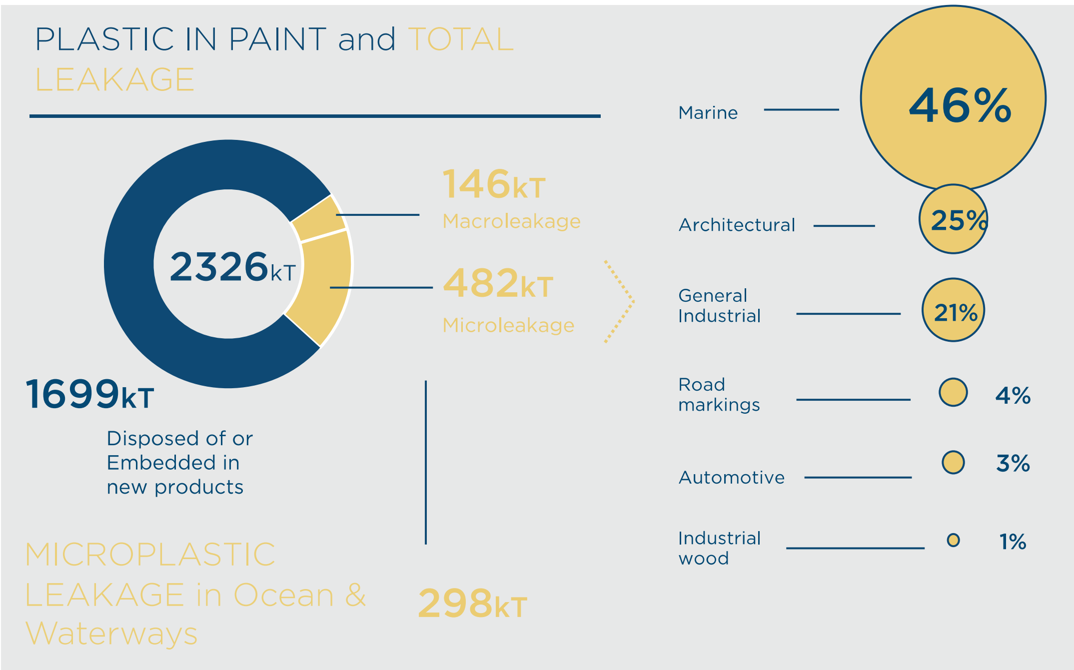

Figure 25: Total amount of plastic in paint each year for the six sectors, EU27

Figure above shows the plastic from paint in leaked and well-managed fractions. The plastic leakage amount is divided into its fractions of micro- and macro-plastics and the amounts that end up in the environment (Ocean & Waterways and Land). On the right side, the picture shows the shares of each sector to the total microplastic leakage. In terms of microplastic leakage to the environment, the marine sector is the largest contributor to the total leakage (46%), while industrial wood is the least important one (1%).

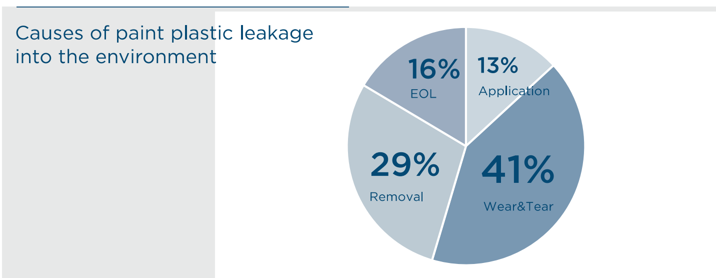

Figure 26: Contribution by loss mechanism of the microplastic leakage to the environment (Land and Ocean & Waterways)

The paint leakage is mainly due to wear & tear (41%) and removal (29%) loss mechanisms (Figure 26). About 16% of the micro-leakage happens at the end-of-life (EoL) of the painted object. In this case, the losses are associated with the practice of shipbreaking of European commercial vessels, which takes place on the beaches of India, Bangladesh, Pakistan, China and for a small part (3.5%) in Turkey (UNCTAD, 2019). All the six sectors contribute to the total leakage, with leakage rates ranging from 2% (industrial wood) to 63% (marine sector) (Table 14), where the leakage rate is defined as the ratio between the microplastic leakage to the environment and the total plastic input.

Table 14 presents the overview of the total leakage contribution for both environmental compartments of each sector and its split between micro- and macro-leakage.

Table 14: Overview of plastic leakage from paint by sector, for EU-27 (2019), in kt

		Unintentional microplastic leakage to the environment				Macroplastic leakage to environment	
Sector	Total input (plastic content)	Leaked to Ocean and Waterways	Leaked to Land	Leakage to the Environment (Ocean & Land)	Leakage rate to Environment	Leaked to Ocean and waterways	Leaked to Land
Architecture	1019.4	28.1	92.7	120.8	12%	20.1	66.5
Marine	356.6	210.2	12.9	223.2	63%	0.5	1.8
General Industrial	268.8	47.0	55.3	102.3	38%	20.5	16.8
Road markings	35.7	9.5	10.5	20.0	56%	0.0	0.0
Automotive	422.1	3.2	9.2	12.3	3%	1.9	7.3
Industrial wood	223.2	0.2	3.2	3.4	2%	1.7	7.4
All paint	*2325.8*	*298.2*	*183.7*	*481.9*	*21%*	*44.8*	*99.9*

The results are obtained following the approach described in Paruta et al. 2022. The values are in thousand tonnes (kt), and they refer to plastic quantities. In the case of marine paints, the microplastic leakage to the environment includes paint lost during maintenance and shipbreaking of European vessels in other countries, for a total of 127 kt. Furthermore, the paint lost while European vessels are at sea has been allocated to the EU – 27 countries, for a total of 68 kt.

In the following sub-sections, we provide an insight into the analysis by sector to illustrate how paint flows across the various stages of its life cycle before reaching its final fate.

5.3.1 Architectural

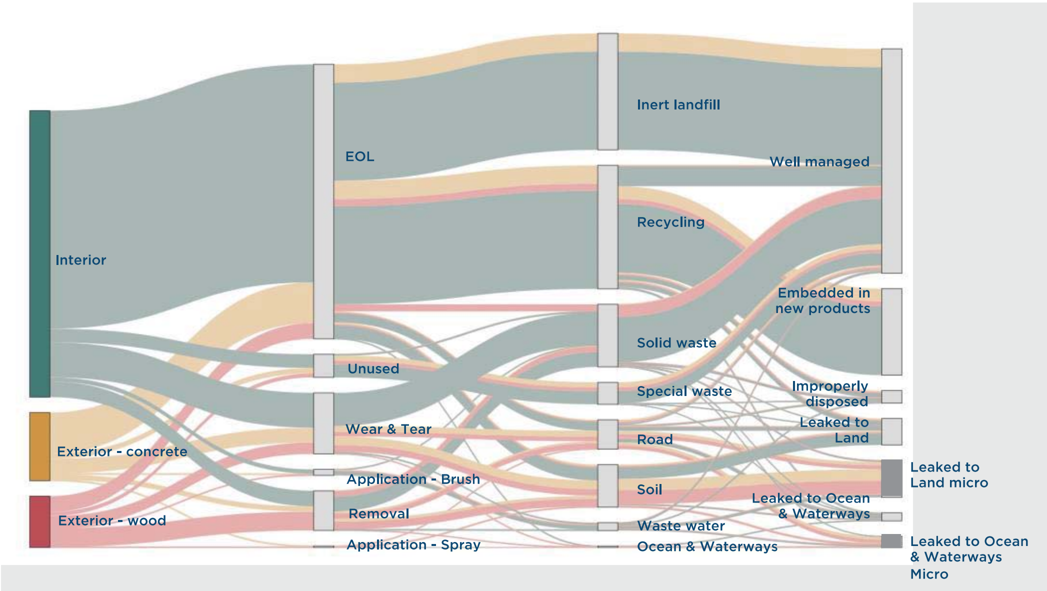

Figure 27: The Sankey diagram of the flow of plastic in architectural paint (2019)

Paint can be lost before reaching its supporting material (application), it can detach from it (wear and tear or removal), or it can be disposed of with or without it (unused or end-of-life). Ultimately, the lost paint can be well managed (disposed to a sanitary landfill or incineration facility), embedded in new products, or leaked to land or oceans and waterways. Here we highlight the part of the leakage that happens in the form of microplastics. In 2019, 1,019 kt of plastic was used in architectural paint within the EU-27 countries. This includes paint used on interior and exterior surfaces. About 71% of the plastic is from paint used on interior surfaces (Hann et al., 2018). The predominance of interior paint is intuitively justified by the fact that there is more interior than exterior surface to paint and that interior paint is re-painted more frequently than exterior due to aesthetic purposes. The amount of architectural paint used in the EU-27 was estimated using the following sources:

- The total amount of plastic used for architectural paint globally, i.e. 10,801 kt according to *MarketsandMarkets Research Limited;*
- The number of households in EU-27 is computed as the total population divided by the average number of people per household (*United Nations, 2019*. Database on Household Size and Composition 2019). Total population by country as reported by the World Bank "What a Waste" database 2.0 (*Kaza, S. et al., 2018*).

The number of households is not the only parameter that impacts the amount of paint used. The income level, the paint type, the weather, and the building material could be additional factors influencing the paint consumption by region. However, they have not been considered here, as no models are available to determine the quantitative impact on the paint used. Nonetheless, according to Hann et al., 2018, 947 kt of plastic was used in architectural paint in Europe in 2018, which is closed to the estimate presented here of 1,019 kt for 2019.

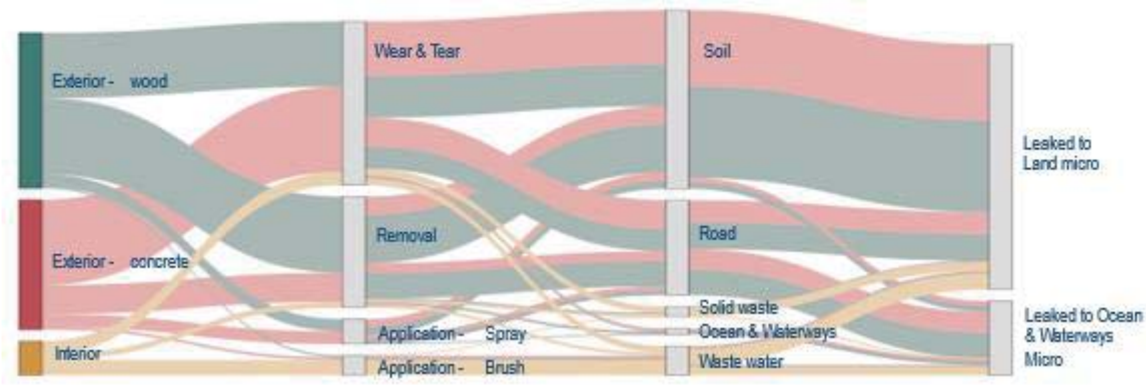

Figure 28: Sankey diagram focusing on the portion of architectural paint that ultimately leaks to the environment in the form of microplastic

Overall, 12% of the plastic in architectural paint put on the EU market leaks into the environment in the form of microplastics, i.e. a total of 121 kt. Of this, 93 kt leaks to land, while 28 kt to oceans and waterways. The leakage is mainly due to exterior paint being lost to the surroundings due to wear & tear and paint removal done without ensuring paint collection. Some of the paint is also lost to the environment during the application, either because of overspray of exterior paint or rinsing brush or rollers for interior and exterior paint. Although losses related to overspray are estimated at 15% (85% transfer efficiency), architectural paint is mostly applied by brush or roller, which accounts for 1.6% of paint losses to wastewater.[166] This assessment assumed that interior paint is always applied by brush or roller and that exterior paint is applied 80% of the time by brush or roller.

We estimate that a large part (68%) of the paint applied to a building will stay on until its demolition (end-of-life). Dust formation during demolition is a known phenomenon, and it has been investigated mostly because fine particles suspended in the air are known to be hazardous to human health[167]. Lacking quantitative estimates, we assume 10% of the paint that is still on the walls during demolition is lost to the environment as dust. The remaining paint follows the end of life of the supporting material. Both concrete, wood and plasterboard (the main support of interior paint) can be recycled. The EU had set a mandatory target of 70% recovery rate of construction and demolition waste by 2020 and concrete is mostly recycled as granulate that is then used in backfilling or road foundations[168]. On average, in the EU, 83% of the mineral waste from construction and demolition was "recycled" in 2016[169]. Plasterboard, which is mainly made of gypsum, can be recycled into new plasterboard through mechanical grinding, and it is then refined to have a uniform texture and be re-used to form plasterboards. According to British Gypsum, a UK manufacturer of interior lining systems, paper flakes (coated with paint) can be separated from gypsum during the recycling process and used as cattle bedding[170]. The hazardous risk to the health of the animals and the food chain safety linked to this practice is still to be investigated. Finally, painted or varnished wood is

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166 A.J. Verschoor and E. de Valk, RIVM 2017, *Potential measures against microplastic emissions to water,* RIVM Report 2017-0193

167 Ebadian et al. Technology assessment of dust suppression techniques applied during structural demolition, 1996

168 Wahlström, M., Bergmans, J., Teittinen, T., Bachér, J., Smeets, A., & Paduart, A. (2020). Construction and Demolition Waste: challenges and opportunities in a circular economy.

169 European Environment Agency, 2021. Accessed on https://www.eea.europa.eu/publications/construction-and-demolition-waste-challenges/construction-and-demolition-waste-challenges

170 British Gypsum (2021). Accessed on 21/10/2021. https://www.british-gypsum.com/about-us/csr/environmental-challenges/plasterboard-recycling

sometimes considered recyclable to produce wood chippings for plywood or particle board. In another context, regulation asks for painted wood to be disposed of as waste.

Overall, knowledge of paint losses during demolition and recycling practices of the support material (EoL) is lacking. They appear to be outside the scope of this assessment on the unintentional release of microplastics. However, the proper management of paint at the EoL needs attention since most of the paint is left on the building material until its end-of-life and the management of the construction and demolition waste stream still remains a challenge.

5.3.2 Marine

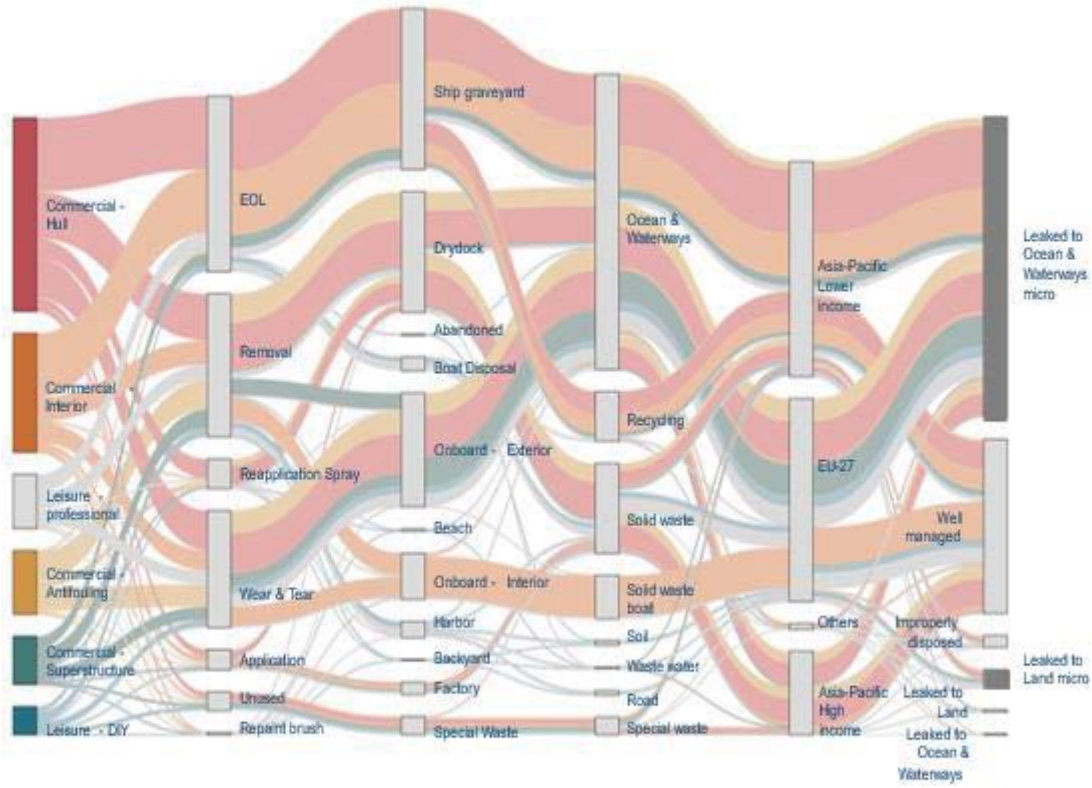

Figure 29: Sankey diagram of flow of plastic in marine paint (2019)

Paint can be lost before reaching its supporting material (application), it can detach from it (wear & tear or removal), or it can be disposed of with or without it (unused, end-of-Life). Ultimately, the lost paint can be well managed (disposed to a sanitary landfill or incineration facility), Embedded in new products, or can leak to land or oceans and waterways. Here we highlight the part of the leakage that occurs in the form of microplastics.

In 2019, 357 kt of plastic was used in marine paint within the EU-27. This includes plastic used in marine paint for commercial vessels (84%) and leisure vessels, both professional and Do It Yourself (DIY)[171]. Marine paint can be applied to the interior of the boat, the superstructure, or the hull, and antifouling paint is applied above the hull and protects the boat from biofouling. The amount of marine paint applied on boats and vessels in the EU-27 was estimated using:

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[171] Hann et al. 2018 Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products

- The total amount of plastic used on boats and vessels paint globally, i.e. 10,801 kt, according to *MarketsandMarkets Research Limited*[172]
- The share of commercial vessels and leisure boats that are owned by EU-27

The share of commercial vessels is computed based on the UNCTAD database, which provides the ownership of propelled seagoing vessels of 1000 gross tonnes and above by dead-weight tonnage. Overall, this leads to a 36% share attributed to the EU (2017 data). If we were to base the assessment only on container-carrying vessels, the share would be 45%[173]. Leisure boats share is based on the share of recreational global boat park per country, as provided by *ICOMIA*[174].

It is worth highlighting that most of the paint applied on commercial vessels is not applied in European drydocks but in Asia. In this analysis, we account for all paint that is applied on European vessels independently of where the maintenance takes place. Overall, 63% of the plastic in the paint applied on European vessels will leak into the environment in the form of microplastics, for a total of 223 kt/year, of which 210 kt leaks to land, while 13 kt to ocean and waterways.

There are three main pathways of microplastic leakage to oceans and waterways:

- Wear and tear of exterior boat paint at sea;
- Removal of paint during maintenance of commercial vessels at the dry dock (mostly in Asia), or of leisure vessels, mostly in the EU;
- End of life of commercial vessels at ship graveyards.

Other minor pathways are maintenance of superstructure paint that takes place while the vessel is at sea. Little is known about the waste management of paint at drydocks. If sand blasting is used, paint dust can travel hundreds of meters before depositing[175]. The world commercial fleet is dismantled in ship graveyards on the beaches of India, Bangladesh, Pakistan, China, and for a small part (3.5%). In Turkey[176]. In Bangladesh, India and Pakistan, ships are broken apart directly on the beach instead of on an industrial site (*NGO Shipbreaking Platform, 2021*). Therefore, a portion of the commercial paint that is left on the ships will be lost to the ocean.

About 57% of microplastic leakage to the environment occurs in drydocks or beaches outside Europe, for a total of 127 kt.

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[172] Market research from MarketsandMarkets Research Private Limited

[173] UNCTAD (United Nations Conference on Trade and Development). (2017, October). Review of Maritime Transport 2017. Geneva: United Nations.

[174] ICOMIA (International Council of marine Industry Associations). (2018). Recreational boating industry statistics 2017

[175] Swedish Environmental Protection Agency, Report n° C183 - 'Swedish sources and pathways for microplastics to the marine environment', 2016 (https://www.ivl.se/download/18.7e136029152c7d48c205d8/1457342560947/C183+Sources+of+microplastic_160307_D.pdf).

[176] UNCTAD (United Nations Conference on Trade and Development). (2017, October). Review of Maritime Transport 2017. Geneva: United Nations.

5.3.3 General industrial

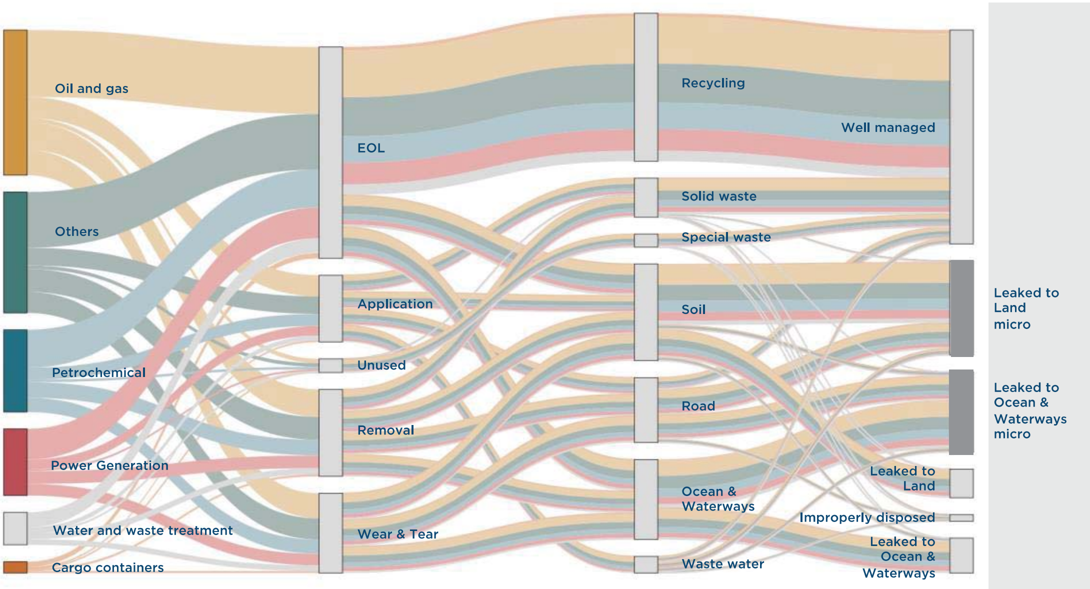

Figure 30: Plastic flow in general industrial paint from the net input to the fates (2019)

In 2019, 269 kt of plastic was used for general industrial paint in the EU-27. General industrial paint is considered here the protective paint used to protect steel or metal surfaces from corrosion. It is used in the oil & gas sector (refineries, pipelines, offshores), petrochemical sector, power generation applications, water and waste treatment, and many other applications.

The amount of general industrial paint used at the EU - 27 level was estimated using the following sources:

- The total amount of plastic used for general industrial paint globally, i.e. 2,915 kt, according to *MarketsandMarkets Research Limited*[177]
- It is assumed that steel is the main surface on which general industrial paint is applied. The share of paint used in Europe is based on the steel used by country in 2018, as provided by *World Steel Association, 2021*[178]

Overall, 37% of the plastic in general industrial paint put on the EU market leaks to the environment in the form of microplastics, for a total of 102 kt. Of this, 55 kt leak to land, while 47 kt to oceans and waterways. The leakage is mainly due to losses during the application, wear and tear and removal. Many aspects surrounding paint practices by the general industrial sectors are undocumented. It would be crucial to know the paint distribution within the sub-sector in the different EU-27 countries. How much of the paint is destined for structures that are close to aquatic environments (e.g. offshores, underwater pipelines, bridges)? The maintenance frequency and general practices are also not clear. General industrial is the sector where data is the scarcest.

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[177] Market research from MarketsandMarkets Research Private Limited
[178] World Steel Association (2021). 2021 World steel in figures

5.3.4 Road markings

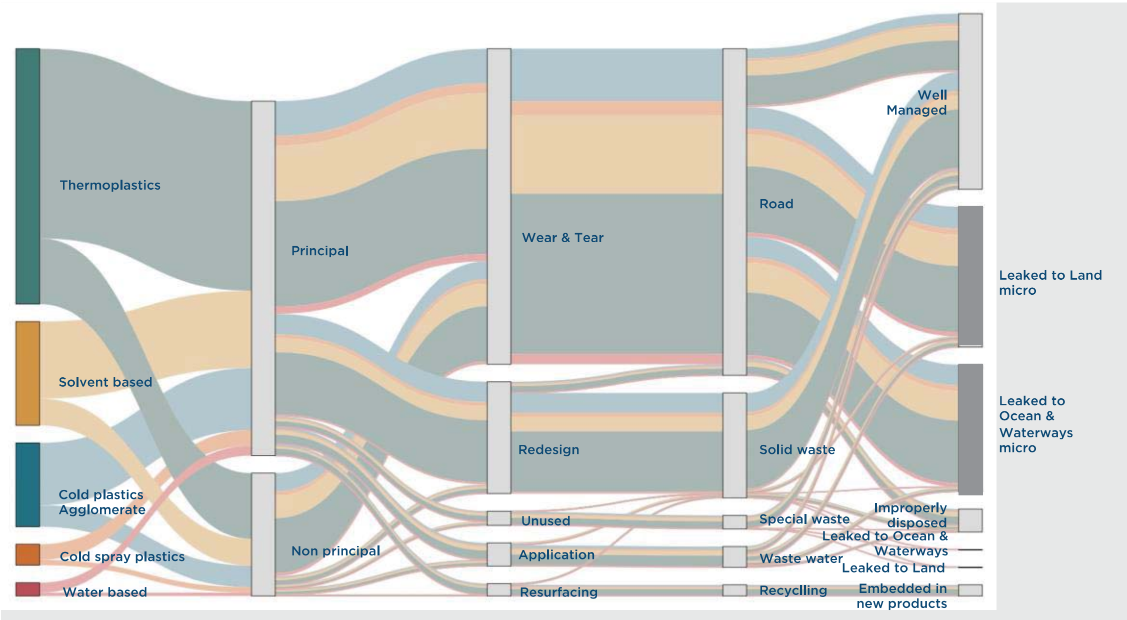

Figure 31: Flow of plastic in road markings paint from the net input to the fates (2019)

In 2019, 36 kt of plastic was used for road markings paint in EU-27 countries. *Hann et al., 2018* lists four different types of paint (solvent-based, water-based, thermoplastics, cold plastics) and provides their demand in the European market. The different paint types have different compositions and plastic content. The amount of plastic used for road markings paint used at the EU-27 level was estimated using the following sources:

- the total amount of plastic used for road markings globally, i.e. 234 kt according to *MarketsandMarkets Research Limited*[179]
- the kilometres of road country, as reported by *CIA*[180]

Overall, 56% of the plastic in the road markings paint will leak to the environment in the form of microplastics, for a total of 20 kt. Of this, 10.5 kt leak to land, while 9.5 kt leak to ocean and waterways. The main pathway for road markings losses to the environment is wear and tear from mechanical abrasion, and this is primarily due to contact with vehicle tyres. Another possible pathway leading to losses of microplastic in the environment could be during the road markings, paint removal to redesign traffic lanes, parking slots, etc. Removal of paint for redesign can be performed in several ways: blasting, grinding, using lasers, chemical methods and even burning[181]. The literature mentions dust formation (in the case of grinding) as a health concern to the removal workers. Still, no evidence has been found of pollution due to the removed paint being uncollected. Interviews conducted with road marking companies in Switzerland affirmed that the removed paint is collected independently from the technique used. Assuming a similar situation in the EU, about 90% of the paint is collected and disposed of as solid waste in EU-27, and 10% is left on the road in the form of finer dust particles and uncollected.

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179 Market research from MarketsandMarkets Research Private Limited
180 CIA. (2021). Roadways. Accessed on 9/11/2021. https://www.cia.gov/the-world-factbook/field/roadways/
181 Pike, A. M., & Miles, J. D. (2013). Effective removal of pavement markings (Vol. 759). Transportation Research Board.

5.3.5 Automotive

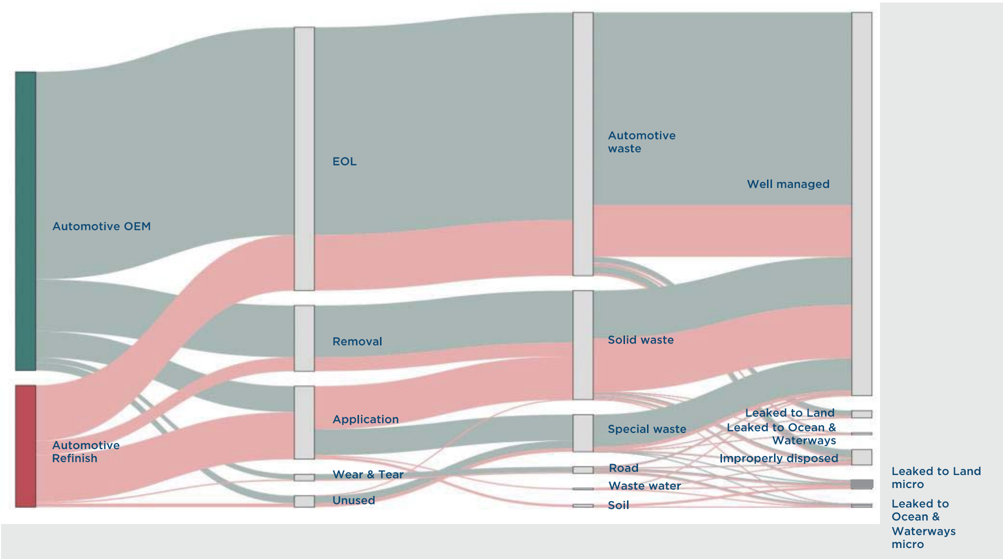

Figure 32: Flow of plastic in automotive paint from the net input to the fates

In 2019, 422 kt of plastic were used for automotive paint in EU-27 countries. About 71% of the paint is used for automotive OEM, applied during the car manufacturing process, and 29% for automotive refinish, applied at a later stage, for example, due to accident damage, damage to the original paint system, or to change the car colour.

The amount of automotive paint used at the EU-27 level was estimated using the following sources:

- the total amount of plastic used for automotive paint globally, i.e. 2'041 kt according to *MarketsandMarkets Research Limited*[182]
- for automotive OEM, the shares of motor vehicles manufacturing by country in 2019, as provided by *OICA*[183].
- the share of automotive Refinish is based on a dataset of motor Vehicles per 1000 people by country. The data set is published on *OurWorldInData*[184], which cites *NationMaster*[185]as the source.

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182 Market research from MarketsandMarkets Research Private Limited

183 OICA (2022). International Organization of Motor Vehicles Manufacturers. 2019 Production Statistics. https://www.oica.net/category/production-statistics/2019-statistics/

184 OurWorldInData, 2014. Accessed on 25/10/2021. Motor vehicles per 1000 inhabitants vs GDP per capita, 2014. https://ourworldindata.org/grapher/road-vehicles-per-1000-inhabitants-vs-gdp-per-capita

185 NationMaster, 2014. Accessed 25/10/2021. Motor vehicles per 1000 people: Countries Compared. https://www.nationmaster.com/country-info/stats/Transport/Road/Motor-vehicles-per-1000-people

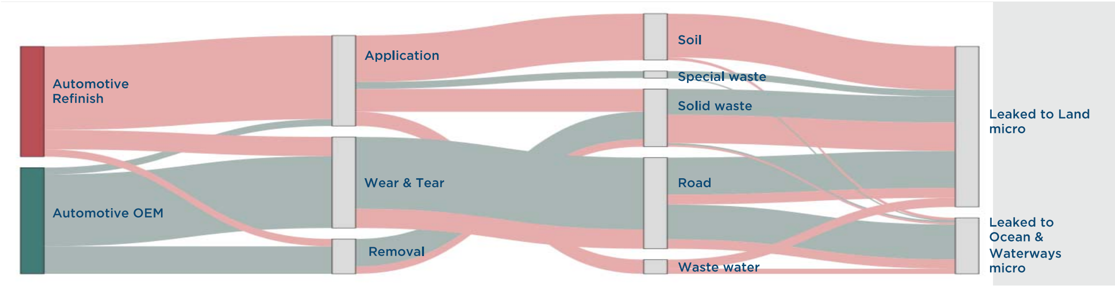

Figure 33: Portion of automotive paint that ultimately leaks to the environment in the form of microplastics

Overall, 3% of the plastic in automotive paint put on the EU market leaks to the environment in the form of microplastics, for a total of 12 kt. Of this, 9 kt leak to land, while 3 kt to oceans and waterways. One of the main pathways for microplastic leakage is the loss at the application of refinish paint.[186] The transfer efficiency of spray guns in body shops is as low as 50%, and an interview with industry experts put the figure closer to 60%. We assume that only a minor part of the over-sprayed paint will be lost to the environment, while the rest will deposit on masking material and will be disposed of with it.

The wear and tear losses include flaking and chipping of the paint due to weathering (such as exposure to ultra-violet sun rays), but also due to accidents and collisions. According to an interview with an automotive paint expert, these types of losses are minimal. Therefore, we assume a 2% loss rate even though, according to *OECD,* flaking and chipping losses of automotive paint are quantified at 10% (after rescaling by the OECD application losses).[187]

5.3.6 Industrial wood

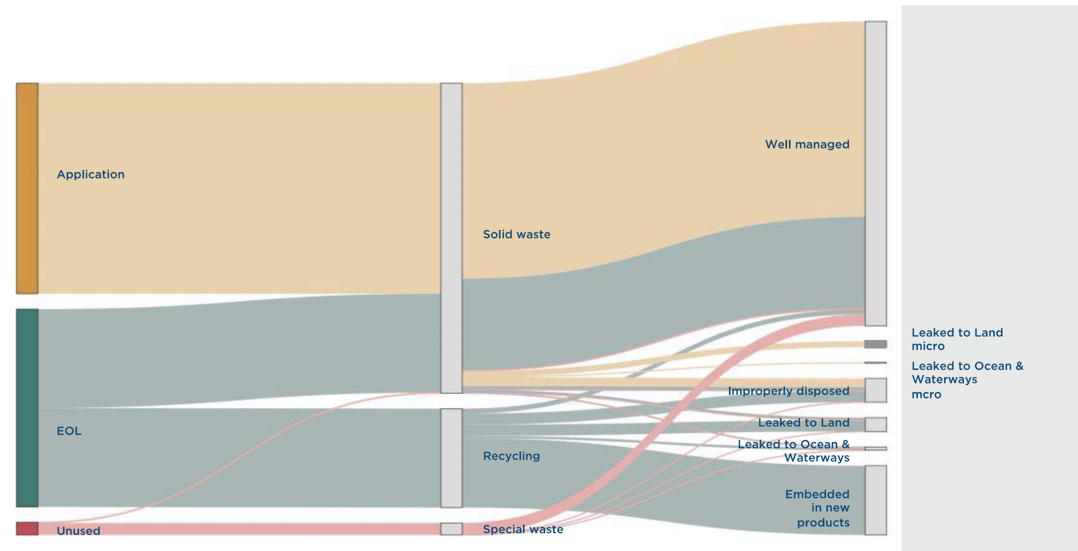

Figure 34: Flow of plastic in industrial wood paint from the net input to the fates

In 2019, 223 kt of plastic was used for industrial wood paint in EU-27 countries. We did not distinguish between the possible direct applications of industrial wood paint. It is typically applied

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[186] OECD (2009) Emission Scenario Document On Adhesive Formulation, 2009
[187] OECD (2009) Emission Scenario Document On Adhesive Formulation, 2009

on wooden surfaces such as “joinery, kitchen cabinets, furniture, flooring, millwork, speciality wood products, and exterior building products” (*American Coatings Association, 2018*)[188].

The amount of industrial wood paint used at the EU-27 level was estimated using the following sources:

- the total amount of plastic used for Industrial Wood paint globally, i.e., 1,232 kt, according to *MarketsandMarkets Research Limited*[189]
- the EU-27 share is determined based on the wood consumption by country. FAO online database *"Forestry Production and Trade"* [190]allows to select the specific wood application and track their production and trade around the world. The applications selected for this study are hardboard, MDF/HDF, OSB, other fibreboards, particle board, plywood, sawn wood, and veneer sheet. The reference year is 2019.

Overall, 2% of the plastic in industrial wood paint put on the EU market leaks to the environment in the form of microplastics, for a total of 3.4 kt, of which, 3.2 kt leak to land, while 0.2 kt leak to ocean and waterways. According to *OECD*[191]analysis of the wood furniture sector, around 50% of the paint is lost at the application when using a dry booth (other techniques being wet booth or curtain coating). We assume that application takes place in an industrial setting and that the over-sprayed paint is dealt with as solid waste.

5.3.7 Data gaps and uncertainties

Microplastic pollution from paint has only recently been investigated, for this reason there are still many uncertainties and data gaps.

Some uncertainties and data gaps are relative to market figures of paint sold per paint sector and plastic content within it. In order to estimate microplastic pollution one needs to know on which type of objects the paint is applied, but often market data are split by type of paint sold or sectors such as "coil coatings” which are not easily related to the final painted object. Therefore, a common understanding between scientific community and paint industry is needed in order to gain insight on the paint market in a way that is useful for microplastic calculations.

In terms of paint loss mechanisms (application, wear & tear, removal, unused, at end-of-life), the estimates used in this assessment are mostly conservative. An example of conservative estimate performed in the study are paint losses due to overspray, which are modelled to be at 15%, i.e., 85% transfer efficiency (Paruta et al. 2022). This performance is well above that of some technologies listed in the Best Available Techniques Conclusions document, related to the Industrial Emission Directive, (Chapter 4 of the Directive 2010/75/EU on Industrial Emissions (the Directive)), which have transfer efficiency of 50%-60%. A transfer efficiency of 60% means that 40% of the applied paint is lost to the surrounding environment.

Another example is unused paint. It is believed that, on average, 3%[192]of professional paint and 15% of DIY paint are unused (Verschoor, A., De Poorter, L., Dröge, R., Kuenen, J., & de Valk, E. (et al.,

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[188] www.paintcare.org
[189] Market research from MarketsandMarkets Research Private Limited
[190] Forestry production and trade, 2021. Accessed on 25/10/2021. Forestry production and trade. https://www.fao.org/faostat/en/#data/FO
[191] OECD (2009) Emission Scenario Document On Adhesive Formulation, 2009
[192] OECD (2009) Emission Scenario Document On Adhesive Formulation, 2009

2016,).[193] These are the same values used in this assessment, but, according to a personal communication with ADEME (the French agency for ecological transition), paint cans recovered through an EPR scheme targeting household chemicals are, on average, 40% full. Additionally, an internal paint company document indicates that 30-40% of paint prepared for an offshore maintenance job can end up being unused and subsequently disposed of. Furthermore, this assessment assumes all unused paint to be properly disposed, while a personal conversation with an industry expert revealed that according to their own experience, disposal of paint down the household drainage system is common practice for both professionals and DIYers.

For wear & tear losses, the lifetime of the paint system is not a subject that is systematically researched and assessed, but its assessment is key in order to determine microplastic pollution during the use phase of the object.

From the modelling point of view, a key assumption in Paruta et al. 2022, is that "Wear & Tear" happens in a localized fashion, meaning that if the outmost layer of paint (top-coat) is affected in a certain place, then the deeper layers will also be affected." This has important consequences on the assessment of wear & tear losses. The hypothesis was formulated after discussing with paint industry experts, but it should be validated through testing on the ground. Other sector-specific assumptions that were used to overcome uncertainty and data-gaps are mentioned in the baseline itself, and more can be found in Paruta et al. 2022, but the aforementioned data gaps are believed to be the key ones to investigate in order to improve the baseline assessment, namely:

- Volumes (in mass) of paint sales per sector (with sector split based on final painted object) as well as plastic content (in mass);
- Average transfer efficiency of spraying technologies;
- Volumes of unused paint and its fate;
- Lifetime of paint (see Measure PNT#1);
- Validation of the assumption that wear & tear happens in localised form and affects all paint layers.

5.4 Baseline for detergent capsules

Among the water-soluble plastic films available for the protective film for laundry and dishwasher detergents, polyvinyl alcohol (PVOH) is the most widely used. With a yearly global production of 650 000 tons, PVOH is therefore becoming more and more used with an annual growth rate of 4% between 2018 and 2023. In Europe, around 100 000 tonnes of PVOH is estimated to be used every year, of which 20 000 tonnes are used as protective films for detergent capsules.[194] A similar growth rate is expected for the coming years.

5.4.1 Calculation of the baseline

To define the baseline about the loss of detergent capsules into the environment, we have estimated their contributions following both bottom-up and top-down approaches.

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[193] Release of microplastics and potential mitigation measures: Abrasive cleaning agents, paints and tyre wear, OECD, 2009.

[194] Renewable Carbon, 'BioSinn – Products for which biodegradation makes sense', 2021.

In our bottom-up approach, we used the data about the number of washes per household in Europe as provided in our report and this article[195] for data on **laundry** capsules. It roughly estimates the amount of PVOH released into the environment as follows.

Number of wash cycles in the EU: 34 000 000 000

Weight of the shell of a capsule: 0.4g – 1.6g (we will use 1g as the average value)

Share of PVOH in a capsule shell: 65% - 99% (we will use 85% as the average value)

The survey performed in the US study evaluates capsule usage at 70% of all laundry detergent use, but there is no information available regarding the European use of capsules and we assume the EU situation comparable to the US. Upon this assumption, we can use a conservative estimation of 50% capsule usage since, in the EU, powder and liquid detergents are more or less used in the same proportion as the US.

By considering the share of washes done using capsules (50%), the **total amount of PVOH entering wastewater due to detergent capsules** is:

T = 34 000 000 000 * 1g * 0.85 * 0.50 = **14 450 tonnes per year**

To estimate **dishwasher** capsules' contribution, we assumed that 45% of European households are equipped with a dishwasher[196] and the number of cycles per household per year (280)[10]. As there are 195 455 million households in Europe[197], the dishwasher capsule shell weighs 0.3g – 0.7g (we use 0.5g as the average). Moreover, the dishwasher capsule shell has the same composition as detergent capsules.

As no information on dishwasher capsule usage in Europe could be found and considering the US situation, we assumed that the number of dishwasher cycles per year is close to that of Europeans (280 cycles), i.e., 34% of the time.

Thus, the total amount of PVOH entering wastewater due to dishwasher capsules is:

195 455 000 * 0.45 * 280 * 0.34 * 0.5g * 0.85 = **3 559 tonnes per year**

The total microplastics emitted to wastewater from the use of detergent capsules and dishwasher capsules can be estimated at **18 009 tonnes per year.**

This number is a rough estimation but remains close to the value reported by Nova Institute in a bottom-up approach. The EU market for dishwasher tabs with water-soluble film is around 400 000

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[195] Rolsky, C. and Kelkar, V., Degradation of Polyvinyl Alcohol in US Wastewater Treatment Plants and Subsequent Nationwide Emission Estimate', *International Journal of Environmental Research and Public Health*, Vol. 18, no. 11: 6027, 2021.

[196] APPLiA, 'What if all Europeans had a dishwasher?', 2021, Accessed November 19th 2021 (https://www.applia-europe.eu/images/2017-03---DW-campaign-analysis.pdf).

[197] Eurostat, 'How many single-parent households are there in the EU?', 2021 (https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20210601-2#:~:text=In%202020%2C%20there%20were%20195.4%20million%20households%20in,single%20parents%2C%20accounting%20for%204%25%20of%20total%20households).

tonnes annually, corresponding to 20 billion tabs of 20 grams each. The film itself weighs less than 1 g, which puts its total volume in the EU at around 20 000 tonnes.[198]

In another bottom-up approach[199], the recent data provided by International Association for Soaps, Detergents and Maintenance Products (A.I.S.E.) indicates that 20.5 ktonnes of dissolved capsules in 2021 were emitted from the use of liquid laundry detergent capsules (8.4 kt), automatic dishwashing tablets (12.1 kt) and WC care products (0.03 kt) in the EU, including Norway (non-EU member) in this estimation. We must highlight that even if Norway as a non-EU member is included in these estimations, the contribution of this country with respect to the EU doesn't impact the overall emission of PVOH grades in the EU. In the case of the first two categories (i.e., liquid laundry detergent capsules and automatic dishwashing tablets), we assumed that 5% of the total capsule or tablet was exclusively derived from PVOH based on the NOVA report[200].

Table 15: Liquid laundry detergent capsules – retail volume (in kilotonnes)*

	2017	2018	2019	2020	2021
EU+Norway	103.2	121.1	137.3	152.6	167.1
PVOH release**	5.2	6.0	6.9	7.6	8.4

* AISE reports that these figures may be slightly underestimated based on their own PVOH consumption. (which may also include internal wastage). The population of Norway is about 1% of that of the EU.

** Based on a conservative assumption of max. 1g PVOH film per capsule (5%).

Table 16: Automatic dishwashing tablets – retail volume (in kilotonnes)*

	2017	2018	2019	2020	2021
EU+NO	197.5	202.0	209.2	237.3	242.9
PVOH release**	9.9	10.1	10.5	11.9	12.1

* AISE member reports that these figures may be slightly underestimated based on their own PVOH consumption (which may also include internal wastage). The population of Norway is about 1% of that of the EU.

** Based on a conservative assumption of max. 1gPVOH film per capsule (1% - values to be confirmed by AISE). However, we made the same assumption as in the case of liquid laundry detergent capsules) to be comparable to the estimations made in the NOVA report, i.e., 5%.

NB. Euromonitor provides sales data for all tablets without differentiation between wrapped/unwrapped or removable/soluble film.

Moreover, WC care products contain a small proportion of toilet cleaning products, such as rim hangers and cistern blocks, corresponding to **an estimated total PVOH quantity of 0.03 kt/annum** in 2021.

In Table 17, a US study[201] indicates that 61% and 18% of PVOH fractions reached the sludge route and the aqueous route (via soil contamination)) respectively. However, the estimations about the 18% losses out of wastewater treatment plants must be considered prudently as the study was conducted

[198] Renewable Carbon, 'BioSinn – Products for Which Biodegradation makes sense', 2021 (https://renewable-carbon.eu/publications/product/biosinn-products-for-which-biodegradation-makes-sense-pdf/).
[199] Annex AISE (sent on April 27th, 2022).
[200] Annex AISE (sent on April 27th, 2022).
[201] Rolsky, C.; Kelkar, V. Degradation of Polyvinyl Alcohol in US Wastewater Treatment Plants and Subsequent Nationwide Emission Estimate. Int. J. Environ. Res. Public Health 2021, 18, 6027.

in India (Kaur et al., 2012)[202] and do not correspond to the situation in the EU. In Europe, we may therefore assume that the situation about the wastewater treatment (even if soil contamination cannot be excluded) is almost optimal, assuming that nearly 50-60% of PVOH and related mixtures shall reach the sludge route and the other fractions 40-50% shall reach the environment, but no studies have addressed this issue after wastewater treatment plants up to now.

Considering the biodegradation level reported in OECD testing, *i.e.*, a simulated degrading environment representative of wastewater treatment plants, 40% of non-biodegradable PVOH could release into the environment using the data reported in the study. Indeed, this study considered a 28-day window while 10 days is the average length of time usually considered for wastewater treatment plants. Other studies have shown that biodegradation of PVOH in acclimated wastewater systems can be even enhanced and reach a degradation rate close to 80% as suggested by Schonberger et al. (1997)[203]. Several conditions must be encountered: (1) steady PVOH influx, (2) sufficiently low food to microorganisms and sufficiently high sludge age and (3) adaptation of the microorganisms (as a rule demands several weeks). The fate of PVOH after wastewater treatment remains challenging as specific approaches (e.g., radioisotope labelling) will have to be developed accordingly. After wastewater treatment, the trace of PVOH has never been reported due to the difficulty of assessing their presence using classical detection techniques to their high solubility in water, and their impact may somehow be underestimated by contrast with microplastics well-identified in sewage sludge[204]. Additional investigations shall be made to assess this.

Table 17: Assessment of PVOH release of detergent capsules into the environment via the sludge route

Source	Geography	Sectors	PVOH leakage to wastewater treatment plants, Tonnes	PVOH release into the sludge in % related to the leakage	PVOH release into sludge, Tonnes	PVOH release into the environment, Tonnes (40% from sludge)
BOTTOM-UP APPROACH Nova Institute, 2021 Byrne 2020	EU-27	Protective films for laundry and dish detergents Garden pond	20 000	20-40%	4 000-8 000	1 600-3 200
BOTTOM-UP APPROACH* AISE	EU-27	Liquid laundry detergent capsules Automatic dishwashing tablets	20 500	20-40%	4 100-8 200	1 640-3 280
TOP-DOWN APPROACH	EU-27	Protective films for laundry and dish detergents	18 000	20-40%	3 600-7 200	1 440-2 880

(*) Including Norway. Excluding Norway, the estimates would approach the Nova Institute figures.

In the EU, the overall amount of PVOH leakage issued from protective films for laundry and dish detergents is estimated to be around 18 000 – 20 000 tonnes annually using different approaches (bottom-up & top-down) obtained from technical literature and stakeholder information. As the

[202] Kaur et al. Wastewater production, treatment and use in India, 2012

[203] Schonberger, H., Baumann, A. and Keller, W., ‘Study of microbial degradation of polyvinyl alcohol (PVA) in wastewater treatment plants’, *American Dyestuff Reporter*, Vol. 86, 1997, pp. 9-18.

[204] Chand, R., Rasmussen, L.A., Tumlin, S. and Vollertsen, J., ‘The occurrence and fate of microplastics in a mesophilic anaerobic digester receiving sewage sludge, grease and fatty slurries’, *Science of the Total Environment*, Vol. 798, 2021, Elsevier BV.

PVOH issued from protective films for laundry and dish detergents is directly discharged into urban wastewater, the overall amount related to PVOH leakage is exclusively through waste water followed by sludge. In the wastewater treatment plants, around 60-80% of the overall amount of PVOH is totally biodegraded, and the remaining fraction, i.e., around 20-40%, is mainly released to the sludge from which the ultimate release of PVOH in the environment is not properly assessed from the current scientific literature. This means that from the microplastics released into wastewater treatment plants, around 3 600-8 000 tonnes reach the sludge. In the EU, about 40% of sludge is applied on agricultural land. Assuming that about 40% (EU average) of this sludge is applied to agricultural land, i.e. 1 440-3 280 tonnes. Of this, about 60% will reach natural waters and the rest remain in the soil. Recent evidence shows that microplastics in soil could also be taken by the crops.[205]

There is only one study estimating the PVOH release in the environment directly through wastewater at 15.7%[206], which would represent around 2 700 tons a year for the EU. The PVOH in water could biodegrade over a period of time, but the extent of biodegradation in natural conditions has not been studied. The possible non-biodegraded part of PVOH could still remain in the water.

Adding the share of PVOH through aqueous and sludge routes, we can assume that **4 140 – 5 980 tonnes (thus on average around 5000 tonnes) of microplastics coming from PVOH of detergent capsules would be directly released into the environment**.

5.4.2 Uncertainties and data gaps

The estimated amount of microplastic losses through capsules to the environment bears several uncertainties. The principal uncertainty comes from a lack of information on the composition of PVOH and related mixtures used for detergent capsules due to trade secrets and uncertainties about the fate of PVOH in WWTP and later in the marine environment and soils upon the existing testing protocols as:

- Initial discussions with the International Association for Soaps, Detergents and Maintenance products/AISE (March 12th, 2022) highlighted that the current PVOH and related mixtures used for detergent capsules are trade secrets due to their long history of implementation as water-soluble plastics not only in detergent applications but other applications. The report made by AISE (April 27th, 2022) has reduced the uncertainties on the PVOH release even though the AISE members report that these figures may be slightly underestimated based on their PVOH consumption (which may also include internal wastage). However, no better basis is currently available to calculate quantities of film placed on the market/released by dissolution during use.
- The testing protocols used for assessing the biodegradation extent of PVOH and related mixtures are related to OECD norms in which a 28-day duration is applied during testing. However, it could be affected because these PVOH and related mixtures are associated with mixtures and/or contaminated with detergents.
- Depending on the characteristic features of wastewater systems, a PVOH biodegradation in acclimated wastewater systems could reach a degradation rate close to 80%, as referenced by

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[205] Sciencealert.com, 'Study shows how microplastics can easily clim the food chain. Should we be worried?', 2022 (https://www.sciencealert.com/study-shows-how-microplastics-can-easily-climb-the-food-chain-should-we-be-worried).

[206] Rolsky, C.; Kelkar, V. Degradation of Polyvinyl Alcohol in US Wastewater Treatment Plants and Subsequent Nationwide Emission Estimate. Int. J. Environ. Res. Public Health 2021, 18, 6027.

Schonberger et al. (1997)[207], but this need to be confirmed. There exist some more appropriate protocols (e.g., EU ECOLABEL)[208].

5.5 Baseline for geotextiles

According to the supporting study for this IA, a total of 530 712 tonnes of geotextiles were used in the EU in 2019 and since 2002, 5 048 962 tonnes of geotextiles have been installed.[209] Geotextiles are used for various construction applications, from building roads to protecting coasts from erosion and enabling vegetation to root. Because of climate change, sea levels are rising, and the intensity of storms is increasing, which in turn will increase the demand for geotextiles. Various market projections suggest a threefold growth in the geotextiles market in Europe during 2019-2029[210] , and one can expect similar growth in emissions.

5.5.1 Calculation of the baseline

Different market data were compiled to estimate the quantities of geotextiles used worldwide yearly.

Table 18: Existing sources on geotextile use and microplastics emissions

Source	Year of estimate	Geotextile quantity	Geotextile type	Emissions
Bai, Xue et al.[211]	2021	14 billion m2	All types, 2% natural fibre, 17% PET-based materials	0.24 – 0.79 million tonnes emitted by PET geotextiles. *However the findings of this study have been strongly criticised for their unreliability.*
Prambauer et al. [212]	2019	1.4 billion m2	All types, 2% natural fibre	
Methacanon [213]	2010	700 million m2	All types, 2% natural fibre	
US Department of Agriculture [214]	1991	700 million m2	All types, 2% natural fibre	
Own calculations	2021	530 712 tonnes (EU) 2 653 560 tonnes (worldwide)	All types, 62.5% non-woven textiles, 27.5% woven, 10% other	

207 Schonberger, H., Baumann, A. and Keller, W., 'Study of microbial degradation of polyvinyl alcohol (PVA) in wastewater treatment plants', *American Dyestuff Reporter*, Vol. 86, 1997, pp. 9-18.

208 European Commission, 'EU Ecolabel', EU Ecolabel - Home (europa.eu).

209 Grand View Research Inc, 'Geotextiles Market Size & Share, |Industry Report, 2020-2027', 2022 (https://www.grandviewresearch.com/industry-analysis/geotextiles-industry).

210 Ibid.

211 Bai, X., Li, F., Ma, L. and Chang, L., 'Weathering of geotextiles under ultraviolet exposure: A neglected source of microfibers from coastal reclamation', *Science of the Total Environment*, Vol. 804, 2022, Elsevier BV.

212 Prambauer, M., Wendeler, C., Weitzenböck, J., & Burgstaller, C., 'Biodegradable geotextiles – An overview of existing and potential materials', *Geotextiles And Geomembranes*, Vol. 47, No. 1, 2019, pp. 48-59, Elsevier BV.

213 Methacanon, P., Weerawatsophon, U., Sumransin, N., Prahsarn, C., & Bergado, D., 'Properties and potential application of the selected natural fibers as limited life geotextiles', *Carbohydrate Polymers*, Vol. 82, No. 4, 2010, pp. 1090-1096.

214 English, B.W., 'Geotextiles, A special Application of biofibers', United States Department of Agriculture, 1995 (https://srs.fs.usda.gov/pubs/5718).

Source	Year of estimate	Geotextile quantity	Geotextile type	Emissions
Miszkowska et al. [215]	2017	NA	Non- woven grammage: 200, 280, 450 g/m^2	
Grand View Research [216]	2020	4.323 billion m^2	All types, non-woven 1 561million m^2, knitted, 279.8 million m^2	

Notably, the table's first source (Bai, Xue et al.)[217] is the only one to estimate geotextile emission but also includes many errors in the methodology and calculations. As a result, it is impossible to rely on the results provided by this study. The quantification of the total quantity of geotextiles used in civil engineering applications is presented here. This will serve as a basis for applying the precautionary principle because although geotextiles are built to last, they will eventually break down into microplastics. The exact emission estimates are being made.

The data used to calculate the figures given below are from Edana, the nonwoven and related industries association. Using this data, the total non-woven production in the EU in 2019 was 1.775 million tonnes[218] (calculated from their country data).

Non-woven materials are used for a wide variety of applications; Edana lists the applications for which their members' products are used, and these percentages are assumed to be the same for non-members. Thus, it is assumed that out of all non-wovens:

- building and roofing industry applications represent 9.8% of the market,
- filtration (air & gas and liquid) applications represent 3.7% of the market, and
- civil engineering / underground applications represent 5.4 % of the market.

Thus, 18.9% of the non-woven production can be considered geotextiles.

Since not all geotextiles produced in the EU are used in the same geographical area perimeter, the export and import of non-woven must be taken into account when estimating the total EU consumption. The EU imports close to 370 000 tonnes of non-woven materials and exports close to 390 000 tonnes, so the total quantity of nonwoven used in the EU is roughly as follows:

1 775 000 + 370 000 – 390 000 = 1 755 000 tonnes

The share of nonwoven used in geotextile applications is 18.9%, so the total quantity of non-woven geotextiles used in the EU is:

[215] Miszkowska A., Lenart, A. and Koda, E., ‘Changes of Permeability of Nonwoven Geotextiles due to Clogging and Cyclic Water Flow in Laboratory Conditions’, *Water*, Vol. 9, No. 9, 2017, pp. 660.

[216] Grand View Research Inc., ‘Grand View Research Forecasts Global Geotextiles Market’, 2014 (https://www.estormwater.com/grand-view-research-forecasts-global-geotextiles-market).

[217] Bai, X., Li, F., Ma, L. and Chang, L., ‘Weathering of geotextiles under ultraviolet exposure: A neglected source of microfibers from coastal reclamation’, *Science of the Total Environment*, Vol. 804, 2022, Elsevier BV.

[218] Edana, ‘Nonwovens markets, facts and figures’, Consulted March 21st 2022 (https://www.edana.org/nw-related-industry/nonwovens-markets).

1 755 000 * 0.189 = 331 695 tonnes.

Assuming that the EU geotextile market is similar to the US one, nonwovens represent 62.5% of the market, woven represent 27.5%, and the other types represent 10%. [219]

Thus, the total tonnage of geotextiles used in the EU in 2019 was estimated to be:

331 695/0.625 = **530 712 tonnes**

As discussed earlier, since geotextiles, once installed, are for the large majority not removed, and despite being stable for an extended period, are going to eventually break down, the total amount of geotextiles installed over the last 20 years was calculated. To do so, a constant CAGR of 10% was used, [220] and so the total geotextile tonnage installed in the EU in the period 2002 – 2022 is:

$$\sum_{n=0}^{n=20} \frac{530712}{1.1^n} = \mathbf{5\ 048\ 962}\ \boldsymbol{tonnes}$$

The figures calculated before are estimations of installed quantities and not microplastic emissions. However, they represent the total quantity of material susceptible to emitting microplastics into the environment. In order to provide an estimate of microplastic emissions from geotextiles, a worst-case scenario is developed. It is based on the microplastic emissions figures presented in the article from Bai Xue et al[221], which, although clearly flawed, is the only source quantifying emissions which we could find.[222] Their estimate global microplastic emissions from non-woven PET geotextiles used in erosion control applications are between 240 thousand tonnes and 790 thousand tonnes. However, as stated previously, they misquoted their source for market data and used multiplied it by a factor of 10. Therefore, their figure for microplastic emissions will be divided by a factor of 10, bringing it down to between 24 thousand tonnes and 79 thousand tonnes. The EU represents 25% of the global geotextile market[223], the worst-case estimate for microplastic emissions from geotextiles (assuming all geotextiles sold in the EU will be used in applications where microplastic emissions could occur) would be:

between 6 000 and 19 750 tonnes per year in the EU.

There are several caveats to these figures, which bear a lot of uncertainties:

- PET geotextiles are not the only materials used for erosion control applications, in fact, the polymers used are more generally polypropylene and polyethylene-containing additives to increase their UV resistance. However, we don't have market figures for other polymer types and thus cannot be extrapolated.

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219 Geotextiles Market Analysis Report By Material, By Application, By Product, By Region And Segment Forecasts From 2020 To 2027. (2020). Retrieved from https://www.millioninsights.com/industry-reports/geotextile-market

220 Markets and Markets, 'Geotextile Market by Material Type (Synthetic, Natural), Product Type (Nonwove, Woven, Knitted), Application (Road Construction and Pavement Repair, Erosion, Drainage, Railway Work, Agriculture), and Region – Global Forecast to 2022', 2017 (https://www.marketsandmarkets.com/Market-Reports/geotextiles-market-492.html).

221 Bai, X., Li, F., Ma, L. and Chang, L., 'Weathering of geotextiles under ultraviolet exposure: A neglected source of microfibers from coastal reclamation', *Science of the Total Environment*, Vol. 804, 2022, Elsevier BV.

222 Stakeholders were consulted on that matter but did not send us articles or scientific data quantifying microplastic emissions.

223 Fact.MR, 'Geotextile Market – Forecast to 2019 to 2029', 2022 (https://www.factmr.com/report/4655/geotextile-market).

- Not all geotextile materials are exposed to the harsh conditions necessary to degrade the polymers and cause microplastic emissions.
- The emissions figures are coming from a study of questionable quality and so are difficult to trust.

5.5.2 Uncertainties and data gaps

There are several uncertainties and data gaps when discussing geotextiles in the EU. The quantities installed and for which application they are used, and the related microplastics emissions are the most important ones. Indeed, depending on their applications, geotextiles do not represent the same microplastic emission potential, e.g., geotextiles used to stabilise the soil during road construction are not exposed to UV, air, or abrasion in the same way as geotextiles used for coastal protection. From these differences will stem variations in microplastic emissions.

6 POTENTIAL MEASURES

6.1 Measures for tyres

6.1.1 Long list of measures

Tyre wear emissions can be reduced by measures that impact one or more of the parameters. Furthermore, there are measures to increase the treatment of road run-off after the emissions have been released. Hence, potential measures have been grouped in the following way:

Tyre characteristics: The most direct type of measure would be to improve tyre characteristics by introducing regulatory limits for tyre wear. Such a measure would aim at banning tyres with high emissions from the market. More broadly, it could require developing tyres with lower tyre wear emissions. There are potential trade-offs with other functionalities of the tyres, notably safety, which need to be taken into account. This would impact the overall tyre design and composition. In terms of specific policy instruments, the Commission should prepare a report on tyre abrasion by the end of 2024 to review the measurement methods and state-of-the-art in order to propose tyre abrasion limits. A placeholder for such limits was introduced in the recently adopted Euro 7 Regulation. The existing legislation on tyre labelling224 could be amended to include tyre abrasion as a criterion for the labelling in addition to energy use, safety and noise. Another measure could be to oblige manufactures to clean the tyres from the fine rubber pins (remaining from the production process) when placing tyres on the market.

Vehicle characteristics: Vehicle characteristics can affect tyre wear emissions. The trends towards the higher weight of passenger cars and consumers buying bigger vehicles potentially increase the wear. Whether it is possible to introduce measures that would limit the weight of the vehicles is difficult to assess, and it depends partly on innovation and development in battery technology. The engine power and acceleration potential also impact tyre wear, so it could be limited in some way to reduce tyre wear emissions. Changing the vehicle characteristics in order to indirectly affect tyre abrasion is not considered an effective method to limit microplastics release.

Road infrastructure characteristics: The use of alternative road surface materials could decrease tyre wear. More generally, the whole layout of the infrastructure plays a role. Given that the design of roads is subject to many requirements, a possible measure would be to also include tyre wear as a

224 European Parliament and Council of the European Union, Regulation (EU) 2020/740 on the labelling of tyres with respect to fuel efficiency and other parameters, OJ L 177, 5.6.2020, pp. 1–31.

criterion in the overall design i.e. to try and reduce overall tyre wear. This could include road layout and/or the materials used for road surfaces. However, there are also important safety aspects (i.e. level of grip) to take into consideration.

Sustainable mobility: Vehicle operation, including the total volume of road transport, is subject to various policy instruments and strategies at local, national and EU levels. Currently, there is a significant focus on the need to decarbonise transport and reduce impacts of air pollution. Most instruments are not directed against the transport volume, but rather reducing transport externalities. The trade-off between the benefits of mobility and the external costs of road traffic demonstrates that it is not likely that transport volumes can be affected as an instrument to reduce the amount of tyre wear. However, adding microplastic pollution to the list of external effects of transport could give a prominence to incentives aiming at reducing the amount of road transport.

Emissions treatment: On the emissions side, measures can be taken by treating the stormwater. A set of rules for treating stormwater runoff for discharge into surface waters, "Requirements for stormwater treatment-DWA A102" (DWA-A 102)225 has been published in Germany. The DWA 102 requires that the stormwater must be treated from a traffic volume of 2000 motorised vehicles / 24 h. As already mentioned above, decentralised filter systems or sustainable drainage systems can be used here. Furthermore, optimised street cleaning is also a potential measure for reducing the input, e.g., cleaning the roads at hot spots before rain events. This requires intelligent networking of street cleaning and weather forecasting. Finally, measures could be taken to remove microplastics from the sewage sludge generated at urban wastewater treatment plants. Microplastics are generally well captured by existing techniques applied at such plants. However, they can then be released into the environment when the sludge is used as a fertiliser and spread on agricultural land.

Overall, 205 measures (including duplicates and measures that could be grouped together) were identified during desk research and by participants of the 2nd stakeholder workshop (24 November 2021). Using this feedback and literature review, a long list of 29 unique measures was established. A number of the measures identified by stakeholders at the workshop were duplicates and/or could be grouped together hence the much smaller number of measures taken forward for the screening process (discussed below).

6.1.2 Measures discarded prior to assessment

The table below summarises the measures that have been screened out from the evaluation as well as the reasons for their exclusion. It should be noted that, in some instances, the measures that have been screened out could be effective for reducing microplastic releases from tyre wear but are not considered appropriate for EU intervention and/or interact/overlap with existing EU initiatives.

[225] DWA-A [German Association for Water, Wastewater and Waste], DWA-A Arbeitsblatt 102-2/BWK-A 3-2 – 'Grundsätze zur Bewirtschaftung und Behandlung von Regenwetterabflüssen zur Einleitung in Oberflächengewässer – Teil 2: Emissionsbezogene Bewertungen und Regelungen' [DWA-A worksheet 102-2/BWK-A 3-2 – 'Principles for the management and treatment of stormwater runoff for discharge into surface waters - Part 2: Emission-related assessments and regulations'], 2020 (https://webshop.dwa.de/de/dwa-a-102-2-regenwetterabflusse-12-2020.html), De.

Table 19: Screening of measures for tyres

Problem area	Measure description	Reason for screening out
Market failure / Information failure	Disclose tyre composition: transparency of all tyre components and additives to reduce toxic leakage into the environment. As tyres are recycled as materials for playgrounds and sports pitches, this would be important to understand.	This measure has been excluded on the grounds of **technical feasibility** and **political acceptability** due to concerns over the confidentiality of information on the exact composition of different tyre models. Tyre composition for generic families of tyres is already made available with more details in data sheets provided by the manufacturers when supplying tyres to the vehicle manufacturers. The use of hazardous substances could be regulated through REACH. The measure is also not considered specific enough on microplastics.
Market failure / Information failure	Monitoring tyre emissions in the environment by adding a tracing material to the tyres.	Whilst this measure would be valuable from a research perspective, it has been excluded from the evaluation on the grounds of **proportionality** and **effectiveness and efficiency**. There is already a significant body of research on tyre particle emissions with lots of ongoing attention. Further research should be continued under the Commission's Horizon programme.
Market/Regulatory failure	Alternative materials (e.g., biodegradable materials): Prioritise sustainable and regenerative materials that do not have externalities (e.g. cutting down forests for more rubber plantations).	The measures is excluded on the grounds of **technical feasibility** as there are no commercially available alternative materials that could replace current materials without compromises for lifetime, safety etc. Additional research and development is required before this can be considered further.
Market/Regulatory failure	Extending tyre lifetime to reduce wear.	A measure focused on extending tyre lifetime could incentivise manufacturers to innovate to reduce abrasion, but it could also lead to manufacturers simply producing tyres with a thicker tread. This would lead to heavier tyres with implications for fuel efficiency and not necessarily any reductions in TWP emissions. The measure to establish an abrasion limit value is considered a more appropriate measure to avoid such outcomes. Therefore, this measure has been excluded on **effectiveness and efficiency** grounds.
Market/Regulatory failure	Reducing vehicle weight: Incentives for reducing vehicle weight	While reducing vehicle weight can reduce TWP emissions, it is not so simple to do so, not least with the increasing development and uptake of electric vehicles. At present these are generally heavier than their internal combustion counterparts due to the weight of the batteries (however higher energy density in future batteries might compensate the difference). There is also a shift towards greater uptake of larger vehicles, e.g., SUVs, with larger wheels and tyres. Therefore, this measure has been excluded for **technical feasibility** reasons as well as **coherence/overlaps with wider EU policies** such as those focused on, e.g. decarbonisation.
Market/Regulatory failure	Install particle catchment systems to collect tyre particles from cars, light-duty vehicles and/or heavy-duty vehicles	This measure has been excluded on **technical feasibility** grounds. The techniques themselves are not fully commercially available, and there are some technical constraints with their implementation, e.g. space constraints.
Market/Regulatory failure	Acceleration limitation in urban areas: Acceleration reduction could be installed in new	Whilst these measures tackle driver behaviour and could help reduce TWP emissions, they have been excluded on the

Problem area	Measure description	Reason for screening out
	vehicles. Buses already use it to prevent people from falling during acceleration. / Kick-downs for emergency situations can be limited to a certain number per time / Slip: traction control system (TCS)	grounds of **political feasibility** as they are expected to face significant opposition from the industry and consumers.
Market failure / Information failure	Advanced driver information systems in vehicles to reduce abrasion	Whilst measures to change driver behaviours can help to reduce TWP emissions, this measure would only be voluntary, so it has been excluded as **effectiveness** is unlikely to be significant.
Regulatory Failure	Speed limits for motorway and/or urban areas	All of the sustainable mobility measures identified act to either reduce overall vehicle kilometres and/or change driver behaviour, all of which can impact TWP emissions. However, these measures have been excluded on **proportionality** and **coherence** grounds and **subsidiarity**. Traffic management and other related measures fall within the remit of local, regional and national authorities and are not appropriate for EU intervention. Furthermore, there is already significant action on sustainable mobility driven by other agendas, including decarbonisation and local air quality. However, whilst these measures have been excluded from further consideration for a specific microplastics intervention, the impacts of such measures on TWP releases (as co-benefits) should be taken into account for their development and review. This may help to make an even stronger case for their adoption.
Market failure / Regulatory failure	Improve traffic management to support smoother traffic flows	
Market failure / Information failure	Awareness campaigns: consumer awareness campaigns on driving impact	
Market failure / Information failure	Reduction in individual automotive traffic promoting shared rides and communal transport as well as public transport.	
Market failure / Regulatory failure	Distance/ Road transport reduction: Reduce road transport (passenger and freight) to limit microplastic released from abrasion of car and truck tyres	
Market failure / Regulatory failure	Bicycle traffic: improved cycle safety and connectivity, e.g. bike lanes	
Market failure / Information Failure	Field research: Research to determine pathways of TWP to the environment, including through drainage infrastructure and storm water pipes, combined sewer overflows (CSOs), wastewater treatment plants (WWTP) / hotspot identification/marker substance	A number of stakeholders indicated that further research was required in order to understand the pathways of TWP to the environment better. There is already a considerable body of research focused on this topic, with more ongoing, including through EU programmes, and **further EU intervention is not considered necessary**.

Problem area	Measure description	Reason for screening out
Market failure / Regulatory failure	Sludge treatment: Reducing/preventing the spreading of sewage sludge on agricultural land	The recent revision of the Urban Wastewater Treatment Directive (UWWTD)[226] identified that existing practices remove up to 80-94% of microplastics from the wastewater and then transfer them to the sludge. According to the ongoing evaluation of the Sewage Sludge Directive (SSD), 40% of sewage sludge is spread on agricultural land and used as a fertiliser. Some MS have introduced a ban on the use of sewage sludge in agriculture. As for the EU level, around half of sewage sludge is applied on agricultural land. The Sewage Sludge Directive (SSD) may be revised in the coming years (depending on the findings of the evaluation) and could consider this issue further.
Market failure / Regulatory failure	Sludge treatment: Enhancement of capabilities of water treatment facilities to eliminate microplastics from sludge	Whilst current treatment techniques at UWWTPs have a relatively high removal rate for capturing microplastics from the wastewater, and this is mostly transferred to the sewage sludge. There are yet commercially available techniques to remove the microplastics (at least to any significant extent) from the sewage sludge prior to its application on agricultural land (in those Member States where it is spread and not incinerated). The supporting study to the evaluation of the Sewage Sludge Directive[227] concluded that further research is needed to understand the potential impacts of sewage sludge treatments on microplastics. Therefore, the measure has been excluded due to a lack of **technical feasibility**.
Market failure / Information Failure	Artificial intelligence / promoting autonomous driving and advanced driver assistance systems vehicles to reduce abrasion (TYR#4)*	This measure is already being taken up by the car industry
Regulatory failure	Improve capture and treat road run-off water (e.g. filter systems for gullies)	A voluntary approach through guidelines would be the best approach in this phase. This is taken up in another measure
Regulatory failure	Improve road cleaning in high emission hotspots (intelligent network)	A voluntary approach through guidelines would be the best approach in this phase. This is taken up in another measure
Regulatory failure	Mandatory shaving off of vent spews	IDIADA information given to the JRC (unpublished) indicates that for a specific tyre brand the total amount of the rubber pins (also called vent spews) could reach approximately 10 g per tyre. Considering an average abrasion of approximately 1.0-1.5 kg during the tyre's lifespan, the overall effect is calculated to be at the level or lower than 1%. Taking into account that most tyres in the fleet do not feature these rubber pins, the overall impact is expected to be much less than 0.5% and probably closer to 0.1%. Further implications: Based on the available information, there are tyres with almost no or very few rubber nibs, while some

[226] European Commission, Commission staff working document - Evaluation of the Urban Waste Water Treatment Directive; SWD(2019)701 final, 2019.

[227] Wood et al., Study report in support to the evaluation of the Sewage Sludge Directive, Exploratory study - final report, 2021.

Problem area	Measure description	Reason for screening out
		other tires feature long and numerous rubber nibs. One can safely assume that this amount of extra rubber will be much different from one tyre to another depending on each tyre manufacturer. Furthermore, there is no information regarding the additional cost of removing the rubber pins at the manufacturing procedure.

(*) To note that this measure was discarded later in the process, which is the reason why it has a number (TYR#4) that cannot be found later in this study.

6.1.3 Measures to be assessed for tyres

Measure TYR#7: Road design and cleaning guidelines

Type of measure: Non-binding approach

Description of the measure

This measure is about the support the EC could give to the development of guidelines at a European level for use by the Member States for road design (design, materials and capture and treatment of run-off water) and cleaning. These guidelines would encompass the following:

- The development of criteria to define the contribution of the road design and material to tyre abrasion and specifications for road design, including considering road materials that can absorb TWP (e.g. porous asphalt) and/or TWP rates (e.g. rubber asphalt).
- Approaches for increasing uptake of capture and treatment systems for road run-off water (focused on urban areas) to prevent or minimise direct runoff into surface waters.
- Options for changing current road cleaning practices to optimise the removal of TWP. This would cover the timing of the cleaning where it should take place before any major rainfall as well as more cleaning of road/street sections with a high level of tyre wear.

How would the measure work?

There are still a number of uncertainties on the effectiveness and technical feasibility of such measures, so a regulatory intervention is not considered feasible. Therefore, the measure would entail the development of guidance and specifications for road design requirements (including options for capture and treatment of road run-off) and material characteristics, which the Member States could then apply when maintaining and building roads. The measure could include criteria for when to collect and treat road run-offs as well as when and how to undertake road cleaning. The guidance could identify best practices to demonstrate examples where such approaches have been delivered in practice and the benefits that have been realised.

For road cleaning, the guidelines would support more informed cleaning of roads in high-release hotspots ahead of major rain and storm events to reduce run-off to UWWTPs and the environment. It could encourage the cleaning of roads with the largest traffic volumes and, therefore, the most significant amounts of TWP and would encourage timings based on weather forecasts. It should be noted that treatment of the run-off water would lead to the generation of sludge and that no commercially available technology is currently available for removing the microplastics from the sludge (to any significant extent). It means that the sludge would need to be incinerated to be removed entirely.

How could the measure be implemented?

The measure could be implemented by developing guidance and technical materials informed by a technical working group to be established. There could also be potential for amendment of the Green Public Procurement (GPP) criteria for road transport in the future to accommodate microplastic considerations[228].

Measure TYR#3: Modulated fees in EPR for tyres

Type of measure: Market-Based Instrument

Description of the measure

Introducing or modifying an EPR scheme so that it covers the use phase of tyres would require that all companies placing a tyre on the EU market would incur fees related to the emissions of the tyre, and the revenue from the fees could then finance the treatment of run-off from roads in order to capture and remove the microplastics and/or consumer awareness raising activities.

How does the measure work?

There are already EPR schemes for tyres in 20 Member States[229], and they have been introduced for managing end-of-life tyres (ELTs). In such a scheme, a producer would be responsible for the disposal and management of tyres after their use. Other systems which exist for managing ELTs in the EU are free market systems and tax systems.[230] Under a tax system, the government is responsible for ELT management, as seen in Denmark and Croatia. A tax on tyre producers is used to finance the government's management of ELTs and will be passed on to the consumer. [231] EPR schemes and tax systems are similar in that producers face a cost to manage ELTs; however, under an EPR, the responsibility of the management falls upon the producer.

A free market system is operated in Germany and Austria. Under a free market system, laws are usually set regarding the transportation, use, disposal and storage of ELTs.[232] Unlike other systems, there is no party which is designated as responsible for the management of ELTs. Any operations to recover ELTs are contracted under free market conditions to comply with the relevant legislation. This is often accompanied by voluntary action within the industry to promote best practices. Unlike EPR and tax systems, there is no direct payment from producers which can go towards ELT management.

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[228] JRC, JRC Technical report and criteria proposal – Revision of the EU Green Public Procurement Criteria for Road Transport, 2021 (https://ec.europa.eu/environment/gpp/pdf/criteria/EUGPP_roadtransport_technicalreport.pdf).

[229] Includes Belgium, Bulgaria, Czech Republic, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. Based on: European Tyre & Rubber Manufacturers' Association (ETRMA), 'Circular Economy' (https://www.etrma.org/key-topics/circular-economy/#:~:text=In%20the%20EU%2C%20three%20different,of%20a%20product's%20life%20cycle).

[230] European Tyre & Rubber Manufacturers' Association (ETRMA), 'Circular Economy, 2019 (https://www.etrma.org/key-topics/circular-economy/).

[231] World Business Council for Sustainable Development (WBCSD), 'Global ELT Management – A global state of knowledge on regulation, management systems, impacts of recovery and technologies, 2019 (https://docs.wbcsd.org/2019/12/Global_ELT_Management%E2%80%93A_global_state_of_knowledge_on_regulation_management_systems_impacts_of_recovery_and_technologies.pdf).

[232] World Business Council for Sustainable Development (WBCSD), 'Managing End-of-Life Tires', 2018 (https://docs.wbcsd.org/2018/02/TIP/End_of_Life_Tires-Full-Report.pdf).

It is unclear how Cyprus, Luxembourg and Malta conduct ELT management or whether any formal system is in place. In 2018, high percentages of ELT were treated in Cyprus (145%) and Malta (100%), suggesting that measures are in place.[233] No data is available for Luxembourg.

The measure considered here would be about the use phase of tyres. The scheme could be designed in alternative ways with regard to how the fees would be calculated and what the revenue would finance. Current EPR schemes and tax systems, as seen across 22 countries in the EU, could be adapted with modulated fees (EPR) or taxes to cover microplastic releases. For Austria and Germany and a free market system, it is unclear if they could be adapted to also account for microplastic releases or if an EPR scheme or similar system would need to be introduced. For those Member States without any such scheme in place, then there would be a need to introduce something new. Any EPR scheme for abrasion (new or modulated fees for an existing scheme) would have to comply with Article 8a(4) of the Waste Framework Directive (Directive 2008/98/EC). It requires that

Member States shall take the necessary measures to ensure that the financial contributions paid by the producer of the product to comply with its extended producer obligations: ..

(b) ***in the case of collective fulfilment of extended producer responsibility obligations, are modulated, where possible, for individual products, or groups of products, notably by taking into account their durability, reparability, reusability and recyclability and the presence of hazardous substances, thereby taking a life-cycle approach and aligned with the requirements set by relevant Union law,*** *and where available, based on harmonised criteria in order to ensure smooth functioning of the internal market*[234]

This requirement could potentially be challenging as the cost of removing the microplastic from road run-off might be difficult to estimate and also challenging to agree on the criteria for what the EPR should cover. See the discussion below under *Implementation.*

The proposed revision of the Urban Wastewater Treatment Directive (UWWTD) establishes an EPR scheme. It would cover releases of micropollutants by introducing a fee for products that lead to their release (e.g. pharmaceuticals), based on the quantities and the toxicity of the products placed on the market. An EPR scheme could be implemented in a similar way.

How could the measure be implemented?

As mentioned above, there are already EPR schemes in many Member States, although it seems that they differ in the way they are implemented. In several Member States, there is more than one scheme[235]. EPR schemes that deal with end-of-life management are more straightforward in many ways. They are focused on ensuring that used tyres are managed safely and ensuring a high level of reuse or recovery of materials/energy. The introduction of EPRs in all Member States would therefore require EU legislation, and it would be necessary to specify some minimum requirements for an EPR. Though there are existing EPRs, changes to their working might be needed, or it might be necessary to define new and specific EPRs to cover tyre wear.

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[233] European Tyre & Rubber Manufacturers' Association (ETRMA), 'End of Life Tyres Management – Europe 2018 Status', 2020 (https://www.etrma.org/wp-content/uploads/2020/09/Copy-of-ELT-Data-2018-002.pdf).

[234] European Parliament and Council of the European Union, Directive 2008/98/EC on waste and repealing certain directives, OJ L 312, 22.11.2008, pp. 3-30.

[235] Winternitz, K., Heggie, M. & Baird, J., 'Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands', *Waste Management*, Vol. 89, 2019, pp. 386-396.

The practical implementation would require the definition of:

- Who should pay the fee, and what should be the level and differentiations?
- What should the collected fee cover?
- Definition of the governance and the practical organisation set-up for the EPR

While the specific governance set-up might be left to the discretion of each Member State, issues of minimum fees etc. might be required at an EU level.

There is a recent OECD study on modulated fees in EPR schemes[236]. The study lists key considerations for an EPR with a more advanced fee structure. Generally, there are few actual examples, but there could be an issue if the EPR is not perceived as fair and transparent. For an EPR to work, the test standard needs to be defined as required for the previous measures (TYR#1 and TYR#2). Then the fee would be correlated to the emission level of each tyre in order to provide an incentive for innovation in tyres with lower emission rates. The next question is what the revenue should cover. Currently, experience suggests that much of the microplastics are actually captured by the wastewater treatment processes but then released into the environment in some Member States via the spreading of sewage sludge. The share of road run-off is not covered; which are collected by separate storm-water systems or just discharged into the ditches along the roads. An EPR system could be used to fund the treatment of stormwater that is not being treated and improve the collection and treatment of road run-off currently not collected. It could also cover consumer awareness-raising activities.

The challenge in setting up the system would be:

- The emissions are not constant along the road network, but the hotspots might not be known or registered.
- An EPR would probably not be able to fund improvement for all roads, and it would be necessary to define priority criteria.
- Collection and treatment of road run-off would also potentially remove other types of pollution.

Given the described issues and challenges, there is a need for further clarifications of the legal aspects on what can and should be defined at an EU level and what will be for Member States to define. For those Member States that currently do not have an EPR scheme in place for the end-of-life tyres, there are two main options:

- Require the establishment of an EPR scheme but potentially only covering microplastic releases.
- Adapt existing approaches (e.g. taxation) to provide a financial mechanism for charging manufacturers depending on the abrasion rates of their tyres, e.g. taxes could be modulated to account for microplastic releases.

<u>Measure TYR#1: Emission limit value for particles from tyre wear/abrasion</u>

Type of measure: Regulatory action

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[236] OECD, OECD Environment Working Paper No. 184 - Modulated fees for Extended Producer Responsibility schemes (EPR); ENV/WKP(2021)16, 2021.

Description of the measure

The aim of this measure would be to phase out the worst-performing tyres from an abrasion point of view through the implementation of an emission limit value. This would require an appropriate test method and standard, which is already under development, as discussed previously. Only then could the absolute limit values be defined for different tyre types (sizes and models). In principle, lower abrasion tyres should also have a longer lifetime, thus increasing the time before they need to be replaced, although tyre design means that no direct comparison can be made between different tyres in terms of durability. As discussed previously, data from recent studies show quite a high variation across different tyre brands and tyres with respect to their abrasion rates. Hence, by restricting the use of the worst-performing tyres, TWP emissions would be decreased. The measure could have an impact fairly quickly, considering that the average lifetime of a tyre before being replaced is around 5-10 years (dependent on usage and driver behaviour).

How does the measure work?

There is no internationally agreed standard for measuring the emission rate of a particular tyre. However, as discussed earlier, such methods are now under development. Then an emission limit for tyre wear can be set (broken down for different tyre types), and only tyres that pass that emission limit value using the agreed test method will be approved. A ban on the worst-performing tyres will lead to lower average emission rates and lower total emissions of TWP from tyres. Limits would need to be defined separately for different types (i.e. summer, winter, all-year tyres, sizes and performance classes) and light-duty and heavy-duty vehicles. Options for setting limits could be based on the lower, e.g. 10% of performers in each category or a certain percentile. Limit values could be phased over time, with limits being tightened (within technical feasibility bounds) as manufacturers innovate to produce tyres with lower abrasion rates.

How could the measure be implemented?

Abrasion limits will be introduced in recently adopted Euro 7 Regulation once the methodology is available.

Measure TYR#2: Emission labelling of particles released from tyre wear.

Type of measure: Regulatory action

Description of the measure

There is already a labelling scheme for tyres focused on safety, energy efficiency and noise. This measure would add tyre abrasion as a fourth element to the label.

How would the measure work?

All tyres placed on the EU market would have to be tested to determine their abrasion rate. As with measure TYR#1, this measure would require that a technical standard and method for measuring the emission rates be established. Once this has been adopted, different emission levels would be defined by label values (like A, B, C etc.) and a symbol to be placed on the label. The label would give the consumer a possibility of taking the microplastic emissions into account when purchasing new tyres. It may be most effective to consider including the abrasion rate alongside impacts on tyre lifetime as lower abrasion rates may equate to an increase in tyre lifetime, thus saving consumers money. This is considered to be a greater driver for consumer purchasing than microplastic emissions[237]. In the future, such a label could also be utilised by city and other local/regional authorities where emissions are greatest, e.g. to apply restrictions on the sale of certain tyres with higher abrasion rates.

How could the measure be implemented?

Regulation (EU) 2020/740 includes a provision for the Commission to introduce tyre abrasion and mileage criteria as soon as reliable test methods are in place (Article 13).

Measure TYR#6: Regular wheel alignment to minimise tyre wear

Type of measure: Regulatory action

Description of the measure

This measure is about ensuring the axis (wheel) alignment is maintained so that the abrasion rate is kept at the level that follows the vehicle design. Misalignment can appear through the use and wear of the vehicle and lead to increased abrasion. Therefore, this measure would be a requirement to test the alignment regularly and correct and adjust the wheels in case of any misalignment.

How would the measure work?

By a requirement to regularly test the alignment, the negative effects of misaligned wheels could be reduced or eliminated. This could be done as part of the mandatory roadworthiness tests. As the roadworthiness tests only take place every fourth year (as a minimum, in many Member States they are more frequent), there would still be an effect from misalignment, assuming the misalignment happens gradually.

How could the measure be implemented?

There are already some requirements on wheel alignment captured by existing EU legislation, namely Directive 2014/45/EU on periodic roadworthiness tests[238]. This sets minimum requirements (and frequencies) for periodic testing of road vehicles, including specific technical elements to be covered. These include wheels and their alignment (namely, to check that the alignment of the wheels is in accordance with the vehicle manufacturer's requirements). However, this specific requirement is marked with an "X" which the footnote specifies: *"(X) identifies items which relate to the condition of the vehicle and its suitability for use on the road but which are not considered essential in a roadworthiness test,"* i.e. it does not appear to be a mandatory requirement for roadworthiness testing. The test is also focused on the steered wheel requirement on driving safety. The alignment of the axis is an additional requirement, but it could be implemented as amendments to the existing legislation.

Measure TYR#5: Enhance monitoring of tyre pressure

Type of measure: Regulatory action

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[237] European Commission, 'Study assessing consumer understanding of tyre labels, 2019 (https://ec.europa.eu/info/sites/default/files/energy_climate_change_environment/overall_targets/documents/tyre-label_final-report_0.pdf).

[238] European Parliament and Council of the European Union, Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC, OJ L 127, 29.4.2014, pp. 51.

Description of the measure

The measure would entail enhancing the on-board monitoring of tyre pressure in new vehicles to reduce TWP emissions.

How would the measure work?

According to the ETRMA[239], under-inflated tyres can increase fuel consumption (up to 4%) and have implications for the tyre's lifespan (reduction up to 45%). Tyre pressure monitoring systems (TPMS) are currently required for new cars and vans and will be for trucks but are primarily calibrated for driver safety, i.e. TPMS currently shows if tyres are at dangerously low pressure, typically 20% below optimal. The measure would entail a more sensitive calibration of the TPMS to flag when the pressure is not optimal from a tyre wear perspective (i.e. it would alert the driver sooner when the pressure has dropped). The feasibility of tightening current thresholds (in the context of the uncertainties of the systems) and the exact threshold at which alerts would need to be determined based on a more in-depth technical assessment of the optimal level for reducing tyre wear, the sensitivity of the systems and likely driver behaviour (including the risk of driver annoyance if set too low). This could be combined with a communication campaign to make consumers aware of the importance of proper tyre pressure.

It should be noted that if the system is very sensitive, then it might face opposition from industry and car users. It might also lead to car users having the system switched off or ignoring it if it is very sensitive.

How could the measure be implemented?

The change of the TPMS to give warnings when lower pressure increases the abrasion rate could be implemented as amendments to the existing type approval regulations.

6.2 Measures for textiles

6.2.1 Long list of measures

Following a workshop with stakeholders and a review of relevant literature, a long list of measures to reduce microplastics releases from synthetic textiles was developed. About 155 measures were identified during the workshop. After removing duplicates and regrouping some measures, the list was refined to 29 measures. The long list of measures is described in the table below. They can be classified by the type of measure:

Standardisation: There is a need to quantify microplastic release from synthetic textiles on the whole life-cycle with a standardised method.
Regulating releases: Microplastic releases can be limited by setting thresholds for specific life-cycle steps. For example, it could be at the production plant or in washing machines by households.
Technological: Technologies can help reduce microplastic releases from textiles at different life-cycle steps.
Communication and behaviour change: To raise awareness and promote behaviour by reducing microplastic releases (purchase decision, washing practice, etc.) could also be relevant to reducing releases and supporting other measures.

[239] European Tyre & Rubber Manufacturers' Association (ETRMA), 'The tyre industry's role in advancing Connected & Automated Driving' (https://www.etrma.org/key-topics/mobility/).

Incentives and disincentives: Taxes and subsidies could provide incentives/disincentives to companies/consumers to change their production process (material input, plant equipment, etc.) and purchase behaviour favouring less microplastic releases.
Research needs: There are still a lot of uncertainties regarding microplastic releases from textiles (quantification, health impact, production techniques to limit releases). Research would help reduce these uncertainties and help companies implement the changes in their production process.

6.2.2 Measures discarded prior to assessment

The table below summarises the measures that have been screened out from the evaluation and the reasons for their exclusion. It should be noted that, in some instances, the measures that have been screened out could be effective for reducing microplastic releases from textiles but are not considered appropriate for EU intervention and/or interact/overlap with existing EU initiatives.

Table 20: Screening of measures for synthetic textiles

Problem area	Name of the measure	Description	Reason for screening out
Market failure / Regulatory failure	Professional laundries' emissions regulation	Making microplastics filters compulsory for professional large-scale laundries. There would be a need to define a minimum efficiency threshold for the filter and define a set of criteria to identify the laundries subject to the regulation.	This measure has been excluded on the grounds of **relevance** because this measure was very close to another measure that was kept (the one making filters compulsory on all washing machines) but with a smaller scope.
Information failure	Textiles production facilities reporting requirement	The reporting of releases of the production facility would be compulsory for all textiles sold on the EU market.	This measure has been excluded on the grounds of **effectiveness** because this measure does not entail reductions in microplastic releases directly. It is only a means to compare production plants on their microplastics releases more easily. In addition, textiles production installations which are regulated by the Industrial Emissions Directive and the European Pollutant Release and Transfer Register (E-PRTR), are already subject to reporting.
Market failure / Regulatory failure	Technological solutions to reduce microplastic releases	Improving the efficiency of the microplastics filters.	This measure has been excluded on the grounds of **effectiveness** because it is not prone to create short-term results, as it is an R&D measure. It would need to support another measure, like the measure to make washing machine filters compulsory.
Market failure / Regulatory failure	Emission limit for textiles placed on the EU market	An emission limit that targets the whole life-cycle will lead to technology changes that enable the textile manufacturer to respect the emission limit.	A custodial sequence that occurs as ownership or control of the material supply is transferred from one custodian to another in the supply chain295 has to be organised to ensure the traceability of the textile's characteristics regarding microplastic emissions. It could be organised via certificate

Problem area	Name of the measure	Description	Reason for screening out
			trading, stating a microplastic emission category, for example296. This measure has been discarded as most of the production is outside the EU, often in SMEs in developing countries, making the implementation very difficult for products place on the EU market. This measure would not be feasible, proportionate nor political feasible. Other measures also seem much more suited, like TEX#3: Restriction of synthetic fibres and fabrics with high releases of microplastics.
Market failure / Regulatory failure	Emission limit during production	During production, an emission limit will lead to technology changes that enable the production plants to respect the emission limit.	Discarded for the same reasons as the measure before (emission limit for textiles placed on the EU market)
Regulatory failure/ Information failure	Develop guidance on Best Available Techniques	Developing Best Available Techniques (BAT) on textiles and their associated levels of releases for these parts of the value chain for which there are no BATs. This measure would make information more easily accessible to a greater number of professionals.	This measure has been excluded on the grounds of **effectiveness** because this measure would only make information more easily accessible. However, it would not create any constraint or incentive to reduce microplastic releases in the short/medium term.
Market failure / Regulatory failure	Mitigate and control WWTP	Equipping WWTP above a size threshold (e.g., > 50 000 PE) with compulsory filters.	This measure has been excluded. It would rather belong to the evaluation of the Urban Wastewater Treatment Directive, which is dealt with in a distinct policy process. Further, the measures is also excluded on the grounds of **effectiveness** because an extra filter in WWTP would not be cost-effective as most of the microplastics are already captured (between 80 and 95 %, according to EurEau).
Market failure / Regulatory failure	WWTP sludge incineration	Compulsory incineration of WWTP sludge.	This measure was screened out on several grounds, including **technical feasibility, coherence with other EU objectives, proportionality, and political feasibility**. Mandating incineration of sewage sludge instead of spreading is not considered realistic. In some Member States, it is an important fertiliser. There is not the capacity to incinerate it, and/or it would conflict with other objectives, including, e.g. decarbonisation, circular economy and agriculture.

Problem area	Name of the measure	Description	Reason for screening out
Information failure	School intervention	Funding programs/associations that intervene in schools to raise awareness on the issue of microplastics and communicate best practices surrounding the issue.	This measure has been excluded on **legal feasibility** because education is not one of the EU areas of action. Moreover, this measure was close to another that consisted of funding communication campaigns to raise awareness on microplastics and communicate best practices.
Regulatory failure	Taxing microplastic release	Taxing textiles sold in the EU based on their estimated microplastic releases over their life-cycle.	The measure was screened out on the grounds of **proportionality** and **political feasibility** of common taxation between all MS.
Regulatory failure	Taxing textile plastic content	Taxing textiles sold in the EU based on the quantity of plastic in their production.	The measure was screened out on **proportionality** and the **political feasibility** of common taxation between all MS.
Market failure / Regulatory failure	Subsidising sustainable clothing	Subsidising clothes producers who make clothes following the product environmental footprint category rules on textile and apparel. This is a long-term measure, and the implementation could take place through the textile EPR scheme (by using eco-modulation).	The measure was screened out on the grounds of **proportionality** and the **political feasibility** of subsidies.
Market failure / Regulatory failure	Subsidising innovative textiles	Subsidising the producers of textiles who apply techniques prone to reducing microplastic releases to their textiles.	This measure was screened out on the grounds of (1) political feasibility, as to subsidise a part of the textile sector, and (2) **technical feasibility** as there are not yet innovative textiles with much lower microplastic releases made with synthetic fibres. It is too soon to think about subsidizing producers of innovative textiles, as the industry is still at the R&D stage on this question.
Information failure	Research yarn/fabric characteristics	Funding research on the link between microfibers release and yarn/fabric characteristics.	These measures are screened out on the grounds of **effectiveness** because R&D measures cannot create short-term results and have highly uncertain outcomes. R&D is nevertheless already happening under EU programmes and will continue to be pursued.
Information failure	Textiles microplastics release sources database	Developing a database of the risk of microplastic release depending on several characteristics (yarn type, fabric, age, washing condition, etc.).	
Information failure	Research textile's use phase	Funding research on microfibers releases during textiles' use phase.	
Information failure	Research dying techniques	Funding research on less emitting dyeing techniques.	

Problem area	Name of the measure	Description	Reason for screening out
Information failure	Research biodegradable	Research on biodegradable microplastics.	
Information failure	Research mixing organic/synthetic fabric	Funding research on the link between microfibers release and the mixing of organic/synthetic fabric.	
Information failure	Research on health effects	Funding research on the health effects of microplastics (airborne included).	
Information failure	Research on pre-wash releases	Funding research on the amount of microplastic released during pre-wash.	
Information failure	Research Microfibre Consortium's roadmap	Funding research on the need for the Microfibre Consortium's roadmap.	

6.2.3 Measures to be assessed for textiles

Measure TEX#8: Raising awareness on best practices for consumers of textiles

Type of measure: Supply chain/consumer information to enable selection of less polluting products or change in behaviour

Description of the measure

The measure would involve a communication campaign aiming to raise awareness on microplastics and communicate best practices surrounding the issue.

How does the measure work?

The Member States could coordinate the communication campaign.

The list below gives a few communication examples:

- Which fibres emit microplastics
- Washing practices to reduce microplastic releases
- Washing machine filter maintenance
- Impact of fast fashion on microplastic releases

Consumers and households will be affected by this measure as the communication campaign will target them.

How could the measure be implemented?

The measure would be implemented through dedicated actions or legislation changes (ecodesign for textiles and electrical and electronic equipment).

Measure TEX#9: Mandatory label showing textiles' emissions of microplastics

Type of measure: Supply chain/consumer information to enable selection of less polluting products or change in behaviour

Description of the measure

The measure implies that each textile item must have a label informing the consumer of the estimated microplastic releases during the product's life-cycle.

How does the measure work?

It is important to note that there is currently no methodology to quantify the microplastic releases of textiles over the life-cycle. Therefore, the mandatory label measure needs to be combined with the measure TEX#1 "Create a standardized measure to quantify microplastic releases on the life-cycle".

How could the measure be implemented?

The measure would be implemented through legislation changes (ESPR or Textiles Labelling Regulation).

Measure TEX#7: Modulated fees in EPR for textiles

Type of measure: Market-Based Instrument

Description of the measure

By 2025[240], there will be targets at the EU level to increase the separate collection of textile waste. Whether it will be applied via an EPR by the Member States is unclear. The European Commission also adopted an EU strategy for sustainable and circular textiles[241], which states that "the Commission will propose harmonised EU extended producer responsibility rules for textiles with eco-modulation of fees". This measure aims to include a "microplastic release" component in existing and future textile EPR schemes[242].

How does the measure work?

Including a "microplastic release" component to existing and future textile EPR schemes can be done via eco-modulated fees, the microplastic release externality into account or financing measures reducing microplastic releases. The EPR is a tool to combine with other measures. The administrative cost of a waste management EPR for textiles with a microplastic component should not be completely allocated to microplastics as the EPR serve many purposes. The cost of the microplastic part in the eco-modulated fee might be very low. An EPR scheme could also be dedicated to microplastics for textiles or combined with other sources of microplastics if reduction measures are similar.

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[240] European Parliament and Council of the European Union, Directive (EU) 2018/851 on waste, OJ L 150, 14.16.2018, pp. 109-140, article 12b.
[241] European Commission, Commission communication - EU Strategy for Sustainable and Circular Textiles; COM(2022)141 final, 2022.
[242] Extended Producer Responsibility.

How could the measure be implemented?

The measure would be implemented through legislation changes (Waste Framework Directive).

Measure TEX#2: Restrict synthetic fibres for certain applications

Type of measure: Regulatory action

Description of the measure

For some types of clothes, synthetic fibres could be replaced by natural or artificial ones. The use of synthetic textiles could be restricted by law to technical applications (see table further).

How does the measure work?

The measure consists of replacing synthetic fibres in all non-technical clothes243 with natural fibres or non-oil based man-made fibres (such as cellulose-based fibres), except for those categories of clothes for which it is impossible to do without synthetic polymers because of their technical specificities (waterproofing, flexibility, etc.). The table below summarises the proportion of such clothing that is not considered feasible to be replaced by natural fibres or non-oil based man-made fibres.

Table 21: Technical products

Products	Proportion of technical clothing (assumption)
T-shirts (sportswear)	50%
Trousers and shorts (sportswear)	50%
Technical jackets	-
Anoraks, ski jackets, etc.	*100%*
Anoraks, ski jackets, etc. (knitted or crocheted)	*100%*
Raincoats	*100%*
Overcoats, car coats, capes (other)	*50%*
Overcoats, car coats, capes (knitted or crocheted)	*50%*
Swimwear	100%
Tracksuits	100%
Ski suits	100%
Hosiery	100%

For all other products, oil-based synthetic materials (polyester, polypropylene/elastane, acrylic and polyamide) are replaced by natural or other artificial materials (cotton, viscose, flax, wool). The current fibre mix was assumed to replace the oil-based synthetic fibres[244]:

[243] The focus is on clothes because the majority of microplastics emissions arise from clothes and not from households textiles.

[244] Beton, A. et al, 'Environmental Improvement Potential of textiles (IMPRO Textiles)', *Publications Office of the European Union*, EUR 26316, JRC85895, 2014.

- Cotton: 66%
- Viscose: 15%
- Wool: 15%
- Flax: 3%

Weight, numbers of units and composition data from the JRC Impro textiles study[245] have been used. The Impro Textiles study is still relevant because the technological changes have been limited since then. Moreover, this study compares the fibres with a consistent methodology relevant to this impact assessment. With this measure, the proportion of oil-based synthetic materials used falls from 38% (baseline scenario) to 12%. Other important assumptions and limitations include the following:

- Natural materials also emit microfibres. There is little evidence about the fate and persistence of natural fibres such as wool and cotton. In addition, natural fibres could be the source of the leaching of chemicals present on the fibres following the dyeing or finishing stages. (ETC, Microplastic pollution from textile consumption in Europe, February 2022). This is, therefore, a limit of this measure.
- The measure was defined by considering an increase in the proportion of cotton in clothing from 41% to 58%. In practice, the proportion of cotton is subject to the constraints of the production (notably land use) and the demand for this material.
- The proportions of natural and man-made materials following the implementation of measure 1a have been calculated based on the current proportions of these materials in clothing. In practice, each fibre has particular characteristics, and its use depends on the properties expected for the product. The replacement of oil-based synthetic materials will therefore require identifying the most suitable natural or artificial material(s) for each use.

How could the measure be implemented?

The measure would be implemented through legislation changes (ESPR).

Measure TEX#3: Restrict synthetic fibres & fabrics with high releases of microplastics

Type of measure: Regulatory action

Description of the measure

For the type of clothes with high releases of microplastics, oil-based synthetic fibres could be replaced by natural or artificial ones. The use of synthetic textiles could be restricted by law in these clothes with high releases of microplastics.

How does the measure work?

Replacing oil-based synthetic fibres in clothes with natural or other man-made fibres where it is feasible from a technical and production capacity points of view and only where the highest emitting types of fibres and categories of clothes are targeted. Synthetic fibres are kept for the specific categories of clothes for which synthetic fibres are necessary for their technical characteristics

[245] Ibid.

According to the literature[246], knitted polyester, acrylic and polyamide lead to the highest microplastic releases.

In addition, the following figure shows that the main categories of clothing, in terms of tonnes, are tops, underwear, nightwear and hosiery and bottoms. These categories also correspond to products with high wash frequencies, which are therefore likely to emit more during washing (variation between 1 and 5 for the number of uses before washing: 1 for T-shirts and underwear, 2 for the shirts, 5 for pullovers, 3 for trousers) (PEFCR Apparel and footwear, draft version, 2021).

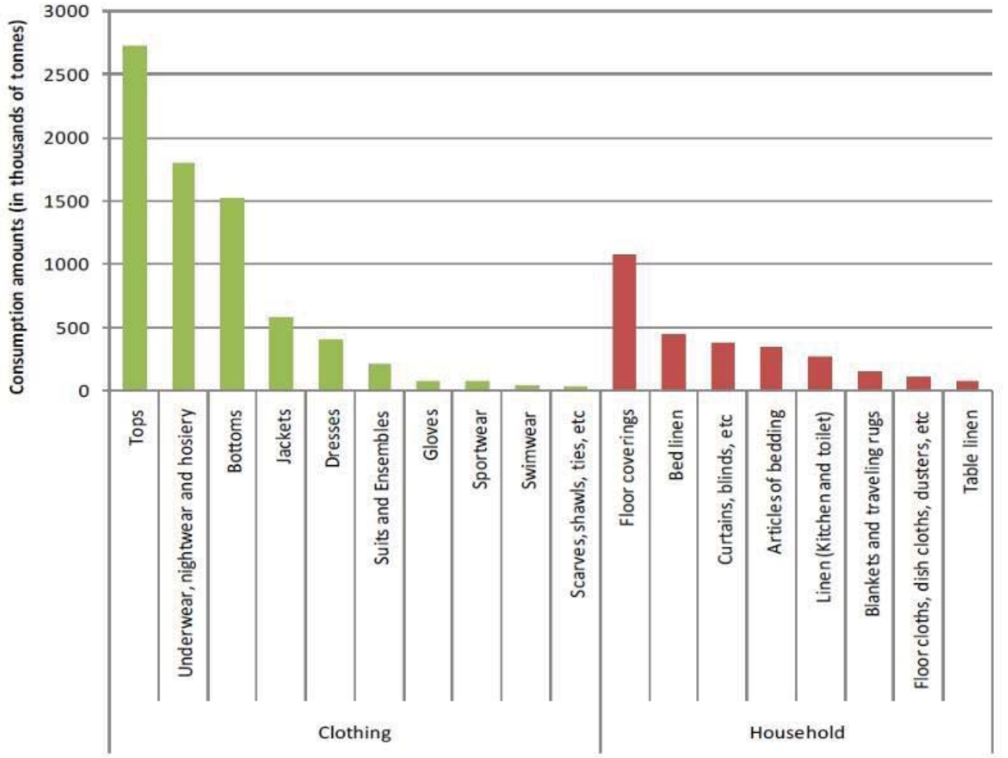

Figure 35: Consumption of different categories of clothing and household textile products in the EU-27 (source: IMPRO textile, 2014)

For non-technical applications with the highest releases of microplastics, oil-based synthetic materials are replaced by natural or other artificial materials (cotton, viscose, flax, wool).

The current natural fibre mix was taken to replace the synthetic fibres[247]:

- Cotton: 66%
- Viscose: 15%

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[246] Cai Y., Mitrano, D.M., Heuberger, M., Hufenus, R. and Nowack, B., 'The origin of microplastic fiber in polyester textiles: The textile production process matters', Journal of Cleaner Production, Vol. 267, 2020, Elsevier BV.
Folkö, A., 'Quantification and characterization of fibres emitted from common synthetic materials during washing', *Environmental Science*, 2015.
Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.
[247] Beton, A. et al, 'Environmental Improvement Potential of textiles (IMPRO Textiles)', *Publications Office of the European Union*, EUR 26316, JRC85895, 2014.

- Wool: 15%
- Flax: 3%

Weight, numbers of units and composition data of the JRC Impro textiles study[248] are used. Only few synthetic fibres have been replaced by natural ones. The proportion of synthetic materials falls from 38% (baseline scenario) to 21%

How could the measure be implemented?

The measure would be implemented through legislation changes (ESPR)

Measure TEX#4: Mandatory prewashing of textiles before placing on the market

Type of measure: Regulatory action

Description of the measure

Prewashing would be mandatory for all the textiles put on the EU market. Therefore, the plants in and outside the EU putting textiles on the EU market would need to equip themselves (washing and drying machines).

How does the measure work?

In practice, a certification mechanism with a chain of custody model could attest to the prewashing of the textiles. The amount of microfibre released from synthetic fabrics is bigger in the first few washes than at other stages. Therefore, at the end of the production phase and/or before the textiles/garments are put on the EU market, mandatory prewashing could reduce the microplastic released during the washing phase. To be efficient, especially outside the EU, where wastewater treatment is limited, this measure should be combined with measure TEX#5: Specific wastewater treatment in production plants.

How could the measure be implemented?

The measure would be implemented through legislation changes (review of the IED Directive, BREF for the companies in the EU and potentially the non-quantitative performance requirements of the ESRP).

Measure TEX#5: Specific wastewater treatment in textile production plants

Type of measure: Regulatory action

Description of the measure

A specific wastewater treatment would be mandatory for all the textiles put on the EU market. Therefore, the plants in and outside the EU putting textiles on the EU market would need to equip themselves. This measure implies a microplastic filtering system for the wastewater of textile production plants. Some of the production plants in the EU are covered by the IED and by the BAT

[248] Ibid.

Conclusions for the Textiles Industry[249], in which cases the corresponding permits must contain emission limit values based on the BAT Conclusions. The BAT Conclusions contain, inter alia, levels for direct emissions of suspended solids into water bodies.

This measure is associated with measure TEX#4: Mandatory prewashing before placing on the market. There are microplastic emissions at several steps of textile production (pre-treatment of the fibres, dyeing, etc.). Therefore, wastewaster treatment is more relevant than only filters for prewashing.

How does the measure work?

In practice, a certification mechanism with a chain of custody model could attest to a specific wastewater treatment to capture microplastics during the production phase, especially during wet processing as dyeing, printing, and chemical finishing.

How could the measure be implemented?

The measure would be implemented through legislation changes (possibly through the Urban Wastewater Directive for the companies in the EU).

Measure TEX#6: Compulsory filters for washing machines

Type of measure: Regulatory action

Description of the measure

This measure aims to reduce microplastic releases from the washing process during the use phase by making filters compulsory for household washing machines.

How does the measure work?

A filtration device can be added to the drum of the washing machine or positioned at the end of the drainpipe (external filters), or it can be a built-in filter (internal filter). Performance criteria and handling criteria have to be defined. There is a risk of mishandling the retained microplastics. For example, if the consumer rinses the filter in the sink, the microplastics will still be transferred to the urban wastewater system. Therefore, clear communication is needed to advise on and promote best practices of filter cleaning.

A filter could be mandatory for new machines sold as those filters are more cost-efficient than the filters added to existing machines. External filters would be advised to consumers with high awareness who would like to reduce their microplastic emissions because they are likely to apply best practices and avoid rinsing the filtering system in the sink. It would take between 7 and 12 years to cover all washing machines with internal filters based on the uptake in new and existing stock and the average lifetime of washing machines.

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[249] COMMISSION IMPLEMENTING DECISION (EU) 2022/2508 of 9 December 2022 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the textiles industry, OJ L 325, 20.12.2022, p. 112–161

How could the measure be implemented?

The measure would be implemented through legislation changes (implementing measure under the Ecodesign Directive for electrical and electronic equipment or possibly under the proposal for Ecodesign for Sustainable Products Regulation).

Measure TEX#1: Standardised methodology to quantify microplastics releases from textiles

Type of measure: Standardised measurement methodology

Description of the measure

This measure entails creating a standard for the measurement of microplastics releases over the life-cycle of synthetic textiles.

How does the measure work?

This measure requires defining a reference method to quantify (via weight, for example) microplastic release at each step of the life-cycle and a standard testing method (filter to use, washing temperature, etc.) for synthetic textiles. The result could be a CEN standard that covers the microplastic releases of textiles on the whole life-cycle.

How could the measure be implemented?

It could be implemented through voluntary or regulatory channels (e.g. a new EU legislation).

6.3 Measures for paints

6.3.1 Long list of measures

Microplastic releases from paints can be reduced by measures that impact one or more of the life cycle stages of the paint and the painted object. Hence, potential measures have been grouped in the following manner:

Knowledge and capacity building: Paint with respect to other sources of microplastic pollution has only recently caught the attention of policymakers. Thus, several actions could be taken to deepen the understanding of the paint microplastics problem and address it at both a scientific and legal/policy level. Awareness-raising and education on the issue is also a key point to tackle.
Product Design; Measures could be taken at the very first stage of the paint life, meaning improving the paint formulations and improving the quality of the products on the market in the light of environmental compatibility.
Application & Maintenance Actions can also be taken at a later stage, at the moment of application or once the paint is already on the intended object (e.g. maintenance and removal).

During the stakeholder workshop organised on 17 March 2022, 53 proposals in total were identified, out of which 7 were excluded as they were only comments and not measures. 5 were screened out. The remaining 41 selected measures were grouped and merged to form 12 more comprehensive measures.

6.3.2 *Measures discarded prior to assessment*

The table below summarises the measures that have been screened out from the evaluation as well as the reasons for their exclusion. The reasons for exclusion are mainly technical feasibility or their lack of coherence with other EU objectives.

Table 22: Screening of measures for paints

Category	Measure description	Reason for screening out
Market failure / Regulatory failure	Use more biocide anti-fouling agents to prevent organisms from sticking to the hull and thereby prolong the lifetime of antifouling paint	The measure has been discarded for **lack of coherence with other EU objectives**. This is because it is in contrast to other efforts at the European level to reduce the detrimental effects of biocide in nature Biocidal Products Regulation (BPR), Regulation (EU) 528/2012.
	Promote the use of self-healing paints	The idea of self-healing paints is based on the reparability of applied paint layers. Repair of the paint layer is currently only possible once for each crack, and this technique is still under development. The expected full-scale application could still take 10 years […].[250]In light of this information, we discarded the measure for reasons of **technical feasibility** as we want to focus on more promptly available solutions.
	Promote the use of paints with higher content of solids (less solvent/water) in order to consume less of the paint itself	This measure was discarded as it doesn't address the problem. The share of the paint that solidifies is the one constituted by the polymers; what renders the mixture liquid is a solvent. Therefore, having thicker paint (i.e. with less solvent) would not affect its microplastic release.
	Replace antifouling paint with silicone paint	Antifouling paint is used to prevent biofouling, which causes increased ship fuel consumption, reduces the ship's top speed, and can spread invasive species. Most antifouling paints release biocide to prevent biofouling, and silicone paint is a biocide-free alternative that prevents fouling by creating a sleek surface. The measure has been discarded because it does not necessarily reduce microplastic releases.
Market failure / Regulatory failure	Since winter maintenance of roads can influence road marking wear (e.g. street sweeping), one could provide a monitor and reporting scheme on when street sweeping should be carried out in relation to precipitation events, etc.	This measure has been discarded for **low efficiency** and **lack of coherence with other EU objectives**; road maintenance is designed to prioritise safety and not avoidance of wear and tear of road markings.

[250] Faber, M., Marinković, M., de Valk, E., & Waaijers-van der Loop, S. L., 'Paints and microplastics. Exploring the possibilities to reduce the use and release of microplastics from paints. Feedback from the paint sector', *RIVM (Dutch National Institute for Public Health and the Environment) report*, 2021.

Category	Measure description	Reason for screening out
	Introduce microplastic releases during paint maintenance as a criterion in the Taxonomy Regulation.	The measure would require economic activities that wish to be labelled as sustainable to not emit microplastics during paint maintenance. The measure would, therefore, target only selected sectors such as wind energy. Consequently, the measure has been discarded due to a potential **lack of effectiveness and efficiency**.
	EPR to finance proper disposal of paint removed during surface maintenance	The measure was discarded because it is not possible to clearly attribute the responsibility (from an EPR perspective) to paint producers as they are not alone responsible for the poor application and maintenance of paints.
Information failure	Assess and try to better understand which paint substitutes can be used for specific applications.	The measure has been discarded for **technical feasibility reasons.** Differentiating the use of paint and pairing it with possible substitutes would require a comprehensive assessment of the economic, environmental, and social impact of all those substitutes. Also, a substitute for application A may not work for application B. Different aspects such as climatic conditions also needs to be considered.
	Investigate the degradation process of paints	"Degradation" in this context refers to the change in polymer-based product (paint particles in the environment) properties such as tensile strength, shape, colour, molecular weight etc., under the influence of one or more external (environmental) factors such as heat, light, chemicals, or other applied forces. Investigating degradation mechanisms alone will not be efficient in reducing microplastic releases, and consequently, this measure has been discarded due to a **lack of effectiveness and efficiency**.
	Innovation challenges	The measure has been discarded due to a lack of **effectiveness** in controlling microplastic release in the short term.
	Monitoring of paint microplastic pollution in the aquatic environment	This measure has been discarded because it is not specific to paints. This can be dealt with by including microplastic monitoring in environmental monitoring through existing policies.
Market failure / Regulatory failure	Preventing boats from undergoing ship-breaking beaching practices	The measure has been discarded because of **proportionality**.

6.3.3 *Measures to be assessed for paints*

<u>Measure PNT#2a: Mandatory label on paint lifetime and plastic content</u>

Type of measure: Supply chain/consumer information to enable selection of less polluting products or change in behaviour. The label requirement should be mandatory. Possibly, the measure could be set up as a voluntary label (not assessed). Further on, the requirement could be transformed as a threshold value needed for product authorisation and to enter the EU market. This is assessed in Measure PNT#2b.

Description of the measure

This measure aims to inform consumers on key properties of paint, i.e., the plastic content of paint (expressed, for example, as a percentage of the total weight) and the paint lifetime, so that they can make an informed choice based on their needs and avoid polluting behaviour. Paint is a mixture; therefore, its performances and properties are correlated to the nature and the relative quantities of its components, a major one being the binder, which is the one commonly made of synthetic organic polymers. Plastic content is, therefore, to some extent, correlated to the paint system properties, for example, the lifetime, but that largely depends on the nature of the polymers themselves and the conditions to which they are exposed. A higher plastic content could, in fact, increase the paint lifetime and therefore decrease the need for repaint). However, examples of completely different systems also exist, such as mineral-based architectural paint, which contains less than 5% of plastic and requires repainting every 20-25 years on exterior surfaces, while most plastic-based paint used for exterior surfaces requires repainting every 8-12 years. Not all applications require long-lasting paint systems. Interior walls, for example, tend to be repainted every 3-4 years, not because the paint system breaks and the substrate risks being damaged, but for aesthetic purposes. Interior decorative paint is estimated to cover 70% of the architectural paint demand[251], which itself covers more than 50% of the market share. The DIY sector is another sector where probably weather-enduring paint systems are unnecessary (e.g., for paintings, woodworks, etc.), although this sector covers a much smaller portion of the market.

How does the measure work?

The measure requires paint producers that sell on the EU market to add on the paint label the plastic content and the lifetime of the paint. To reach this goal, several steps are required. Having a clear definition of plastic content in paint is key: whereas the REACH[252] only refers to polymers (chapter 2), and the Single use plastics directive [253] – point 11 – clearly excludes paint from the scope, a definition of the plastic content in the paint is missing. This creates disagreement among stakeholders regarding the issue.

As a first step, a scientific task force can be created to investigate the use of synthetic polymers in paint and come up with a definition of plastic content in paint that is sufficiently inclusive to cover the development of a new formulation of synthetic polymers. In that regard, after scientific discussions conducted with polymer experts in academia, the following point of discussion (non-exhaustive list) need to be considered:

- *Should the plastic in the paint definition include all synthetic polymer-based materials?* The definition of plastic material should comprise the terms polymer and resin as well, as resins are actually polymers. Also, the definition should be inclusive enough to account for the current paint formulation and synthesis/usage of new polymers.
- *In which physical state is a substance considered plastic: solid/liquid/gas?* Typically, with the term plastics, only solid polymers are considered, but one has to pay attention to the fact

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[251] Hall et al., Constructing sustainable tourism development: The 2030 agenda and the managerial ecology of sustainable tourism, J. of Sustainable Tourism, 27:7, 2018.

[252] European Parliament and Council of the European Union, Regulation (EC) 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, OJ L 396, 30.12.2006, pp. 1.

[253] European Parliament and Council of the European Union, Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment, OJ L 155, 12.6.2019, pp. 1-19.

that an amorphous solid polymer is considered liquid by thermodynamics because it is not crystalline. In this context, though, a liquid should be considered as a material showing the container's shape. Polymer dispersions instead could also be solid (e.g. pigmented plastics) but also liquid as those in paint. The inclusion of liquid polymers and PLF (Polymer in Liquid Formulations), which can solidify in various circumstances (type of polymer, temperature, evaporation of solvent etc.), should also be discussed.

- *What should be biodegradability?* For this point is particularly important to discuss whether to include biodegradable polymers (if so, which are the characteristics of the material to be considered biodegradable)? A valuable starting point is represented by the analysis done in the RIVM report 2016 (Verschoor et al., 2016). To be noted that in this case, the definition of what should matter is the final product and not the synthetic route nor the source (e.g., bio-sourced polymer) as they do not affect potential risk assessments.

The measure would require that agreements are made on the definition of paint lifetime and that the use of a standardised test is being ensured (see PNT#1).

Thresholds to limit plastic content below a certain amount and/or lifetime above a certain number of years could be set to access the European market (PNT#2b).

Antifouling paints should be excluded from this legislation. Antifouling paints are applied on ship hulls to prevent marine biofouling (e.g., algae, barnacles, and mussels). Biofouling reduces the speed and increases fuel consumption, which is crucial in preventing non-indigenous species contamination from one water basin to another. The principle through which the paint works is based on the presence of the release of active substances, i.e., toxic biocides, from the coating that acts to repel and/or poison fouling organisms. These types of paint are either hard paints, which are more durable (but still wear off over time) or ablative paints, also known as self-polishing paint, which slowly slough off in the water. This kind of paint contaminates the environment by design with both toxic substances and microplastic particles. We suggest excluding antifouling paint from the scope as plastic releases being one of the concerns, as antifouling paint is also related to biocides emissions, CO_2 emissions and the spread of non-indigenous species. Therefore, for antifouling paint, a more inclusive approach needs to be taken into account to avoid trade-offs between a reduction in microplastic releases and an increase in biocides or CO_2 emissions, for example.

<u>Benefit</u>:

The expected/desired impact is:

- Consumers choose less plastic-intense paints, especially when a long paint lifetime is not a key requirement for the application (e.g., interior architectural paint, DIY decorative works)
- Promote the use of mineral-based paints (as opposed to plastic-based paints), especially for exterior architectural paint
- Inspire formulations of new products or improvement of existing ones or other technological alternatives to paint to reduce the environmental impact of paint coatings

Negative environmental impacts in terms of CO_2 emissions or toxicity cannot be excluded, for example, a more toxic compound could be introduced by extending the lifetime of the paint. There is insufficient evidence on the effects of reduced plastic content, and whether it could impact the functional properties of the paint and its cost. Once a definition of plastic paint is agreed upon at the EU level, it should be easy for paint producers to determine the amount of plastic in paints based on the paint formulation. The plastic content could be expressed as a “wet” share, i.e., plastic weight/paint weight, as a “dry” share, i.e., plastic weight / (paint weight when cured), or in grams. Probably, the “dry” share, in %, is the one that would have the most significant impact in driving consumer behaviour, as it is easier to understand than values in grams, and it is higher than the “wet” share. Having the plastic content in grams instead would simplify reporting of plastic content for paint importers (see the measure on a deposit-return scheme for paint containers).

The crucial step is the development and adoption at the EU level of a standardised methodology to determine the paint-system lifetime (linked to the wear & tear rate)[254]. While in light of new legislation, testing the lifetime of the paint products should not be a burden for big paint producers, small businesses might encounter difficulties. Open access or creating conventions with testing facilities at the European level for companies might be a valuable means of implementation. Alternatively, a threshold on the amount of paint put on the market could be set to exclude smaller companies from the labelling requirements. Attention should be put on how the consumer understands the concept of paint "lifetime". The lifetime should be understood as "time needed before repaint" and not as "time before the paint degrades in the environment". The label's design must be agreed upon so that it is easily understandable and highly visible since the main target group of the measure is the general public. A monitoring framework should verify compliance with the legislation. In order to facilitate monitoring of compliance with the label requirements, standardised tests to assess plastic content could be put in place.

We believe imposing thresholds to enter the EU market should take place at a later stage (see measure PNT#2b). Following this reasoning, if the thresholds on maximum plastic content would be imposed, the compositions of the paints will need to change to provide the same (or improved) performances. There is no way to predict what new formulations would look like in terms of environmental impact (one possibility out of many: lower plastic content, same lifetime but more toxic degradation products once released into the environment).

How could the measure be implemented?

At the EU level, some directives on paint composition exist already, for example, to define eligibility requirements that minimize environmental impact (e.g. Ecolabel[255]), or GPP that requires the inclusion of clear and verifiable environmental criteria for products and services in the public procurement process and also directives on the VOCs (Volatile Organic Compounds[256]) aimed to prevent the negative environmental effects of emissions of chemicals included in paint. Other relevant legislation which could take up this measure include the Construction Products Regulation and the Ecodesign for Sustainable Products Regulation.

Measure PNT#3a: Promote mineral paint in the architectural sector

Type of measure: Non-binding approach

Description of the measure

Measure 'PNT#3b: Restrict polymer-based paints in the architectural sector' has a similar set-up, but with a regulatory, binding approach. Currently, the paint market is dominated by formulations based on polymeric organic binders. This doesn't leave much space for alternatives, which might be valuable for some sectors that might not necessarily require high plastic content paints or might even benefit from different formulations. Mineral paint (formulations based on inorganic binders like silicate or lime) is a valuable alternative in the Architectural sector. Mineral paint should contain less

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[254] KTA-Tator, 'Expected service life and cost considerations for maintenance and new construction protective coating work', 2016 (https://kta.com/kta-university/expected-service-life-coatings/).
[255] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014D0312
[256] Directive 2004/42/EC

than 5% organic compounds (including binder, solvent, and additives) (according to German regulation DiN 18363 2.4.1), while the rest is mineral raw materials (e.g., alkali potassium silicate). The very nature of the chemical bonds within the ingredients renders these products robust and resistant, especially to UV radiation (in contrast to paint based on organic binders). When applied to a mineral substrate, these products present a lifetime which can go up to two folds the one of usual dispersion paint (the one based on organic binders), i.e., a lifetime of 20-25 years compared to a standard 8-12 years, for exterior coatings[257]. This measure aims to increase the market for mineral paint and render it the primary product used in architecture. The desired impact is to decrease the use of paints with high plastic content in the Architectural paint sector, which represents the highest market share. This will significantly decrease the amount of microplastic pollution due to paint particles from buildings.

How does the measure work?

This measure will use voluntary approaches to increase the penetration of mineral paints through market demand and supply.

How could the measure be implemented?

The measure could be implemented as an inclusion of the mineral paint in the GPP or the ECOLABEL in a way that will be a soft push towards this kind of no-plastic-containing coatings.

Measure PNT#5: Good practices for paint applications in all sectors

Type of measure: Non-binding approach

Description of the measure

This measure is about the EC support to draft guidelines by the paint sector on good practice guidelines for all sectors using paints to prevent microplastic releases to the environment during the paint application and maintenance of the painted layer of an asset. This measure could indirectly incentivise the technological development of clean maintenance techniques. The measure requires compiling a set of good practices for various assets (buildings, road markings, industrial facilities, auto, industrial wood items) for paint application, removal, surface preparation and waste management. In terms of enforcement, environmental permits granted to asset owners could include the requirement of compliance with good practices. The expected impact of the measure is the reduction of microplastic release from paint maintenance in Europe and incentivising the technological development of clean paint removal methods.

How does the measure work?

The first step is to define a set of good practices to limit paint releases to the environment. These practices should cover (non-exhaustive list):

1) Paint application in a closed environment
2) Paint application in an open environment
3) Paint removal in a closed environment
4) Paint removal in an open environment

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[257] Personal communication by a stakeholder

Furthermore, they should include best practices for surface preparation, as good surface preparation is key to guaranteeing good paint adherence to the substrate and maximising the paint lifetime (reducing paint input on the market and microplastic releases during the use phase).

Overall, we estimate that around 139 kt of microplastic is leaked into the environment due to improper paint removal (note that of this, 48 kt are lost during ship maintenance outside of Europe). Losses at applications are also to be considered, especially in sectors where spray is used (automotive and industrial wood) and in situations where the application cannot be made indoors (e.g. general industrial settings). The architectural sector, in this respect, contributes less than others because brushes and rollers are used.

Specifically for the sectors of Marine, Road Markings, Architectural, General Industrial, and Automotive, good practices are already available, as presented below.

Marine:

Various activities occur at shipyards that can lead to paint microplastic releases into the environment. Overall, we estimate that around 50 kt of microplastic is lost to the ocean during commercial ship maintenance at dry-dock, and another 10 kt is lost due to the maintenance of leisure vessels. For commercial vessels, the activities performed in shipyards are: paint application during boat building, paint removal and re-paint during boat maintenance (for example, at dry-dock or floating dock), and in-water removal of biofouling of the boat hull. For leisure vessels, instead is generally paint removal and re-paint (mostly done onshore, in the open air).

The good practices for ship maintenance should cover (non-exhaustive list):

1) Paint application in a closed environment (for leisure boat maintenance or ship-building)
2) Paint application in an open environment (for leisure boat maintenance onshore and commercial boat maintenance in dry-dock or floating dock)
3) Paint removal in a closed environment (for leisure boat maintenance)
4) Paint removal in an open environment (for leisure boat maintenance onshore and commercial boat maintenance in dry-dock or floating dock)
5) In water hull cleaning

Furthermore, they should include best practices for surface preparation, as good surface preparation is key to guaranteeing good paint adherence to the substrate and maximising the paint lifetime (reducing paint input on the market and releases during the use phase). For points 1 and 3, it is straightforward to identify good practices, as the paint losses are confined to a closed space. On the other hand, avoiding releases requires technological development or capturing mechanisms when it comes to maintenance in the open environment or in water.

Some of the technologies known to prevent releases during maintenance of metallic surfaces are vacuum blasting and ultra-high pressure water jetting with vacuum systems and filter technology. For the maintenance of wood surfaces (mostly for leisure vessels), infrared paint removal prevents dust formation and facilitates the collection of removed paint. For paint application, air-less spray guns have a higher transfer efficiency, 90%, than air guns, 70% (*International Labour Office (2012). Encyclopaedia of Occupational Health and Safety 5th edition*). For in-water hull cleaning, which is done to remove biofouling but can also lead to antifouling paint losses, technologies exist that provide in-water vacuum cleaning of the hull. In general, open-sand blasting of painted surfaces should be avoided in open environments, as it has been shown that the dust formed can travel hundreds of meters from the blasting site (*EPA, 2016. Evaluation distances for effective air quality and noise management.*), directly polluting ocean and seas. Dust formation during maintenance has been a concern mainly for the workers' health. During a personal communication, a stakeholder mentioned that China is now banning the use of open sandblasting in shipyards and promoting hydro-blasting instead. Hydro-blasting without a pump/vacuum system prevents dust formation, requiring the water to be collected and filtered to remove microplastic. Currently, some shipyards are using gravitational settling tanks to "treat" the water collected from drydocks (email exchange with InfoMil Netherlands). This could be insufficient to guarantee to capture microplastics, which have specific gravity similar to that of water (0.9 – 1.4g/cm3, *Andrady AL, 2011.)*

The Best Available Techniques Conclusions document for surface treatment using organic solvents including preservation of wood and wood products with chemicals define Best Available Techniques for painting of ships, including removal of old paint, for those shipyards using a large quantities of organic solvents. Shipyards in the scope of this document are required to implement the BAT in order to operate. The techniques allowed during drydocking involve the use of protection systems like nets when sandblasting or the use of wet blasting methods. Both these techniques redirect the removed paint residues to the water that is collected at the bottom of the drydock. The document indicates that the water should be collected, separated, and sent to wastewater treatment plants. In addition, a document of the Infomil Knowledge centre in the Netherlands[258]also states that the water collected from the dock is to be sent to wastewater treatment or treated aside with settling tanks and then released to surface water or water treatment plants.

In conclusion, in application of the current set of BAT, the paint lost during surface preparation and paint re-application would be redirected to wastewater. Unfortunately, as a study made by the Tumlin and Bertholds for the Swedish Svenskt Vatten shows, 40-60% of the microplastic in the incoming wastewater is then found then in the sludge, which in Europe is often used as a soil fertilizer. Another aspect on which the guidelines could be clear and strict is the spraying techniques. In fact, some of the spray techniques listed in the BAT have a transfer efficiency of 50% or 60%, which is much lower than the transfer efficiency of 90% that one can obtain with airless spray guns. Transfer efficiency of 50% would imply that half of the paint is lost at application, and if the paint application is made outdoors, this is a significant direct leakage to the environment.

The conclusions that can be drawn from the analysis of the BAT document show that the good practices for ship maintenance should then involve techniques that maximise transfer efficiency at application and minimize dust formation at removal. The latter can include both vacuum blasting techniques and water blasting, but in the second case (as for any technique involving water usage), the wastewater should be appropriately treated; otherwise, the microplastics that end up in the sludge would just be used in agricultural soil.

Road Markings: The document *"Effective Removal of Pavement Markings"* by the *National Academies of Sciences, Engineering, and Medicine 2013. Washington, DC: The National Academies Press*[259] reports various techniques for removing road markings, and for our purposes, we may focus on those with low to no dust formation. These will be grinding, shot blasting, excess oxygen, laser and chemical removal. Another potential solution is the creation of inlaid road markings; although this is a quite demanding technique which might compromise the integrity of the road, therefore it is valuable only in countries with heavy snowfalls where snow can ruin the markings[260].

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[258] Rijkswaterstaat Environment [The Directorate-General for Public Works and Water Management], 'Kenniscentrum InfoMil [Knowledge Centre InfoMil] (https://www.infomil.nl/), Nl.

[259] Pike, A.M. and Miles, J.D., 'Effective Removal of Pavement Markings', *National Cooperative Highway Research Program*, Report 759, 2013.

[260] Johannesson, M., & Lithner, D., 'Potential policy instruments and measures against microplastics from tyre and road wear: mapping and prioritisation', *Swedish National Road and Transport Research Institute (VTI)*, No. 1092, 2021.

Architectural: For the application of paint products on buildings, mineral paint can be used when mineral substrates are as concerned (see PNT#3a & PNT#3b). For interior surfaces, using paint products with low polymer content should be considered, as performance against harsh weather is not an issue.

In the removal phase, especially on wood substrates, the best practices to minimise paint release from wood surfaces are vacuum sanding or infrared removal. For metal surfaces, instead, the best option is to optimise the applications using technologies with a high transfer rate.

General Industrial: This sector is characterised almost exclusively by metal surfaces on which the paint is applied. The best option to reduce microplastic leakage is to optimise the applications, reducing overspray losses using higher transfer rates. Technologies with transfer rates from 50% to 75% could be found in the Best Available Techniques Conclusions by Chronopoulos et al.[261]. According to the ILO, air-less spray guns have a transfer efficiency of 90% (*International Labour Office (2012). Encyclopaedia of Occupational Health and Safety 5th edition*).

During the removal phase, it is imperative to use technologies that capture the paint particles during operation. This will guarantee the elimination of releases into the environment. Lastly, during removal, a critical step is to perform proper surface preparation prior to reapplication. Indications on the process are provided by the paint product warranty, and this will maximise the paint lifetime.

Automotive: The only recommendation we can provide is to increase the transfer efficiency of paint guns for repair jobs. Several studies exist where they relate spray systems and application conditions to transfer efficiency. *Heitbrink et al., 1996; Poozesh, S., et al., 2018.* The recommendation is always to use the best system and condition possible to minimize the losses of paint ad application.

Once good practices have been developed, they could be implemented by granting a certification to paint professionals who comply with good practices to promote their work and incentivize the use of clean methods for asset maintenance.

How could the measure be implemented?

A set of guidelines should be developed per sector and adopted by the relevant industrial sectors voluntarily.

Measure PNT#4: Deposit-return scheme for paint containers

Type of measure: Market-Based Instrument

This measure should be mandatory.

Description of the measure

The aim of this measure is to put in place an EPR scheme to drive knowledge creation and gather valuable insight on the volume of unused paint, its contribution to environmental pollution and its fate (points 1-3 above). Subsequently, once a better understanding exists, the EPR scheme will be valuable in driving change, reducing unused paint, microplastic pollution and increasing circularity.

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[261] Chronopoulos G. et al., 'Best Available Techniques (BAT) Reference Document on Surface Treatment Using Organic Solvents including Preservation of Wood and Wood Products with Chemicals', *Publications Office of the European Union*, EUR 30475 EN, JRC122816, 2020.

It will address the problem of market failure and regulatory failure. I will also address the information failure problem because:

1. The amount of unused paint is potentially currently underestimated
2. It is unknown how much unused paint is improperly disposed of in EU-27 (e.g., disposal to unauthorised dumpsites, disposal through household drainage system), leading to environmental pollution
3. Of the unused paint that is collected, only a small fraction is recycled

Point 1

It is believed that, on average, 3% (OECD, 2009) of professional paint and 15% of DIY paint are unused.[262] (Release of microplastics and potential mitigation measures: Abrasive cleaning agents, paints and tyre wear)., OECD, 2009.). But, according to a personal communication with ADEME (the French agency for ecological transition), paint cans recovered through an EPR scheme targeting household chemicals are, on average, 40% full. Additionally, an internal paint company document indicates that 30-40% of paint prepared for an offshore maintenance job can end up being unused and subsequently disposed of.

Point 2

In terms of fate, in our baseline assessment, we assumed that the 85 kt of plastic within unused paint in Europe is always disposed of as waste. A personal conversation with an architectural paint industry expert revealed that professionals and DIYers might use the domestic drainage system to dispose of unused paint. Since sludges recovered from wastewater treatment in Europe (except for the Netherlands) are spread on agricultural land as fertilizer, the disposal of unused paint in the domestic drainage system leads to microplastic pollution to the environment. Moreover, some paint is also disposed of in unauthorised dumpsites (personal conversation with ADEME), although an assessment of the volumes of improperly disposed paint is not yet available.

Point 3

Unused paints are a valuable resource, and their recycling is technically feasible[263]. Paint is 37% plastic as the binder. Added microbeads are a specific case used only in some technical coatings (e.g. road markings). So unused paint has also plastic and though emission from unused paint into the environment is not necessarily in the form of microplastic, but as plastic, that in turn will be fragmented in microplastics. It is unknown how much of the unused paint is recycled in EU-27. According to a personal communication with ADEME, in France, where there is an EPR system in place to target the disposal and management of household chemicals (including paint), it is estimated that less than 1% of the recovered paint is recycled. The lack of recycling is due to a conflict between the PRO and the only paint recycler on French territory. “The vast majority of the waste is still incinerated (mostly with energetic valorisation – R1 treatment)”. But in the process, metallic containers are also incinerated.

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[262] Verschoor, A. et al., ‘Emission of microplastics and potential mitigation measures: Abrasive cleaning agents, paints and tyre wear’, Dutch National Institue for Public Health and the Environment, 2016 (https://rivm.openrepository.com/bitstream/handle/10029/617930/2016-0026.pdf?sequence=3).

[263] AkzoNobel, ‘AkzoNobel launches recycled paint to help close loop on waste’, 2019 (https://www.akzonobel.com/en/media/latest-news---media-releases-/akzonobel-launches-recycled-paint-to-help-close-loop-on-waste).

Benefit: The ultimate desired impact is to increase the disposal of unused paint through proper channels and finance its recycling. An efficient way to target DIYers could be by actively involving the distribution chains through deposit-return schemes (i.e., easily accessible collection points and communication/promotion campaigns to encourage the general public) or by promoting the door-to-door collection.

How does the measure work?

This measure requires setting up an EPR scheme where paint producers pay based on how much plastic they put on the market. The money collected will be used in the first phase to drive knowledge creation and in the second phase to drive change.

The EPR scheme requires paint producers, as well as paint importers within the EU market, to declare to the EPR operator how much (wet) paint they put on the market and how much of that paint is plastic. In order to harmonise the reporting, a standard definition for plastic in the paint should be agreed upon. A threshold could be set to only target the main producers, therefore avoiding excessive administrative burdens for the authority as well as for small paint producers. A small number of large producers dominate the paint industry. Both European and non-European paint companies sell paint on the EU market. We could not find figures for the paint sold to the European market from non-European producers, but there are figures for paint sold by European producers[264]. These indicate that the top 3 European producers cover more than 50% of the paint sales (from EU producers to the EU market), and the top 10 cover 80%. At the global level, the trend is similar, with the top 20 producers covering 80% of the global paint sales[265]. Input from ADEME confirms the trend; according to their data, the top 5 paint producers represent 81% of the market.

For each paint sector, after it has been determined how much paint is sold in the EU market, one could decide that all producers and importers of more than a tenth of it should be included in the EPR scheme. This would probably limit the number of paint producers/importers to 3-5 per sector. There is currently no single definition of the different paint sectors. In this assessment, we used a split based on the asset on which the paint is applied, but a different split could be more suitable for the paint industry. In the first phase, the objective of the EPR scheme and the role of the PRO would be to:

1. Assess the amount of unused paint as well as the amount of paint put on the market
2. Finance research and assessment studies of improper disposal of unused paint
3. Assess the current recycling rate of unused paint and the potential recycling capacity

In the second phase, the objective of the EPR scheme will be to increase the collection rate of unused paint through the proper channels (e.g. by setting up deposit-return schemes, door-to-door collection, etc.) and reduce microplastic pollution through preventive measures (such as communication campaigns) or curative measures (e.g., by financing wastewater treatment). Ultimately, the EPR should incentivise the recycling of unused paint. A successful example of a take-back scheme seems to be PaintCare, a program of the American Coatings Association, active in 10 US states, that encourages households and businesses to bring unused paint to the collection site.[266]In Denmark, the city of Odense put in place a door-to-door collection system for hazardous household waste (see *GOOD PRACTICE ODENSE: Hazardous Waste Collection October 2014, for reference).).* In

[264] European Coatings, 'Ranking: The 25 largest coatings producers in Europe', 2018 (https://www.european-coatings.com/articles/archiv/ranking-the-25-largest-coatings-producers-in-europe).

[265] Coatings World, 'Top Companies Report', 2021 (https://www.coatingsworld.com/issues/2021-07-01/view_top-companies-report/top-companies-report-163001/).

[266] PaintCare, 'Home page'(www.paintcare.org).

Odense, paint accounts for 75% of the volume of the recovered hazardous waste. On the other hand, a distribution chain in France, Tollens, currently allows for the take-back of paint cans. However, a conversation with a local distribution centre revealed that they accept only clean cans or small quantities of paint residue. The recovered cans are sent to recycle the can itself and not the paint. Therefore, if a take-back scheme is put in place, the scheme's basic principles and organization should be clearly stated and communicated to actually target the paint and avoid the return of the can alone.

The information gathered through the EPR scheme and the PRO should be made publicly available. Such a report could also implicitly allow keeping track of the amount of paint that has not been recovered and improperly disposed of by comparing the performance in the different Member States. To facilitate the comparison, it would be better to require the paint producers or the importers to declare the amount of "wet" paint put on the market, i.e., including the solvent or water that evaporates upon application.

How could the measure be implemented?

This measure would require setting up a Producer Responsibility Organisation (PRO).

Measure PNT#2b: Threshold on lifetime and plastic content for paints

Type of measure: Regulatory action

This measure is dependent on measure PNT#1 and PNT#2a.

Description of the measure

This measure aims to regulate access to the European market only to paints that have plastic content below a chosen threshold (expressed, for example, as a percentage of the total weight) and a lifetime above a certain threshold, in order to reduce microplastic pollution. A better insight on how plastic content and paint lifetime are defined and their relation to plastic pollution is available in measures PNT#1 and PNT#2a.

How does the measure work?

The measure aims on building on the knowledge created through the introduction of labels on paint lifetime and plastic content (PNT#2a), in order to exclude from the market the worst performing paints in terms of microplastic pollution potential. The thresholds could become increasingly stringent over the years. The measure should be applied on all paints sold on the European market (with the exception of antifouling paints – see measure PNT#2a). The thresholds could be different for the different paint sectors. The direct benefits of setting an upper threshold for plastic content and a lower threshold for paint lifetime would be:

- Reduction of wear & tear losses (due to longer lifetime of paint system), which should be visible as a reduction of paint demand (less repaint needed);
- Reduction in microplastic releases due to lower plastic content in paint formulation.

It is necessary for measure PNT#2a to be introduced first in order to have a clear idea of what is the current configuration of the market in terms of plastic content and its correlation with paint lifetime. As this becomes clear, thresholds can be imposed. After the introduction of thresholds, the compositions of the paints will need to change to provide the same (or improved) performances. There is no way to predict what new formulations would look like in terms of environmental impact (one possibility out of many: lower plastic content, same lifetime but more toxic degradation products once released into the environment).

How could the measure be implemented?

Imposing thresholds on plastic content and lifetime is a type of product regulation.

Measure PNT#3b: Restrict polymer-based paints in the architectural sector

Type of measure: Regulatory action

Description of the measure

This measure builds on the analysis of 'Measure PNT#3a: Promote mineral paint in the architectural sector', but going from a non-binding to a binding, regulatory approach. Currently, the paint market is dominated by formulations based on polymeric organic binders. This doesn't leave much space for alternatives, which might be valuable for some sectors that might not necessarily require high plastic content paints or might even benefit from different formulations. Mineral paint (formulations based on inorganic binders like silicate or lime) is a valuable alternative in the Architectural sector. Mineral paint should contain less than 5% organic compounds (including binder, solvent, and additives) (according to German regulation DiN 18363 2.4.1), while the rest is mineral raw materials (e.g., alkali potassium silicate). The very nature of the chemical bonds within the ingredients renders these products robust and resistant, especially to UV radiation (in contrast to paint based on organic binders). When applied to a mineral substrate, these products present a lifetime which can go up to two folds the one of usual dispersion paint (the one based on organic binders), i.e., a lifetime of 20-25 years compared to a standard 8-12 years[267], for exterior coatings. This measure aims to increase the market for mineral paint and render it the primary product used in architecture.

How could the measure be implemented?

The measure requires a new regulation which imposes limits on the use of dispersion paint (based on organic polymeric binders) for the architectural sector. The desired impact is to decrease the use of paints with high plastic content in the Architectural paint sector, which represents the highest market share. This will significantly decrease the amount of microplastic released due to the paints used in buildings.

How does the measure work?

It could be in the form of imposing limits on the use of dispersion paint (based on organic polymeric binders) in the architectural sector. It can be intended as a full ban on this kind of product or a limitation on the allowed share. We advise this measure not to be imposed on architectural coatings intended for wood and metal, as mineral-based paint is brittle and weak when tensile forces are applied. At the moment, to the best of our knowledge, only one independent study was done (Trischler & Partner GmbH, Ökobilanzierung von Silikatfarben- und Kunstharzdispersionsfarben – ein systematischer Produktvergleich, Darmstadt u. Freiburg, 1996) and points in favour of the mineral paint. But it is an outdated report with respect to new LCA standards and to new technologies in paint production. Therefore, an updated life cycle assessment would be needed first.

[267] Personal communication with a stakeholder

How could the measure be implemented?

The measure could be implemented through the CPR or a new legislation.

Measure PNT#1: Standardised methodology of paint lifetime

Type of measure: Standardised measurement methodology

Description of the measure

When a plastic-based coating (for this measure, we consider any organic polymer-based coating) starts losing its intended properties, it is at risk of detaching from the support and being released into the environment contributing to microplastic release. Evaluating how well and how long a paint coating will last on the support is one of the big challenges the paint industry has to face. There is no unique way to do it as it depends on numerous factors: paint formulation (type and quantities of ingredients) and substrate properties, environmental conditions, coating thickness, etc. Currently, the "expected lifetime" is reported for certain paints to establish a warranty for the product. The definition of the expected lifetime, though, is currently open to interpretation and it can be different for decorative paints and performance coatings. In the case of decorative coating, it indicates the time after which the coating loses its decorative purpose; in the case of performance coatings, it indicates the time after which the coating loses its functional purpose. The lifetime is usually estimated by the paint producers using different techniques. For example, for coatings designed to protect assets in exterior environments, accelerated testing is one means by which formulators assess the specific performance properties relevant to different end-use applications. Long-term performance under harsh conditions is, as a matter of fact, required for coatings used in the oil and gas, petrochemical, and wastewater industries.

There are several internationally applied standardised test methods — ISO (e.g., ISO 12944 on corrosion), ASTM (e.g., B117 salt fog test for evaluation of corrosion performance, D4587 weathering assessment based on UV exposure coupled with condensation, D5894 cyclic salt fog/UV testing, etc.) — but not all are required nor applicable for every coating and, to the best of our knowledge, are not mandatory. Furthermore, these standardised tests assess only one phenomenon at time, be it abrasion, corrosion, exposure to UV light, resistance to water, etc, but the lifetime is determined by the combination of all. These testing methods are also not free from limitations, evolving coating technologies, lack of real-time monitoring for test conditions, new expectations of coating performances, regulations and a certain level of subjectivity involved in reporting the results, only to mention a few. In addition, there is a need to identify the appropriate tests to perform for a given coating formulation and application.[268]

A word of caution is needed at this stage: a direct, clear, positive correlation between one parameter, plastic content, and lifetime or other properties of paint cannot exist, or at least cannot be the same for all paint types. It is, in fact, the combination of all the components of the paint mixture (which includes the polymers) and how they interact with each other that determines the product's performance. Polymer properties (strength, elongation at break, elasticity, environmental resistance etc.) are determined by the chemical composition, the molecular weight and molecular weight distribution, the morphology of the polymer particles and of the polymer film itself. The first step should be to agree on a definition of paint lifetime, valid for all sectors, and this should be intended as "time needed before repaint" and not as "time before the paint degrades in the environment". For

[268] Element, 'Materials testing: Abrasion & wear testing' (https://www.element.com/materials-testing-services/abrasion-and-wear-testing).

example, it could be defined as the time until 5%-10% of coating breakdown occurs (KTA, 2017), which implies a release of 5-10% of the paint (and plastic) to the surrounding environment. This measure is applicable for all paint types independently from the solvent they are based on (water-born – dispersion paints and water-soluble paints - or solvent-born) because they can all release microplastics. A special case could be constituted by those paints which are both water-soluble and water-sensitive. These, in fact, might release polymers as molecular dispersions in water. Nevertheless, they should be assessed and accompanied with a lifetime because they do release polymeric content into the environment, just on occasion, not in solid form[269].

How could the measure be implemented?

It could be implemented through voluntary or regulatory channels. A scientific panel with coating experts should develop a definition for paint lifetime and identify the best testing methods available – which should be regularly updated by the agency which develops them – for each type of paint application.

6.4 Measures for detergent capsules

6.4.1 Long list of measures

During the stakeholder meeting (17 March 2022), a preliminary list of policy measures was first presented to the stakeholders, such as the eventual environmental persistence and the complete biodegradability of these PVOH in different natural compartments; the most suitable standard to assess the biodegradation of these PVOH and related mixtures; the use of alternatives to PVOH and related mixtures such as casein- and starch-based products in which their water-solubility and biodegradability in water have been demonstrated; and the redesign of the capsules in such as a way that the use of PVOH is not necessary. After discussing these different measures, six main ideas were identified in the stakeholder workshop, divided into different themes. After eliminating the duplicates, the list of selected measures is shown below:

- Commitment to propose a fully biodegradable water-soluble plastics and related additives;
- Redesign the capsules in such a way to avoid the use of PVOH;
- Ensure the implementation of a suitable standard to demonstrate the biodegradation of PVOH films with respect to microorganisms/references used for testing in real-life conditions (e.g., wastewater treatment plants);
- Implement the OECD test guidelines selectively to PVOH and related mixtures;
- Use instructions on how to load the capsules in an appropriate way to avoid any overloading;
- Strengthening enforcement and sanctioning for breaches of relevant obligations deriving from applicable EU legislation.

[269] Kopeliovich, D., ‘Classification of paints’, *Substances & Technologies*, 2014 (https://www.substech.com/dokuwiki/doku.php?id=classification_of_paints).

6.4.2 Measures discarded prior to assessment

Table 23: Screening of measures for detergent capsules

Problem area	Measure title	Reasons for screening out
Market/Regulatory failure	Implementing alternatives to PVOH	The detergent industry is willing to deliver more sustainable products, mainly based on bio based and biodegradable alternatives. However, the current biodegradable alternatives derived from biomass cannot meet the minimum technical requirements of PVOH and related mixtures, i.e., an appropriate water-solubility on use, a good compatibility with detergent products and good film-performances.
Market/Regulatory failure	Make biodegradation standards compulsory for marine and freshwater	The biodegradation assessment is conducted on the basis of six tests in OECD 301, and each method results in an assessment of aquatic effluent biodegradability in fully aerated conditions. Briefly, OECD 301A measures the disappearance of organic carbon, OECD 301B quantifies the generation of carbon dioxide, OECD 301C, 301D, and 301F monitor oxygen uptake, and OECD 301E monitors the disappearance of dissolved organic carbon. These tests are stringent tests that provide clear figures about biodegradation. A compound giving a positive result in such a test may be assumed to biodegrade quickly in municipal wastewater treatment plants and the environment. A separate measure is not needed at this moment.
Market/Regulatory failure	Banning PVOH and related mixtures	Even if the measure could solve the microplastic releases from PVOH, it could result in excess use of detergents, leading to increased environmental impact. Another reason is related to the health issue because using PVOH and related mixtures avoids any skin contact with detergents and any allergic issues during handling and using the capsules.
Market failure	Load the capsules in an appropriate way	This is already part of existing policy and market practices.
Regulatory failure	Strengthening enforcement	Biodegradation standards are not taken up yet so enforcement of this cannot happen.

6.4.3 Measures to be assessed for capsules

Measure CAP#1: Standardised methodology to quantify microplastics releases from detergent capsules

Type of measure: Standardised measurement methodology

Description of the measure

As there is a critical knowledge gap, this measure will enable an understanding of the volume and scale of capsule losses occurring at different life cycle stages and addresses the problem driver, “information/knowledge failure”. There remain some uncertainties on the release of PVOH into the environment, particularly the exact usage of PVOH and related mixtures as detergent capsules and after wastewater treatment in which the biodegradation of PVOH depends on acclimatised microorganisms. These uncertainties are related to the fact that the current standards to assess the biodegradation of commercial PVOH and related mixtures, particularly OECD 301, gives a quick figure about the biodegradation of tested compounds in municipal wastewater treatment plants. However, a positive result is obtained when a certain value of biodegradation (beyond 60%) is achieved after 28 days, and it is assumed that the compounds will continue to get biodegraded after water waste treatments. The complete biodegradation of the tested compounds is not required for validating the test, giving some uncertainties on the fate of PVOH, particularly whether the non-degraded fractions will completely biodegrade after or not.

How could the measure be implemented?

It could be implemented through voluntary or regulatory channels (REACH, Detergents Regulation, ESPR, new EU Framework on microplastics), including the use of appropriate characterization techniques to assess the biodegradation of PVOH and related mixtures after wastewater treatments in an appropriate manner.

<u>Measure CAP#2: Apply current biodegradability standards to detergent capsules</u>

Type of measure: Regulatory action

Description of the measure

This measure will enable complete biodegradation of PVOH and related mixtures after wastewater treatments. Currently, no tests are applied to evaluate the biodegradability of PVOH. The measure would mean that PVOH is required to comply with an already available biodegradability test method potentially the OECD 301B[270] (with or without the relevant 10-day window) which would ensure a higher level of biodegradation. According to the OECD guidelines for the testing of chemicals, the 10-day window begins when the degree of biodegradation has reached 10% Dissolved Organic Carbon (DOC) removal, theoretical oxygen demand (ThOD) or theoretical carbon dioxide (ThCO2) and must end before or at day 28 of the test. Pass levels after 28 days (with 10–day window):

• 60% ThCO2 - Theoretical carbon dioxide production

• 60% ThOD - Theoretical oxygen demand

• 70% DOC - Dissolved organic carbon removal

Chemicals which reach the pass levels after the 28-day period are not deemed to be readily biodegradable.

How could the measure be implemented?

The Detergents Regulation could be adapted to use an existing biodegradation standard.

<u>Measure CAP#3: Redesign biodegradability standards for detergent capsules</u>

Type of measure: Updated standardised measurement methodology and its application

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[270] Test No. 301: Ready Biodegradability | OECD Guidelines for the Testing of Chemicals, Section 3 : Environmental fate and behaviour | OECD iLibrary (oecd-ilibrary.org)

Description of the measure

This measure will enable assessing the biodegradability of any water-soluble plastics in normal environmental conditions.

How does the measure work?

Once the films are dissolved in water after use, the dissolved polymer chains are disposed of and degraded during the wastewater treatment. In principle, they must be biodegraded afterwards, but some PVOH could remain intact and could be released into the environment. However, the natural conditions are different in terms of temperature and the likely absence of acclimatized microorganisms. The adaptation of biodegradability standards to more relevant natural conditions could be envisioned in such a way that even if PVOH traces are released, their full biodegradation is ensured.

How could the measure be implemented?

This could be taken up potentially in the detergents regulation or a new legislative framework.

6.5 Measures for geotextiles

6.5.1 Long list of measures

After desk research, through the stakeholder workshop held on 17 March 2022, and bilateral discussions with industrial stakeholders, 58 measures were identified. After refining this list, 6 measures were retained; a large reduction in the number of measures came from the removal of duplicates and the combination of measures that different stakeholders identified. Following is the longlist of measures:

- Guidelines for correct installation, use and maintenance of geotextiles in different applications
- Work with relevant industry groups/associations to gather data
- Define an appropriate testing protocol to measure the potential release of microplastics
- Design product to ensure adequate durability and end-of-life handling, and optimum Life Cycle assessment (including global warming)
- Ban of geotextiles
- Plastic-free alternatives should replace geosynthetics used for coastal or riverbank protection
- Publication of product passports to give the exact list of contained chemicals for each product
- Work on developing erosion-control applications in which the geotextile is covered and unlikely to be able to release microplastics
- Procedure to request and receive approval by authorities to use the geotextile must be established, not just free for all
- Inform municipalities and other public administrations on the environmental impacts of geosynthetics in the open environment
- Make producers/users responsible for regular reporting on the condition and maintenance of geotextiles in use

6.5.2 Measures discarded prior to assessment

The table below presents the measures which were discarded after the preliminary screening of measures, along with the justification for discarding.

Table 24: Screening of measures for Geotextiles

Problem Area	Measure Title	Reason for screening out
Information/knowledge failure	Work with relevant industry groups/associations to gather data	This measure was discarded because it is included in other retained measures. It is not a standalone measure but an element that can be used in other measures to achieve a goal.
Product design	Design product to ensure adequate durability and end-of-life handling, and optimum Life Cycle assessment (including global warming)	This measure is part of other retained measures.
Regulatory failure	Blanket ban of geotextiles	It doesn't seem politically acceptable nor proportionate nor efficient to ban geotextiles in general; they serve a purpose and should be kept among the possible solutions for civil engineering solutions available in the EU.
Market failure/ Regulatory failure/ Information failure	Product passport gives the exact list of contained chemicals for each product	This measure would not reduce microplastic releases nor increase our understanding of microplastic releases from geotextiles; it would only give information regarding the potential release and toxicity of microplastics from geotextiles as well as some information on their material properties.
Information failure	Inform municipalities and other public administrations on the environmental impacts of geosynthetics in the open environment	The gains from this measure are expected to be minimal if enforced on its own because geotextiles are cheaper to install than traditional materials and so will still be used in construction works. It is also covered by a retained measure.

6.5.3 Measures to be assessed for geotextiles

Measure GEO#2: Guidelines for geotextile use

Type of measure: Non-binding approach

Description of the measure

This measure requires the industry to develop guidelines for: the selection of geotextiles for specific applications, the proper installation methods for geotextiles to limit microplastic releases, the correct maintenance of geotextiles (how to repair damaged materials, when to replace damaged geotextiles, their end-of-life management, etc.). The industry has extensive knowledge regarding the applications that their products can be used for as well as the optimal conditions to use their materials in, e.g., during an exchange with members of the International Geotextiles Society (IGS), we were informed that the society does not recommend using geotextiles to reduce glaciers melting and that geotextiles exposed to UV light should have high stabilizer content to reduce their weathering.

How does the measure work?

Whenever a project is designed to contain geotextiles, the industry would follow the guidelines provided with the material. Moreover, the clients would be able to verify that the selected material and its installation are up to the industry's standard set by the guidelines.

How could the measure be implemented?

A set of guidelines for the proper usage of geotextiles (which material, what manufacturing process and how to install them) will be published by the industry and used when appropriate when geotextiles are installed.

Measure GEO#3: Use biodegradable geotextiles for specific applications

Type of measure: Regulatory action

Description of the measure

There are applications of geotextiles for which geotextiles are needed for a limited time, such as holding vegetation still while they root. For these applications, a plastic mesh (Figure 36) is used, which will then biodegrade and released into the environment.

Figure 36: Geotextile mesh used for vegetation support

These materials might not be fully biodegradable; the measure GEO#3 would require that only geotextiles biodegradable, following certain standards, are used in the EU for vegetation support applications.

How does the measure work?

The measure works by restricting the use of non-biodegradable geotextiles for vegetation support applications.

How could the measure be implemented?

This measure could be implemented through the CPR or the Waste Framework Directive. However, in the current version of the CPR, it would be non-binding for the Member States.

Measure GEO#4: Establish geotextile classes according to emissions of microplastics

Type of measure: Regulatory action

Description of the measure

This measure aims to develop an emission control framework. Similar to existing classifications in the CE marking for construction materials, a classification system for geotextiles would be developed. It would be based on the microplastic release potential of the geotextile (depending on its material and manufacturing process). This classification would then be used to define applications where, depending on the class, only certain geotextiles could be used, requiring the highest class of materials to be used for the harshest applications.

How does the measure work?

First, using a testing method for microplastic releases (currently non-existing) from geotextiles (see GEO#1), the materials would be classified according to the quantity of microplastics they emit. Then, the applications for which a certain class of material are required (because their environment is harsher than others) will be defined. The result would be a list of applications for which each class of geotextile could be used. As a result, the geotextiles with higher microplastic release potential would be only used in certain conditions (e.g. not exposed to UV, sea water etc.). Consequently, only geotextiles with low microplastic release potential would be used in exposed conditions, which will limit releases

How could the measure be implemented?

It could be implemented through the existing CPR[271], which already has the class concept implemented for other materials. This measure can be implemented under the current version of CPR, provided that GEO#1 has been implemented.

Measure GEO#1: Standardised methodology to quantify microplastics released from geotextiles

Type of measure: Standardised measurement methodology

Description of the measure

Develop measurement standards and testing protocols for microplastic release from geotextiles to assess the impact of UV, temperature variations, water and salt-water and abrasion on release rates for all types of geotextiles. These measurement protocols will need to be designed so that they consider the interactions between the different weathering agents. Indeed, a recently published study shows that the interactions have a non-negligible impact on the weathering of geotextiles. Moreover, the measurement protocols will need to be designed to monitor microplastic releases since current standards used to monitor the impact of different weathering agents on geotextiles focus on their

[271] European Parliament and Council of the European Union, Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88, 4.4.2011, pp. 5-43.

influence on the mechanical properties (e.g. tensile strength) of the materials, not on the microplastic releases. Some work is already done, or first steps are taken; for instance, the method to assess the effects of internal hydrolysis/oxidation is regulated and included in CE marking; the method for abrasion is an ISO standard and needs further development to include microplastic release potential. The impact of UV and temperature variation needs to be assessed further because the internal hydrolysis test is done at 100ºC. The assessment of microplastic release makes sense for the leaching obtained from the abrasion test, but further ageing approaches because the test is not aggressive enough to produce microplastic release. This point needs to be verified.

How does the measure work?

This measure requires defining a reference method to simulate the influence of different weathering agents (such as UV light, temperature variation, exposure to fresh and seawater, abrasion, etc.) on microplastic releases from geotextiles and then quantify the microplastic releases.

How could the measure be implemented?

It could be implemented through voluntary or regulatory channels (new EU Framework).

6.6 Summary of policy measures

The following table summarises the policy measures initially retailed for assessment.

Table 25: Summary of policy measures

Sources	Policy measures
Paints	PNT#1: Standardised methodology of paint lifetime PNT#2a: Mandatory label on paint lifetime and plastic content PNT#2b: Threshold on lifetime and plastic content for paints PNT#3a: Promote mineral paint in the architectural sector PNT#3b: Restrict polymer-based paints in the architectural sector PNT#4: Deposit-return scheme for paint containers PNT#5: Good practices for paint application in all sectors
Tyres	TYR#1: Emission limit value for particles from tyre wear/abrasion TYR#2: Emission labelling of particles released from tyre wear/mileage TYR#3: Modulated fees in EPR for tyres TYR#5: Enhance monitoring of tyre pressure TYR#6: Regular wheel alignment to minimise tyre wear TYR#7: Road design and cleaning guidelines
Textiles	TEX#1: Standardised methodology to quantify microplastic releases from textiles TEX#2: Restrict synthetic fibres for certain applications TEX#3: Restrict synthetic fibres & fabrics with high releases of microplastics TEX#4: Mandatory prewashing of textiles before placing on the market TEX#5: Specific wastewater treatment in textile production plants TEX#6: Compulsory filters for washing machines TEX#7: Modulated fees in EPR for textiles TEX#8: Raising awareness on best practices for consumers of textiles TEX#9: Mandatory label showing textiles' emissions of microplastics
Detergent capsules	CAP#1: Standardised methodology to quantify microplastics releases from detergent capsules CAP#2: Apply current biodegradability standards to detergent capsules CAP#3: Redesign biodegradability standards for detergent capsules
Geotextiles	GEO#1: Standardised methodology to quantify microplastics released from Geotextiles. GEO#2: Guidelines for geotextile use GEO#3: Use biodegradable geotextiles for specific applications GEO#4: Establish geotextile classes according to emissions of microplastics

7. Initial identification and screening of impacts

The first step in assessing the impacts is a screening to identify the most important ones. The identification of impacts covers both direct and indirect impacts. The following section sets out how we have screened the impacts to be considered in the impact assessment.

7.1 Identifying and selecting of impacts

The list of impacts that need to be considered is based on the Better Regulation Toolbox Tool #18. The table below presents the impact by the three categories: environmental, economic, and social.

Table 26: Potential economic, social and environmental impacts

	Economic	Social	Environmental
Climate			√
Quality of natural resources			√
Biodiversity			√
Animal welfare			√
Working conditions etc		√	
Public health & safety and health systems		√	
Culture		√	
Governance, participation and good administration		√	
Education and training	√	√	
Conduct of business	√		
Position of SMEs	√		
Administrative burden on business	√		
Sectoral competitiveness, trade and investment flows	√		
Functioning of the internal market	√		
Public authorities (and budgets)	√		
Sustainable consumption and production	√		√
Efficient use of resources	√		√
Land use	√		√
The likelihood or scale of environmental risks	√		√
Employment	√	√	
Income distribution, social protection and inclusion	√	√	
Technological development/digital economy	√	√	
Consumers and households	√	√	
Capital movements, financial markets and stability of the euro	√	√	
Property rights, intellectual property rights	√	√	
Territorial impacts (specific (types of) regions and sectors)	√	√	√
Innovation and research	√	√	√
Fraud, crime, terrorism and security	√	√	√
Resilience, technology sovereignty, open strategic autonomy, security of supply	√	√	√
Transport and the use of energy	√	√	√
Food safety, food security and nutrition	√	√	√
Waste production, generation and recycling	√	√	√
Third countries, developing countries, and international relations	√	√	√
Sustainable development	√	√	√
Fundamental rights	√	√	√

For the issues to be covered in the impact assessment, we have screened the following as potentially relevant impacts (but not necessarily significant).

Table 27: Potentially relevant impacts

Environmental impacts
Quality of natural resources / reducing pollution of microplastics for the biodiversity
Efficient use of resources
Waste production, generation and recycling and its impact on land use
Climate change
Economic impacts
Conduct of business (operating costs)
Administrative burdens on businesses
Position of SMEs
Public authorities including local communities (and budgets) Change in costs to MS authorities for administrative, compliance and enforcement activities; Change in costs to EU institutions
Innovation and research
Technological development / digital economy
Functioning of the internal market and competition
Macroeconomic environment
Third countries and international relations
Consumers and households
Social impacts
Public health & safety
Employment
Governance, participation and good administration

When selecting the most relevant and significant impacts, the following criteria have been taken into consideration:

- The **relevance** of the impact within the intervention logic: this considered whether the impact is relevant to assessing the policy options' direct contribution to the objectives.
- The expected absolute **magnitude** of the expected impacts.
- The relative size of expected **impacts for specific stakeholders**: this considered whether any of the impacts would be particularly relevant and significant for a specific stakeholder group, even if the impact overall may be small. This includes whether impacts will be concentrated on specific Member States or industries and whether they will add to the existing regulatory burden for any specific stakeholder group. Impacts on SMEs are also considered.
- The **importance for Commission's horizontal objectives and policies**: this considered whether the impact is relevant to determine any trade-offs between the objectives for amending the Regulation and other EU objectives and policies.

The outcome of this step is the final list of impacts that have been examined, indicating whether they are likely to be positive or negative (using the following signs: ++, +, o, -, --) and which stakeholder groups they are most likely to impact. Colour coding is used to summarise the impacts referring to the direction (positive or negative) and size (small or large) of any expected impacts.

Table 28: Coding used to present expected impacts

--	-	0	+	++	U
Strongly negative	Weakly negative	No or limited impact	Weakly positive	Strongly positive	Unclear

Table 29: Screening of significant impacts

Impact	Significance	Impact on key stakeholder groups	Justification for inclusion / exclusion
Impacts included			
Environmental impacts			
Quality of natural resources	++	Reduced microplastic pollution or better quality of natural resources means improved eco-systems, improved biodiversity and improved services for the economy and society (e.g. fishery), but the general public is the affected group	The objective is to reduce microplastic pollution, so this is a key impact category.
Efficient use of resources	+/-	No specific group is impacted	Reducing waste is about more efficient use of resources. In particular, the objective is to reduce the waste, and therefore this category should be included. Some mitigation strategies could in turn, lead to increased resource use (e.g. reduction of product lifespan leading to increased renewal rate), e.g. reducing paint spillage. It is, therefore, an important category that should be included.
International environmental impacts	++	Reduced eco-system services could impact fisheries, but it is the general public being the affected group	Pollution with microplastic affects both cross-border river basins and the seas and is, therefore, an important international impact that should be included.
Waste production, generation and recycling and its impact on land use	+	Wastewater treatment companies Sectors potentially affected by microplatics waste such as tourism and agricultural sectors	The amount of microplastics is impacting the infrastructure needed for waste water treatment. If not properly managed, microplastics can pile up in certain areas (such as coastal areas) and negatively impact other activities (tourism, agriculture) As with efficient resources, reducing and managing waste is part of the objectives, and the impact category should be included.
Climate change	+ / -	No specific group is impacted	Reducing waste will lead to less GHG emissions, for example, during the

Impact	Significance	Impact on key stakeholder groups	Justification for inclusion / exclusion
			production of plastics. Some mitigation strategies could, in turn, lead to increasing or decreasing GHG emissions. It is, therefore, an important category that should be included.
Economic impacts			
Operating costs and conduct of business	--	Industrial operators	Most measures will affect the operating costs of industries.
Administrative burdens on businesses	--	Industrial operators	Some of the considered measures will have administrative costs that should be quantified and included.
Operation / conduct of SMEs	- / 0	SMEs are part of the affected sectors.	The affected industries include SMEs. There are high shares of SMEs in the textile industry.
Functioning of the internal market and competition	++	Industrial operators	Several Member States are starting to take action, it is therefore important to tackle this at EU level, preserving the internal market. The proposed measures are not expected to significantly affect the internal market's functioning. As the options will place the same obligations on industries and businesses in all Member States, the functioning of the market should not be affected. However, if EU policies replace national policies affecting only a few Member States, the impact will be more equal competition across the EU and therefore have a positive impact on the internal market.
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities (at local, regional and/or national levels depending on PRTR responsibilities).	The considered measures will impact Member State authorities in terms of data collection, verification, correction and enforcement activities.
Public authorities: Change in costs to the Commission	-	European Commission	The considered policy options could have impacts on the Commission and its services.
Innovation and research	+	Industrial operators.	Some of the options could provide incentives for innovation and research.
Third countries and international relations	+/-	Third countries	There could be effects on countries outside of the EU with both direct and indirect impacts, and this category should be included.
Consumers and household	-	Households	Some measures directly target consumer behaviour or affect consumers through prices or availability of products. The impacts are likely to be negative (price increase)

Impact	Significance	Impact on key stakeholder groups	Justification for inclusion / exclusion
Social impacts			
Reduced health impacts due to lower pollutant emissions	++	Public	It is an objective of the considered measures to reduce risks to human health.
Governance, participation and good administration: Improved public access to information	+/0	Public	The options are not expected to change governance and public administration significantly. Though the options might not directly target access to information, there might be improved data on microplastic pollution.
Impacts not included			
Macroeconomic environment	0	Manufacturers primarily	Though there could be significant costs associated with some of the considered measures, it is not likely to have macroeconomic impacts.
Technological development / digital economy	0	Industrial operators, Member State authorities, manufacturers	The innovation and research impact category covers the impacts on technological development related to the sectors concerned.

The economic impacts primarily include the costs of implementing the measures. The benefits of the measures are reductions in emissions of microplastics. Whilst it is not feasible to quantify or value changes in environmental impacts, reductions in emissions of microplastics will reduce the negative environmental impacts from the baseline. In most cases, the emission reductions will affect emissions to all environmental compartments. Hence, the environmental impacts will be more or less proportional to the reduced emissions. There may also be impacts on fuel efficiency for some measures and associated changes in GHG emissions. Similarly, the social impacts, which include the possible negative human health effects, are also likely to be affected proportionally by reductions in emissions. It means that all measures have more or less the same types of environmental and social impacts, and only the magnitude differs. Where there are differences, they are described under the respective measure.

The approach to the assessment of cost impacts draws on evidence identified as part of the literature review and stakeholder consultations. In many cases, the costs are affected by multiple factors, so the cost estimates presented are generally an order of magnitude estimates. Similarly, for the assessment of the reduction potential and the likely realisation of it. Many factors influence the assessment of the reduction potential, and the assessment provides order of magnitude estimates.

7.2 Impact of measures for tyres

Table 30 shows the comparison between all measures evaluated to reduce microplastic emissions from tyres.

Table 30: Comparison of measures for tyres

Measure	Estimated reduction potential		Estimated Cost-effectiveness (EUR/tons reduced/year)	Other environmental impacts	Other economic impacts	Social impacts
	%	Ktons/ year				
TYR#7: Road design and cleaning guidelines			Not quantified – guidance only		Additional costs for road authorities for new road costs and road maintenance	
TYR#3: Modulated fees in EPR for tyres				Not quantified		Costs are likely to be passed on to consumers in higher prices although they can choose to purchase lower abrasion tyres where cost increases will be much more limited.
TYR#1: Emission limit values for particles from tyre wear/abrasion	5-25%	85 500	136	Reduction of microplastic pollution in marine environment, air and soil	Costs are likely to be passed on to consumers in higher prices	Health and environmental benefits from microplastic release reductions
TYR#2: Emission/mileage labelling of particles released from tyre wear	less than 1%	4 275	1 604	Reduction of microplastic pollution in marine environment, air and soil	Costs are likely to be passed on to consumers in higher prices	
TYR#6: Regular wheel alignment to minimise tyre wear	1% - 2%	9 108	145 245 (without fuel savings)	CO2 emission reductions due to fuel savings Reduction of microplastic	Positive impact for motorists and customers (increased	

			-43 287 (with fuel savings)	pollution in marine environment, air and soil	tyre lifetime and lower fuel consumption)	
TYR#5: Enhance monitoring of tyre pressure	1% - 3%	10 403	996 (without fuel savings) -23 298 (with fuel savings)	CO_2 emission reductions due to fuel savings Reduction of microplastic pollution in marine environment, air and soil	Positive impact on motorists and customers (increased tyre lifetime and lower fuel consumption) Additional costs for motorists for testing and alignment (where necessary)	Marginal positive impact on road safety and noise reduction

Table 31 shows the comparison of the impacts of the measures assessed to reduce microplastic emissions from tyres.

Table 31: Summary of impacts for measures for tyres

Policy Option	Environmental impact	Economic Impact	Social impact
TYR#7: Road design and cleaning guidelines		Additional costs for road authorities for new road costs and road maintenance	
TYR#3: Modulated fees in EPR for tyres	Provide incentive for manufactures to innovate and produce tyres with lower abrasion rate Provide incentive for the consumers to purchase low abrasion rate tyres Provide financing for road infrastructure measures	Medium costs to set-up and manage the scheme (where required) / minimal costs to amend existing schemes. Costs for industry depends on fee level and structure Fee might be passed on to consumers – higher costs of tyres	There are already EPR schemes for tyres covering end-of-life management in 20 Member States so limited social impact.

TYR#1: Emission limit values for particles from tyre wear/abrasion	Benefit in the order of 5-25% reduction of emissions Benefits can be realised fairly quickly	Precondition to have test method in place Costs of testing is assessed as low No or low additional costs for tyres with low abrasion rate	Important to make sure that safety is not compromised. Testing seems to indicate that there are lower abrasion tyres on the market which do not compromise on safety.
TYR#2: Emission/mileage labelling of particles released from tyre wear	Benefit depends on consumer reaction, supporting consumer awareness raising will be needed Benefits in the order of less than 1% reduction of emissions.	Precondition to have test method in place Costs of inclusion of abrasion levels on label minimal	To maximise the impacts of inclusion of tyre abrasion levels on labels, there should also be consideration of impacts for tyre lifetimes so consumers can see the potential financial benefits of buying lower abrasion tyres.
TYR#6: Regular wheel alignment to minimise tyre wear	Benefit potential depends on current situation which is not known. Maximum potential is in the order of 2%.	High total costs for checking wheel alignment at regular inspections and realigning where necessary.	Significant co-benefit is lower energy use and longer tyre life. This should increase the incentive for vehicle users. In some Member States these checks may already be mandatory.
TYR#5: Enhance monitoring of tyre pressure	It is estimated that this measure could give up to 10-20% emission reduction for an individual vehicle, but it depends on vehicle user's behaviour i.e. whether they actively follow the warning signals to inflate tyres.	System is already in place. Potentially only minor costs of calibrating the systems. Technical assessment to determine feasibility and appropriate threshold and consumer awareness raising activities.	Significant co-benefit is lower energy use and longer tyre life. This should increase the incentive vehicle users.

The impact of each measure is outlined below.

TYR#7: Road design and cleaning guidelines

What would be the costs of the measure?

The direct costs of developing guidelines for road design and road cleaning will be relatively small. The guidance could be incentivised by the EC and developed by a technical working group comprised of relevant Member States experts in road design, road cleaning and tyre abrasion.

In order for the guidance to achieve results, road authorities in the Member States would have to invest in specific technical measures. They are discussed below.

- For road design:
    - The road design elements where abrasion rate criteria could be added include, for example:
        - Choice of road surface materials (porous asphalt / rubber asphalt)
        - Road designs (use of roundabouts and traffic lights, road curvature etc.)
    - Using road surface materials which generate less abrasion is one that can be applied on most roads. It is likely that such pavements are more costly than the standards used today. Overall, it is difficult to estimate the costs as it will depend on how much of the road network where such surfaces would be applied. Applying careful identification of sections with high traffic loads and high levels of TWP emissions, the cost-effectiveness of this measure can be increased. There are examples of road surfaces that lead to more energy-efficient driving and less noise generation, where the additional investment costs are in the order of 10%[272]. The Danish example illustrates that although the surface is more expensive, the savings on energy consumption and the lower noise levels lead to a positive economic cost-benefit assessment.
    - Having abrasion rate criteria for road design is mostly relevant for new roads. Existing roads are not changed very frequently in terms of the use of different types of crossings, curvatures, etc. It is, therefore, a more long-term measure. There are no data to allow an assessment of the cost implications of including a criterion on abrasion rate in the construction or reconstruction of roads.
- Collection of road run-off
    - The costs of improving the collection and treatment of road run-off vary according to local conditions. There are many factors that make it very difficult to generalise the costs.
    - In urban areas with combined sewer systems, run-off is already collected and treated at UWWTP, albeit microplastics captured at the plant end up in the sewage sludge, which, in some Member States, is then spread on agricultural land. At heavy rain events, there may be storm-water overflows meaning the run-off is not treated and is released directly into the environment. In urban areas where run-offs are collected in a separate system, there are no additional costs of collection, but additional treatment needs to be put in place. Additional treatment can be costly to install.
    - Outside of the main urban areas, there might be varying degrees of collection and treatment. In many Member States, a collection of road run-off is installed for the most utilised roads[273] Upgrading existing collection and treatment could lead to

[272] See M. Pettinari, Bjarne Bo Lund-Jensen, B. Schmidt (2016) Low rolling resistance pavements in Denmark

[273] CEDR, 2016, Management of contaminated runoff water: current practice and future research needs

increased treatment, but the costs would vary depending on the specific local conditions.
    - In all cases, increased treatment would result in the generation of volumes of sludge with high concentrations of microplastics. There is currently no commercially available technology for removing microplastic (at least to any significant extent). It means that only the incineration of the sludge will remove the microplastics in the sludge.
- Intelligent road cleaning
    - The costs of this technical measure depend on current practices across the EU. If there is already regular road/street cleaning, then by focusing on cleaning of hotspots and aligning the timing with weather forecasts might not lead to any significant additional costs. If more frequent cleanings are required, the measure will increase the operating costs of the responsible authorities.
    - There are no data that provide an overview of the current practices in EU27, and therefore, it is difficult to estimate the costs. It would be necessary to have an estimate of the length of roads that could be considered as hotspots and costs per km of road cleaning.
    - The RIVM (2018) study has assessed the technical measure, and through a small survey of 8 municipalities in the Netherlands the study indicates that road cleaning takes place from 2 to 12 times annually. This indicates a large possible variation in current practices.

As this measure provides guidance, the actual level of implementation of the specific measures and the associated costs will depend on the uptake of the guidance by relevant Member State competent authorities.

What would be the benefits of the measure?

Given that the measure is guidance, the impacts will, as mentioned above, depend on the uptake by Member States.

Below, we discuss the possible benefits for each type of technical measure: road design, road run-off management and road cleaning.

- Road design:
    - Quantification of the benefits is challenging as there are no data on the distribution of emissions by the length of the network. The RAU study has estimated that emissions are higher at crossings and curves[274], but without more specific data, it is not possible to estimate the reduction potential. It can be noted that:
        - By considering hotspots, it might be possible to achieve cost-effective reduction
        - A full realisation of the measure will only happen in the long term. The road designs are not changed very frequently. Also, road surfaces have long lifetimes.
- Collection of road run-off
    - This technical measure will reduce the amounts of microplastic that are being washed into the freshwater environment. The total reduction potential is difficult to estimate. In principle, all the run-off in urban areas is collected. With the installation of filter systems on gullies in urban areas, at least 50% of the emissions collected by not treated

[274] TyreWareMapping

road-run off could be removed. Currently, about half the urban emissions are not treated. Installation of filters on all urban roads which are currently not subject to treatment of the run could amount to reductions in the order of 10%.

- Intelligent road cleaning
  - The RIVM 2018 study concludes that the effect is relatively low. The study estimates an effect of road cleaning in the order of 2% of the emissions being captured. The result was based on simulating a large number of cleaning events with varying efficiency. Such impacts are very localised in nature.

Economic impacts

The economic impacts depend on the use of the guidance and the level of implementation of the technical measures covered by the guidance.

- Road design:

The choice of using road surfaces that create less abrasion might initially lead to higher investment costs for road authorities. The benefits in terms of less energy consumption are gained by the road users.

The economic impacts depend on how road authorities will apply abrasion criteria and whether including such criteria will impact the costs of road construction and/or road maintenance. It might lead to higher costs, but data do not allow for the estimation of the magnitude of potential costs.

- Collection and treatment of road run-off

Increased collection and treatment of road run-off will require investment costs in collection and treatment systems. It is important to note that there are considerations on the management of stormwater in relation to the ongoing revision of the UWWT Directive. Storm-water overflows and non-treated stormwater causes pollution with a number of pollutants. Considering all the pollutants from road run-off might increase the cost-effectiveness of increased collection and treatment. However, the level of costs that would be attributable to the problem of tyre wear cannot be further assessed with significant in-depth analysis.

- Intelligent road cleaning

The economic impacts will be increased costs for road maintenance authorities. The costs will depend on current practices. In case street cleaning already takes place on a regular basis, optimisation with regards to hotspots and before major rainfall might not lead to any additional costs.

Environmental impacts

The environmental impacts depend on the use of the guidance and the level of implementation of the technical measures covered by the guidance.

- For road design

The environmental impacts will be proportional to the reduction in emissions, although they cannot be quantified.

- Collection and treatment of road run-off

Collection and treatment of road run-off will reduce the emissions reaching soils and being discharged into water bodies. The magnitude of the impacts depends on how much road run-off will be additionally collected and treated. As discussed above, the ongoing revision of the UWWT Directive might lead to changes in the management of stormwater, including road run-offs. If there are changes to the management of stormwater, it might have impacts on pollution with nutrients and micropollutants as well as microplastics.

It is important to note that currently, there is no commercially available technology to remove microplastics from the wastewater sludge to any significant extent (based on current knowledge). It means that the only method to manage the sludge so that the microplastics are permanently removed is incineration. Incineration could lead to negative air quality impacts as well as CO_2 emissions, and it is not in line with EU objectives on the circular economy.

- Intelligent road cleaning

The environmental impacts will be proportional to the reduction in emissions which are highly uncertain. Furthermore, it should be noted that if the overall level of street cleaning is increased, then it will lead to higher energy and water consumption.

Social impacts

The social impacts depend on the use of the guidance and the level of implementation of the technical measures covered by the guidance.

- For road design

The impact on human health from lower microplastic emissions will be proportional to the reductions achieved. If the use of more porous asphalt surfaces leads to less noise, it will have a positive impact on the human health of residents living nearby the roads.

- Collection and treatment of road run-off

The potential impacts on human health will be affected to the degree that the microplastic emissions are no longer released into soil or end up in water bodies.

- Intelligent road cleaning

The potential impacts on human health from less microplastic emissions will be proportional to the achieved reductions.

Illustrative example of the impacts and cost-effectiveness of collection of road runoff

An illustrative example comprises the installation of a filter at road gullies that collects the road runoff. The possible cost-effectiveness of this measure can be illustrated by estimating the costs of measures under different circumstances. It should be noted that local specific conditions can vary and the following calculations are illustrative.

Based on data from a project on improved collection and treatment of road runoff in Berlin[275], the following assumptions can be applied. The area that one gully drains is assumed to be 400 m2. The investment cost of a filter system that can retain 50% of microplastic emission is EUR 2000[276] and the lifetime of the filter system is assumed to be 20 years. The annual maintenance costs are EUR 120[277]. Based on these assumptions, the annualised investment costs can be estimated at EUR 130[278], so the total annual costs are EUR 250 per gully. The resulting costs for different road examples are illustrated below.

[275] Barjenbruch, Matthias „DSWT - Dezentrale Reinigung von Straßenabflüssen - Projekt im Berliner Umweltentlastungsprogramm UEPII/2“ / final report Berlin 2016

[276] Ibid

[277] Ibid

[278] The BR suggested discount rate is 3% and here a lifetime of 20 year is applied.

Table 32: Illustrative examples of potential costs of installation of filter systems in road gullies

Road section of 1 km	Road width(*)	Area	Number of gullies	Total annual costs in EUR
500 AADT	10 meter	10000	25	6,361
5,000 AADT	10 meter	10000	25	6,361
50,000 AADT	20 meter	20000	50	12,722
100,000 AADT	20 meter	30000	75	19,082

Source: Own calculations.

(*) The assumptions are that each lane including shoulder etc. is about 5 meter in width.

The annual amount of TWP is estimated using the standard emission rates. The filter is assumed to provide 50% efficiency, meaning the 50% of the microplastic will be retained in the filter.

To complete the illustrative example, the benefits of the gully filters installed at roads with different traffic loads has been assessed and is presented in the following table.

Table 33: Illustrative examples of potential benefits of treatment for different scenarios and overall cost-effectiveness

Road section of 1 km	TWP emission reduction in kg per year	Total costs of treatment	Cost-effectiveness
500 AADT	6,400	15	435
5,000 AADT	6,400	150	44
50,000 AADT	12,700	1,460	9
100,000 AADT	19,100	2,920	7

Source: Own calculations.

The illustrative example shows that for the busiest roads, the measure might be cost-effective. As noted, the filter system for road run-off will prevent the emission to soil and water if the sludge from the filters is managed in a safe way, for example, incinerated. The costs of filter sludge incineration are not included in the above calculation.

The above calculation indicates that it will only be cost-effective to install such a filter on the busiest urban road. There are no data on how much of the urban emissions are from such roads.

It should be noted that such filter systems are not likely to be cost-effective for rural roads. Not only are traffic volumes often low, but additional investment in collection systems will be needed.

<u>TYR#3: Modulated fees in EPR for tyres.</u>

What would be the costs of the measure?

The administrative costs would comprise:

- Setting up the organisation that should manage the EPR
- Running costs of the organisation managing the EPR

Currently, the majority of Member States (20 MSs) have set up an EPR for the end-of-life management of used tyres. These existing EPRs could be expanded to include tyre wear. Then, there would be a modulated fee where each manufacturer pays a fee differentiated by the level of abrasion. For the Member States with currently no EPR, there would be an initial cost of setting up and operating the system (noting that some of these appear to have some form of taxation in place covering end-of-life management of used tyres). For existing systems, the additional operating costs would be very limited. For new systems, the operating costs would have to be financed by the collected fee.

For all the companies placing tyres on the market, the costs would be:

- Testing of tyres in order to determine the fee (testing costs would be as defined under measure TYR#1)
- Payment of the fee

The cost burden of the importers and manufacturers will therefore primarily depend on the fee level. The fees are likely to be passed on to the consumers, so the costs will lead to price increases for the tyres, where the tyres with the highest abrasion rates will be more expensive.

The current EPR systems seem to vary with respect to organisational setup. In several Member States, there are more than one Producer Responsibility Organisation (PRO)[279]. It would therefore require further actions at the level of Member State authorities and industry to define and agree on set-up that could include tyre wear.

What would be the benefits of the measure?

The measure would provide benefits in several ways:

- Give manufacturers/importers an incentive to innovate to sell tyres with less emissions (to reduce their fee and thereby costs of the tyres)
- Give consumers an incentive to change to tyres with less tyre wear (assuming the fee would be passed on to the price of the tyre)
- Provide funding for road design and maintenance, collection and treatment of road run-off, intelligent road cleaning (see measure TYR#7) and/or other measures to capture and treat microplastic emissions from tyres.

It is not possible to quantify the total potential. Assuming the fee would be passed on the consumers and that it would be differentiated by emission rates, the measure might achieve reductions comparable with the effects of measure TYR#1 on type-approval although likely towards the lower end of the range unless fees were set very high. The likely impacts are highly uncertain and depend on the levels at which any fees are set.

The collected fees would then provide funding for the collection and treatment of road run-off, awareness-raising and/or other measures to capture and treat microplastic emissions from tyres. It is difficult to estimate how much this funding would be able to increase the collection and treatment of road run-off.

[279] See for example: Winternitz, K, Heggie, M & Baird, J 2019, 'Extended producer responsibility for waste tyres in the EU: Lessons learnt from three case studies – Belgium, Italy and the Netherlands', Waste Management, vol. 89, pp. 386-396. https://doi.org/10.1016/j.wasman.2019.04.023

Economic impacts

The economic impacts will include the costs of expanding existing EPR schemes or setting up a new EPR scheme to cover the issue of tyre wear. The collected fees will be paid by the manufacturers but will be passed on to the consumers of the tyres. How much the consumers will be impacted will depend on the level of the fee.

Environmental impacts

The environmental damages are estimated to be reduced by the same order of magnitude as the reduction of the tyre wear. Potentially, this measure might lead to reductions of around 5% (lower end of the range for TYR#1) depending on the level of the fee and how much it would be differentiated by abrasion rate of the individual tyre.

The detailed environmental impacts cannot be assessed. The tyre wear comprises different particle sizes and has different content of hazardous substances. There are no data on the detailed composition of particle size and substances in the current emissions. Therefore, the impacts of the reduction of emissions cannot be estimated (see also the discussion on the health effects).

The reduction in emissions will be proportional for all the environmental compartments. No significant impacts are expected on waste, efficient use of resources or climate change.

Social impacts

The social impacts include potential human health impacts associated with microplastic emissions. If the measure would achieve emission reductions in the order of 5-25%. As discussed in the problem definition, the emissions of tyre wear contain a large number of chemical substances with varying levels of toxicity. A study has estimated the difference in a weighted toxicity index of a factor of 4 between the most and the least toxic tyre[280]. The health impacts will therefore depend on how the limit values are defined. If they include particle size and toxicity, the health impacts could be significantly reduced. If the criteria only focus on total tear wear mass, then there is a potential risk of an increase in the negative health impacts.

TYR#1: Emission limit value for particles from tyre wear/abrasion

It should be noted that there are significant uncertainties attached to the assessment. The following factors are most important for understanding the nature of the assessment and the inherent uncertainties.

- Test methods: Currently, the test methods for tyres are under development. Before a standardised test has been developed and agreed upon, the estimated reduction potentials are based on currently applied test approaches which vary between different studies. They might therefore give different results than what will be the case when a standard test method has been implemented.
- Volumes of different tyres sold (type, model, size) and their usage (i.e. vehicle kilometres driven).
- Costs of tyres and regulatory costs: As the test is not yet agreed upon, the costs for compliance with the test requirements and type approval are not yet known. Whether compliance with the

[280] Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions

future test requirements might lead to significant additional costs cannot be estimated using current evidence and will be evaluated in detail in Euro 7. The thorough analysis that will be required for setting limits in Euro 7 will also take into account potential R&D costs in order to change the tyre formulation and design in order to comply with the new limits and expected cost increases in the tyre price by the different materials/composition.

Therefore, the estimated values are uncertain, but the assessment provides the order of magnitude estimates based on current evidence for most of the measures.

Key assumptions:

- The emissions calculation, as presented in section 5 underpins the assessment of impacts on emissions as well as costs. The estimation is based on emission factors disaggregated by type of vehicle and the total km by urban roads, rural roads and motorways.
- The distribution of the emissions by environmental compartment, as described in section 4 underpins the assessment of any changes to where the emissions are released to.
- Where costs are annualised, the relevant lifetime is included, and the discount rate is 3%[281].
- The average lifetime of a tyre is assumed to be between 5-10 years (and depends on driving styles and mileage).

The measures will affect either the emission factors by vehicle types or the distribution of emissions by environment compartment.

What would be the costs of the measure?

The implementation of the measure would include the following potential cost elements:

- Compliance costs for type approval and market surveillance
- R&D Costs for tyre manufacturers of changing their design in case their tyres fail to comply with emission limits
- Cost premium of producing compliant tyres (if applicable)

Each of these cost elements is discussed below.

The cost of the type-approval procedure is one of the cost elements to be considered for this measure. Introducing an emission limit will require a type-approval procedure for all tyres placed on the EU markets. Data from the assessment of testing of tyres on safety, noise, and energy efficiency suggest costs in the order of EUR 5 000 - 10 000 per type of tyre[282]. The Eunomia (2018) study assessed and estimated the costs of introducing a type-approval requirement. The study estimated testing costs in the order of EUR 5 000 – 10 000, but it could be up to EUR 40 000[283]. Information from the industry indicates that type approval costs would be in the order of EUR 15 000[284]. The higher value is because the test is likely to be on-the-road tests. To reflect the uncertainties in what exactly the final testing

[281] BR Tool#64 Discount factors
[282] SWD(2018) 189 final
[283] Hann, S., Sherrington, C., Jamieson, O. et al., *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*, Eunomia report for the Directorate-General for Environment, 2018.
[284] Personal communication from ETRMA, April 2022

method(s) will entail, this assessment assumes a range of EUR 5 000 - 15 000 with a mid-point of EUR 10 000.

The next step is to estimate the total costs associated with type approval and the cost impact for each tyre placed on the market. This impact depends on how many tyres are supplied for each specific type and tyre brand. Therefore, more popular tyres will be less cost impacted.

The Eunomia 2018 study found, through using different databases containing the individual tyre brands and types, that there are between 2 500 and 30 000 individual types of tyres (types and brands). Feedback provided by ETRMA[285] suggested that, on average, manufacturers renew their ranges every four years (or longer for some tyre types). ETRMA also provided a "worst case" estimate of tyres requiring type approval of around 1,700 each year. Taking this as an upper estimate and using the Eunomia lower estimate (but divided by four to derive an annual figure), the total costs of type approvals can be estimated and are presented in the table below.

Table 34: Total costs of tyre type approval costs (per year)

	Costs per type approval in EUR		
Number of tyre models (brand and type)	**5,000**	**10,000**	**15,000**
625	3 125 000	6 250 000	9 375 000
1,700	8 500 000	17 000 000	25 500 000

Source: Own calculation

According to the ETRMA database, the annual sales of tyres amounts to 325 million. Based on that the approximate cost impact per tyre sold on the market can be estimated assuming that all additional costs for type approval would be passed on to the consumer. This is done by dividing the total type approval costs by the total number of tyres sold.

Table 35: Average additional cost per individual tyre of type approval costs

	Type approval costs EUR per type of tyre		
Number of tyre models (brand and type)	5,000	10,000	15,000
625	0.01	0.02	0.03
1 700	0.03	0.05	0.08

Source: Own estimation

It means that the additional costs will vary between EUR 0.01 to EUR 0.08 per tyre. It is, in any case, a relatively low additional cost. This would amount to less than 0.1% of the price of an average tyre[286].

The introduction of type approval for tyre abrasion would require some market surveillance by the Member State authorities in order to ensure that only tyres meeting the requirements are being placed

[285] Personal communication from ETRMA, June 2022
[286] Assuming a price around EUR 100 per tyre.

on the market. Such surveillance will already be done by the Member States to check for other requirements; therefore any additional time and cost burdens are expected to be minimal.

The next cost elements to consider include:

- Costs for tyre manufacturers of changing their design in case their tyres fail to comply with emission limits
- Cost premium of producing compliant tyres (if applicable)

Manufacturers will have to ensure that all the tyres they produce comply, and that may require a redesign of certain tyres. It should be noted that the tyre industry is constantly developing tyre designs aimed at improving tyre performance based on R&D activities. The design of tyres includes balancing and optimising a large number of performance criteria. The additional costs for adjusting the tyre design to comply with the type approval specifically for abrasion are highly uncertain and cannot be quantified.

There are also no detailed statistics that can allow for an assessment of the cost difference between tyres with low or high abrasion rates, and discussions with the industry have not revealed any obvious price differentials linked to abrasion rates. The ADAC study indicates that both low and high rates of TWP are found in different price segments of the tyre market. It is, therefore, not necessarily the case that tyres with lower abrasion rates are more expensive to produce and, therefore, more expensive for the consumers. Consultation with the industry has also not identified any evidence of lower abrasion tyres costing more. Therefore, for this assessment, no additional costs are assumed for producing compliant tyres.

The last cost-related element to consider is that of a potential longer lifetime of the tyres with lower abrasion rates. There is no strict correlation between abrasion rate and lifetime (mileage of a tyre). A longer lifetime of tyres can be achieved by improving the quality of the material and adding to the thread depths and mass. It means that there could be examples of tyres where poorer material is causing the high abrasion rate but also a higher lifetime due to design characteristics. There are no data to undertake a detailed assessment of this aspect.

It is assumed the additional costs for producers to comply with a type approval regulation will be passed on to the tyre price. Savings from a longer lifetime might partially offset the additional costs of tyres, although this is highly uncertain, as discussed above.

Therefore, the costs expected for this measure are those associated with type approval which gives costs between EUR 3 and 26 million per year depending on the final costs of the test method and number of tyre models to be tested each year.

What would be the benefits of the measure?

A few studies have assessed the reduction potential of setting emissions standards that prevent the worst-performing tyres from being placed on the market. For example, a study by ADAC that tests passenger car tyres regularly has compared abrasion rates with safety performance across several different tyre models, sizes and types. They conclude that it is possible to find tyres with low emission rates and sufficient safety performance. The emission reductions from the best performing tyres to the average are about 15-30% in all the tested tyre categories (summer/winter and tyre sizes).

Table 36: ADAC tyre testing abrasion rates

Type of tyres	Average in g/1000 km	Lowest abrasion rate	% Difference
Summer tyres			
185/65/R15	95	60	37
205/55/R16	115	80	30
225/40/R118	130	110	15
Winter tyres			
185/65/R15	110	85	23
195/65/R15	140	100	28
205/55/R16	120	85	29

Source: ADAC

Another study is by Emissions Analytics 2022[287]. They have measured a sample of 13 tyres, whether the wear rate varies between 38 mg/vkm and 89 mg/vkm[288]. The average of the 13 tyres was 65 mg/vkm. The absolute values cannot be compared as the testing methods might vary. However, the study indicates that the tyres with the lowest abrasion rate are around 37% lower than the average, and the tyres with the highest abrasion rates are 33% above the average. The distribution of the total tyre sales (and their subsequent usage) by abrasion rate for both studies (ADAC and Emissions Analytics) is not known.

The estimated reduction potential will depend on the testing method. As an official testing method is still only under development, it might be that the reduction potential will turn out differently when a standard test method is finally agreed upon. Another factor is that increased focus on the abrasion rate and the potential definition of the limit values for abrasion might lead to innovation given even lower abrasion rates. There could be merit in considering phased limits which tighten over time as the manufacturers produce new, lower abrasion models.

A study by RIVM[289] has assessed the likely impacts of this measure (amongst others) on reducing emissions from tyres based on a review of available literature and traffic and vehicle statistic for the Netherlands. The study estimates a reduction potential in the order of 5-15% out of the total emissions from tyre wear.

Based on the above discussion, a range in the order of 5-25% is estimated as the reduction potential. The low end of the range is based on the above considerations on what removing the worst-performing tyres would mean on the total emissions combined with the RIVM study results. The high end of the range is based on a higher degree of ambition and would require the replacement of at least 50% of current tyre types with lower-emitting ones.

The estimated emission reductions for TYR#1 is shown in the table below. The range is estimated to be between 29,000 and 143,000 tonnes per year.

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287 Emissions Analytics 2022 Tire chemical composition and wear emissions

288 There is one value of 161 which for this assessment is excluded as it very much different from rest of the tyres.

289 A.J. Verschoor and E. de Valk, RIVM 2017, *Potential measures against microplastic emissions to water,* RIVM Report 2017-0193

Table 37: Estimated emission reductions for TYR#1 – annual emissions in tonnes

	2020	2030		
Effect of measure	Total emissions	Total emissions	Emissions with measure	Effect of measure
Low (5%)	450 000	570 000	541 500	28 500
High (25%)	450 000	570 000	427 500	142 500

Based on the estimated costs and the estimated reduction potential, the cost-effectiveness of the measure can be estimated. This is estimated to be between EUR 41 and 612 per tonne of microplastic emission reduction (depending on assumptions). There are also likely to be additional benefits in terms of a longer lifetime of lower abrasion tyres, although there is limited evidence to quantify this, and the industry has noted[290] that tyre lifetime is not just a function of tread but also overall tyre structure and integrity.

Economic impacts

The economic impacts are summarised in the table below based on the above analysis. Economic impacts are expected to be weakly negative overall, with some additional costs for manufacturers. These costs are likely to be passed on to the consumers of tyres.

[290] ETRMA, personal communication, April 2022.

Table 38: Economic impacts of TYR#1

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Importers and manufacturers of tyres	It might cost more to produce compliant tyres (although the evidence does not seem to indicate this), but the cost increase will affect all manufacturers and importers. Hence it can be passed on to the consumer prices.
Administrative burdens on businesses	-	Importers and manufacturers of tyres	The estimated cost of type-approval per tyre is in the order of EUR 5 000 to 15 000 based on the costs of different options for the testing method.
Operation / conduct of SMEs	- /0	Few SMEs would be affected	Tyre manufacturers are generally larger companies and hence, limited impacts on SMEs.
Functioning of the internal market and competition	0	Importers and manufacturers of tyres	The cost impacts are moderate and affect all importers and manufacturers of tyres. Hence the internal market and the level of competition should not be affected.
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities	This measure will only require resources in the phase of introducing the measure.
Public authorities: Change in costs to the Commission	-	European Commission and EU institutions	This measure will only require resources in the phase of introducing the measure.
Innovation and research	-/+	Manufacturers of tyres	There will be an incentive to innovate to comply with emission limits, and this might take R&D resources away from R&D in other aspects of tyre performance. Unclear whether there are trade-offs or synergies.
Third countries and international relations	+/-	Third countries	The measure will require third-country manufacturers to comply.
Consumers and household	0	Households	The potential impacts on tyre prices are uncertain but are expected to be limited.

Environmental impacts

Overall, the emission reduction is estimated in the order of 5-25% (between 28,500 to 142,500 tonnes per year) and the environmental damages are estimated to be reduced by the same order of magnitude. The detailed impacts cannot be assessed. The tyre wear comprises different particle sizes and has different content of hazardous substances. There are no data on the detailed composition of particle size and substances in the current emissions. Therefore, the impacts of emissions reduction cannot be estimated (see also the discussion on the health effects).

The reduction in emissions will be proportional to all of the environmental compartments. No significant impacts are expected on waste, efficient use of resources or climate change.

Social impacts

The social impacts primarily include human health impacts. There are two components to consider:

- Potential health impacts from reduced emissions of microplastics
- Possible impacts on road safety leading to more casualties

Overall, the emission reduction is estimated in the order of 5-25%. As discussed in the problem definition, the emissions of tyre wear contain a large number of chemical substances with varying levels of toxicity. A study has estimated the difference in a weighted toxicity index of a factor of 4 between the most and the least toxic tyre[291]. The health impacts will therefore depend on how the limit values are defined. If they include particle size and toxicity, the health impacts could be significantly reduced. If the criteria only focus on total tear wear mass, then there is a potential risk of an increase in the negative health impacts.

The safety of the tyres could potentially be compromised, but it depends on how the measure is implemented (and the level at which a limit value is set) and the choice of the consumers. However, there is a minimum standard for safety, so the introduction of a limit value for abrasion cannot lead to tyres with safety characteristics below the type-approval requirement[292]. Furthermore, the ADAC study has shown that there are already tyres on the market with low abrasion with no compromises for safety. Therefore, no reduction in safety is expected.

No impacts on employment are expected considering the relatively low-cost impacts and the fact that any additional costs would likely be passed on to the consumer.

TYR#2: Emission labelling of particles released from tyre wear

What would be the costs of the measure?

The introduction of TWP emission labelling requires – just as the measure on type-approval above – that standardised test methods have been developed. As described above under TYR#1, such a test method is being developed, and it is considered to be available (and needed) before introducing TWP labelling of tyres. Hence, the implementation of the measures would include the following costs:

- Costs for tyre manufacturers of having their tyres tested
- Cost of changing the label
- Consumer information campaigns

There will be a cost of having each type of tyre labelled. The cost of testing is assumed to be similar to the costs of type-approval described above the TYR#1(but if both measures are combined, then testing costs here would be zero as already accounted for in 4f). The cost of the testing has been estimated to be in the order of EUR 5 000 to 15 000 per type of tyre. It has been estimated to mean additional costs per tyre at a level between EUR 0.01 and 0.08 depending on how many individual tyres are produced and sold for a given type as well as the final choice of test method; see Table 128.

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[291] Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions
[292] See Type Approval Regulation (EC/661/2009) Annex B

Tyre manufacturers would not have to redesign their tyres, but the label will give an incentive to improve the design in order to achieve a better scoring on the criteria.

The final cost element is related to the modification of the label to include the abrasion rate. Eunomia (2018) concludes that the costs of modifying the label will be marginal when compared to the price of each tyre sold on the market. The Commission's Staff Working Document accompanying the proposed revision of the Tyre Labelling Directive provides some estimates of the costs to manufacturers of revising the existing labels[293]. This assumes a one-off cost of EUR 40 million for the readjustment of label classes and reprinting labels. The costs for incorporating abrasion classes / levels in the label have been assumed to be similar to this.

In addition, it is assumed that some level of consumer information campaigns would be delivered to maximise the benefits of the measure and ensure that consumers understand what the labels are showing. Based again on the estimates developed for the revision of the Tyre Labelling Directive, this is assumed to be a one-off cost of around EUR 12 million.

Therefore, the total costs associated with the measure (excluding type approval which is included within 4f) are around EUR 52 million (one-off) equating to around EUR 6 million per year when annualised over 10 years.

For the motorist, the measure will not lead to additional costs as it will still be possible to purchase any tyres (although it is likely that manufacturers would pass on the above costs in tyre prices). If the label includes the mileage of the tyre, the consumer will be able to see whether a low abrasion tyre would also be the better choice from a financial perspective.

What would be the benefits of the measure?

The effect of a label depends on how the consumers will react, which is difficult to assess. The level of information that is provided will affect the impacts of the label e.g. whether consumer awareness information campaigns are launched.

Eunomia (2018) has assessed the uptake and effect of introducing a TWP label. The study refers to the observed effects of the labels on energy efficiency and wet grip, where the annual changes have been in the order of 1% improvement for energy efficiency (in total across all tyres due to changes in consumer purchase behaviour). While energy efficiency improvements have a financial implication for vehicle users and wet grip has a safety aspect, tyre abrasion is much more abstract for the consumer (unless a clear link to tyre lifetime / durability could be established and communicated). Therefore, the reduction potential of the label is estimated to be much lower, between 0.1-0.2% annual improvement on overall tyre microplastic emissions, which, if introduced in 2025, could give a total reduction of 0.5-1% in 2030.

Table 128: Estimated emission reductions for TYR#2

	2022	2030		
Effect of measure	Total emissions	Total emissions	Emissions with measure	Effect of measure
Low (0.5%)	450 000	570 000	567 150	2 850
High (1%)	450 000	570 000	564 300	5 700

293 Available from : https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1460-Evaluation-and-potential-revision-of-the-EU-tyre-labelling-scheme_en

The costs-effectiveness of the measure is estimated in the order of EUR 1 100-2 100 per tonne reduced emissions of TWP.

Economic impacts

The main economic impact is the costs of having all type of tyres tested to determine the label rating. While the testing costs might turn out differently from what is the current estimate when the final testing method has been developed and agreed, it is unlikely to be of a different order of magnitude. These costs are described and included under TYR#1. Costs for changing the label and information campaigns are expected to be around EUR 6 million per year.

The testing and label cost will firstly be borne by the manufacturers/retailers but is then expected to be passed on to the consumer in the price of the tyre. For the consumers, it means a marginal increase in the price of the tyre. Therefore, it is not expected to have any significant impacts on consumers. Costs for information campaigns are expected to fall to the Member States and Commission.

It may be most effective to consider including the abrasion rate alongside impacts on tyre lifetime as lower abrasion rates may equate to an increase in tyre lifetime, thus saving consumers money. This is considered to be a much greater driver for consumer purchasing than microplastic emissions[294]. The effect of a label depends on how the consumers will react, which is difficult to assess. The level of information that is provided will affect the impacts of the label e.g. whether consumer awareness information campaigns are launched.

Eunomia (2018) has assessed the uptake and effect of introducing a TWP label. The study refers to the observed effects of the labels on energy efficiency and wet grip, where the annual changes have been in the order of 1% improvement for energy efficiency (in total across all tyres due to changes in consumer purchase behaviour). While energy efficiency improvements have a financial implication for the vehicle users and wet grip has a safety aspect, tyre abrasion is much more abstract for the consumer (unless a clear link to tyre lifetime / durability could be established and communicated). Therefore, the reduction potential of the label is estimated to be much lower, between 0.1-0.2% annual improvement on overall tyre microplastic emissions, which, if introduced in 2025, could give a total reduction of 0.5-1% in 2030.

Impacts on other economic impact categories are expected to be similar as for TYR#1.

Environmental impacts

Overall, the emission reduction is estimated to be in the order of less than 1% and the environmental damages are estimated to be reduced by the same order of magnitude. The detailed environmental impacts cannot be assessed. The tyre wear comprises different particle sizes and has different content of hazardous substances. There are no data on the detailed composition of particle size and substances in the current emissions. Therefore, the impacts of the reduction of emissions cannot be estimated (see also the discussion on the health effects).

The reduction in emissions will be proportional for all of the environmental compartments. No significant impacts are expected on waste, efficient use of resources or climate change.

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294 https://ec.europa.eu/info/sites/default/files/energy_climate_change_environment/overall_targets/documents/tyre-label_final-report_0.pdf

Social impacts

The social impacts primarily include potential human health impacts. There are two components to consider:

- Potential health impacts from reduced emissions of microplastics
- Possible impacts on road safety leading to more casualties

Overall, the emission reduction is estimated to be in the order of less than 1%. As discussed in the problem definition, the emissions of tyre wear contain a large number of chemical substances with varying levels of toxicity. A study has estimated the difference in a weighted toxicity index of a factor of 4 between the most and the least toxic tyre[295]. The health impacts will therefore depend on how the limit values are defined. If they include particle size and toxicity, the health impacts could be significantly reduced. If the criteria only focus on total tear wear mass, then there is a potential risk of an increase in the negative health impacts.

The safety of the tyres could potentially be compromised, but it is not likely. There are minimum standards for safety, so the introduction of a label for abrasion rate cannot lead to tyres the safety characteristics below the type-approval requirement[296]. It is not likely that consumers will be more inclined to buy tyres where the safety performance is low if a tyre abrasion rate label would be introduced. Therefore, no reduction in safety is expected.

No impacts on employment are expected considering the relatively low-cost impacts and the fact that any additional costs would likely be passed on to the consumer.

TYR#6: Regular wheel alignment to minimise tyre wear

What would be the costs of the measure?

The costs of this measure relate to ensuring the wheels are aligned as part of the regular vehicle roadworthiness inspection. Some Member States seem to have this included as a mandatory requirement as part of regular vehicle inspections (at least France, Ireland and Spain[297]) although there is very limited data on the national practices across all of the EU27 for this particular check and therefore, it is difficult to estimate the costs (so costs and benefits presented below may be overestimates if more Member States already require such checks). Furthermore, the share of cars which may have wheels / axis that are not aligned is not known. RIVM (2017) refers to studies that suggest that potentially a large share of cars needs this adjustment. The estimate for the Netherlands is that it could affect between 20% to 40% of the total car stock. They estimate that the level of abrasion could be around 10% higher for vehicles with poor alignment. It means that if these estimates would apply to the EU27, the total reduction potential would be between 2% - 4% (in practice it is lower as some Member States already require such checks).

To assess the cost-effectiveness of this measure, the following assumptions have been used. The cost of testing for the alignment would be in the order of EUR 20 and in case the axis would need adjustment that would cost around EUR 40[298]. It is assumed that 30% of the inspected cars and vans needs the adjustment every 4 years. This gives a total cost of around EUR 1.2 billion per year

[295] Emission Analytics / PEW report (2022) - Research report - Tire chemical composition and wear emissions
[296] See Type Approval Regulation (EC/661/2009) Annex B
[297] Personal communication from the International Motor Vehicle Inspection Committee (CITA), July 2022.
[298] Expert estimates based on information from car repair shops

assuming all Member States apply the measure (except for France, Ireland and Spain who already require such checks).

The alignment of wheels would also have an impact on the energy use of the car or van. The RIVM (2017) study suggests that it is in the same order as for abrasion rates i.e. 10%. Assuming that 30% of existing cars and vans would need adjustment, this would give a potential fuel saving for the fleet of around 1.6% (as new cars and vans are excluded). This equates to a financial saving of around EUR 1.5 billion per year[299]. The potential saving for tyre costs is highly uncertain so has not been quantified but would increase the cost savings further.

Total estimated costs and cost savings are presented in the table below.

Table 39: Estimated total costs and cost savings for TYR#6 in 2030 (million Euros)

Cost element	One-off costs	Recurring costs	Total annualised costs
Testing and alignment costs	0	1,176	1,176
Fuel savings	0	-1 526	-1 526
Total costs	**0**	**-350**	**-350**

Overall there is expected to be a net cost saving associated with this measure due to the potential fuel savings that may be realised. These equate to a cost-effectiveness of EUR -28 900 to -57 700 per tonne of microplastics reduced i.e. a saving overall. If fuel savings are excluded, then the cost-effectiveness is EUR 96 400 to 193 700 per tonne of microplastics reduced.

What would be the benefits of the measure?

Based on RIVM (2017) the emission reductions per car or van which is subject to an adjustment of misaligned wheel would be around 10%. Assuming that the vehicle drives 12 000 km per year, the savings can be estimated to be around 0.12 kg per car.

As discussed above, the RIVM also estimated the share of vehicles with misalignment to be between 20 and 40%. This leads to annual emission reduction of 2% to 4% for cars and vans and 1.1% to 2.1% for the fleet overall (taking into account that some Member States already require such checks).

Table 40: Estimated emission reductions for TYR#6

	2022	2030		
Effect of measure	Total emissions	Total emissions	Emissions with measure	Effect of measure
1.1% reduction	450,000	570,000	563,928	6,072
2.1% reduction	450 000	570 000	557 856	12,144

299 Based on vehicle kilometre data from Eurostat, average fuel economy figures from the IEA Fuel Economy in the European Union analysis and average fuel costs from the EEA (available from https://www.eea.europa.eu/data-and-maps/daviz/nominal-and-real-fuel-prices-6#tab-chart_1).

In addition to the reductions in microplastic emissions, improvements in fuel efficiency, discussed above, could also lead to a reduction in CO_2 emissions of around 6,610 kt in 2030. The CO_2 savings can also be valued and equate to around EUR 661 million per year[300]. There would also be benefits for the reduction of exhaust emissions of air pollutants (for ICEVs).

Economic impacts

The main direct economic impacts would be the costs for motorists to have the wheel alignment checked at the roadworthiness inspection and the alignment adjusted where needed. The inspection is mandatory when the car is four years old and then at least every four years[301]. The additional costs at the inspection could be around EUR 20 every four years. For those where adjustment would be needed, there would be another EUR 40 to be paid. Total costs would be in the order of EUR 1.2 billion in annual costs.

A side-effect of wheel alignment is reduced energy consumption and lower tyres costs due to longer lifetimes. These will lead to cost savings for the motorists. As described above, these have been estimated to be in the order of EUR 1.5 billion per year due to fuel savings, although these are highly uncertain due to limited evidence on the proportion of vehicles that operate with misaligned tyres.

Environmental impacts

Based on the RIVM (2017) study, the reduction potential could be estimated in the order of 1.1% to 2.1% for the fleet overall (taking into account that some Member States already require such checks). If testing of alignment is already mandatory in more Member States than those identified, the potential would be less. The environmental damages would be reduced by the same order of magnitude (as would costs).

The reduction in emissions will be proportional for all the environmental compartments. The measure would also reduce energy consumption. It means a positive impact on climate change as in 2030 a significant share of passenger cars would still be with internal combustion engines. Reductions in CO_2 emissions of around 6,610 kt may be realised in 2030.

No significant impacts are expected on waste.

Social impacts

The social impacts include potential human health impacts. Overall, the emission reduction is estimated in the order of 1.1% to 2.1% for the fleet overall (taking into account that some Member States already require such checks). Any potential health impacts are estimated to be reduced by the same order of magnitude.

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300 Based on average fleet emission factors from EEA analysis and expectations for the future (https://www.eea.europa.eu/ims/co2-performance-of-new-passenger). The avoided CO2 cost is based on the Update of the External Costs of Transport, with a central value for the short-and-medium-run costs (up to 2030) of EUR 100/tCO2 equivalent for external costs of climate change (https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1)

301 There are Member States with more frequent inspections.

TYR#5: Enhanced monitoring of tyre pressure

What would be the costs of the measure?

Tyre Pressure Monitoring Systems (TPMS) are already required on new cars and vans (and have been since 2014), and will be in the future for trucks. This measure includes two elements:

- Change the calibration of the systems for new vehicles being placed on the market so that it gives a warning with smaller deviations from the optimal pressure levels (exact threshold to be determined based on a more in-depth technical assessment).
- Information campaigns to make all motorists aware of the importance of having the right pressure (as it has several benefits).

Changing the systems to provide a warning at a lower threshold is not expected to entail any significant costs for new cars and vans. However, an in-depth technical assessment would need to be undertaken at an EU level to determine the feasibility of changing the threshold considering the uncertainties associated with the existing systems. Both indirect and direct systems are currently applied across the EU and the uncertainties associated with the systems differ. Engagement with relevant stakeholders has not identified any clear evidence on whether or not it is feasible to tighten the current threshold so further investigations are necessary. Furthermore, if deemed feasible to tighten the thresholds, then such an assessment would need to consider the optimal level at which the thresholds should be set taking into account levels of tyre abrasion, the sensitivity and accuracy of the systems and likely driver behavioural response. This has been assumed as a one-off cost of EUR 1 million.

The main effect will only be achieved if motorists are aware of the importance of having the correct pressure. Therefore, information campaigns would be useful to actually achieve the desired effects. Such campaigns can differ in scope and scale of effort, and with more effort, more impacts are expected to be achieved. Assuming the campaign would cost in the order of EUR 0.8 million per Member State[302], the total costs would be around EUR 22 million one-off costs for a campaign across the EU. If such campaigns could be done at EU level or based on material produced for all Member States, it might be possible to reduce the costs.

By having the right pressure, energy consumption will also decrease and the lifetime of the tyres would increase. It means that motorists that frequently drive with tyres at low pressure will save on fuel and tyre costs if they make sure to regularly fill tyres with air. Fuel consumption is estimated to increase by 1% every 2,9 psi / 0.2 bar the tyre is under-inflated[303]. Current TPMS systems should alert the driver when the pressure drops by 20%[304]. If we assume that the system would be changed to alert the driver when tyre pressure drops by 10% instead (actual figure to be determined via an in-depth technical assessment) and the average car tyre has a recommended pressure between 2 and 2.2 bars (when cold)[305] then the impact (benefit) on fuel consumption could be around 1%.

However, this is based on the assumption that all drivers would refill their tyres when the warning shows. Recent surveys have shown that with the current systems (which are much less sensitive than

302 Data from Danish Road Safety organisation that runs multiple campaigns indicating that the average costs of a campaign is 6 million DKK. (https://www.ft.dk/samling/20191/almdel/TRU/bilag/418/2218983/index.htm)
303 https://unece.org/DAM/trans/doc/2007/wp29grrf/ECE-TRANS-WP29-GRRF-62-inf17e.pdf
304 https://op.europa.eu/en/publication-detail/-/publication/e96ed45b-d8a8-11e8-afb3-01aa75ed71a1
305 Review of selected tyres available on the market.

they would be under this measure) some drivers still ignore such warnings[306]. TNO (2013)[307] considered a low and high response scenario, with the latter assuming the user always responds to TPMS warnings and the former around half respond. The high response scenario is not considered realistic here; therefore, a range of 50-75% of users responding to TPMS alerts has been assumed.

Considering the introduction of the measure in 2025 and around 25% of cars and vans in 2030 having such a system, this would give a potential fuel saving for the fleet of around 0.1-0.2%. This equates to a financial saving of around EUR 124 to 210 million per year[308]. The potential saving for tyre costs is highly uncertain, so it has not been quantified but would increase the cost savings further.

Total estimated costs and cost savings are presented in the table below.

Table 41: Estimated total costs and cost savings for TYR#5 in 2030 (million Euros)

Cost element	One-off costs	Recurring costs	Total annualised costs
Technical assessment	1.0	0.0	0.1
Information campaigns	21.6	0.0	7.6
Fuel savings (low)	0.0	-124.4	-124.4
Fuel savings (high)	0.0	-210.7	-210.7
Total costs (low)	**22.6**	**-124.4**	**-116.7**
Total costs (high)	**22.6**	**-210.7**	**-203.0**

Overall there is expected to be a net cost saving associated with this measure due to the potential fuel savings that may be realised. These equate to a cost-effectiveness of EUR -7,470 to -39,130per tonne of microplastics reduced, i.e. a saving overall. If fuel savings are excluded, then the cost-effectiveness is EUR 500 to 1500 per tonne of microplastics reduced.

What would be the benefits of the measure?

The effect of the measures is difficult to estimate as the share of cars and vans driving with tyres with sub-optimal tyre pressure is not known. RIVM (2017) refers to older data on the share of both heavy-duty vehicles and cars, indicating that a large share of vehicles is operated with tyres with sub-optimal pressure. The RAU project (see Figure 4) suggests that the effect of the tyre pressure on microplastic emissions is 30-40%, but it is unclear how low the pressure should be before such an effect materialises. RIVM (2017) estimates that the reduction potential could be 10-20%, but the uptake by the motorist is key for achieving the full potential.

Here is assumed that, in combination with information campaigns, the measure can achieve around a 10-20% reduction in microplastic emissions, which, when combined with the share of cars and vans expected to have the new threshold applied by 2030 (25%) and an assumption that 50-75% of users respond to TPMS alerts, gives a total microplastic reduction of around 0.9-2.7%.

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306 https://www.transportenvironment.org/wp-content/uploads/2021/07/Report%20-%20EU%20drivers%20at%20risk%20of%20under-inflated%20tyres.pdf
307 https://ec.europa.eu/clima/system/files/2017-03/tno_2013_final_report_en.pdf
308 Based on vehicle kilometre data from Eurostat, average fuel economy figures from the IEA Fuel Economy in the European Union analysis and average fuel costs from the EEA (available from https://www.eea.europa.eu/data-and-maps/daviz/nominal-and-real-fuel-prices-6#tab-chart_1).

Table 42: Estimated emission reductions for TYR#5

	2022	2030		
Effect of measure	Total emissions	Total emissions	Emissions with measure	Effect of measure
0.9% reduction	450 000	570 000	564 813	5 187
2.7% reduction	450 000	570 000	554 382	15 618

In addition to the reductions in microplastic emissions, improvements in fuel efficiency, discussed above, could also lead to a reduction in CO_2 emissions of around 540 to 910 kt in 2030. The CO_2 savings can also be valued and equate to around EUR 54 to 91 million per year[309]. There would also be benefits for the reduction of exhaust emissions of air pollutants (for ICEVs).

Economic impacts

The main direct economic impacts will be the costs of undertaking an in-depth technical assessment to determine the optimal level at which the systems should be set (assumed as a one-off cost of EUR 1 million) and the costs for undertaking information campaigns to raise awareness amongst consumers (assumed to be around EUR 22 million one-off costs for a campaign across the EU). Changing the systems to provide warning at a lower threshold is not expected to entail any significant costs for new cars and vans.

Having the optimal level of tyre pressure will reduce energy consumption and lead to a longer lifetime of the tyres. These will lead to cost savings for motorists. As described above, these have been estimated to be in the order of EUR 124 to 210 million per year due to fuel savings, although these are highly uncertain and depend on the reaction of the consumer to a more sensitive TPMS.

Environmental impacts

Overall, the emission reduction is estimated in the order of 0.9-2.7% in 2030 (increasing in future years as more vehicles have the new threshold applied) and the environmental damages are estimated to be reduced by the same order of magnitude.

The reduction in emissions will be proportional for all the environmental compartments. The measure would also reduce energy consumption. It means a positive impact on climate change as in 2030 a significant share of passenger cars would still be with internal combustion engines. Reductions in CO_2 emissions of around 540 to 910 kt may be realised in 2030 depending on consumer behaviour.

No significant impacts are expected on waste.

[309] Based on average fleet emission factors from EEA analysis and expectations for the future (https://www.eea.europa.eu/ims/co2-performance-of-new-passenger). The avoided CO2 cost is based on the Update of the External Costs of Transport, with a central value for the short-and-medium-run costs (up to 2030) of EUR100/tCO2 equivalent for external costs of climate change (https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1)

Social impacts

The social impacts include potential human health impacts from reduced emissions of microplastics. Overall, the emission reduction is estimated in the order of 0.9-2.7% in 2030, and any potential health impacts are estimated to be reduced by the same order of magnitude.

Having the correct tyre pressure may also have marginal impacts (benefits) on safety and noise, but they cannot be further quantified.

7.3 Impact of measures for textiles

Table 43 shows the comparison between all measures evaluated to reduce microplastic emissions from textiles.

Table 43: Comparison of measures for textiles

Measure	**Estimated reduction potential**		**Estimated Cost-effectiveness (EUR/tons reduced/year)**	**Other environmental impacts**	**Other economic impacts**	**Social impacts**
	%	**Ktons/ year**				
TEX#8: Raising awareness on best practices for consumers of textiles		Not quantified small				
TEX#9: Mandatory label showing textiles' emissions of microplastics		Not quantified small	> 411 000		Costs are likely to be passed on to consumers	
TEX#7: Modulated fees in EPR for textiles				Not quantified		Costs are likely to be passed on to consumers in higher prices.
TEX#2): Restrict oil-based synthetic fibres for certain applications		26 353 (1 420 – 51 285)	202 000 €/t (103 000 – 3 747 000 €/t)	Negative impact on water consumption & biodiversity Reduction of microplastic pollution in marine environment, air and soil	Costs are likely to be passed on to consumers in higher prices	

Measure	Estimated reduction potential		Estimated Cost-effectiveness (EUR/tons reduced/year)	Other environmental impacts	Other economic impacts	Social impacts
	%	Ktons/ year				
TEX#3: Restrict synthetic fibres & fabrics with high releases of microplastics	28 %	17 168 (923 – 33 412)	176 000 (90 000 – 3 265 000)	Negative impact on water consumption and biodiversity Reduction of microplastic pollution in marine environment, air & soil	Costs are likely to be passed on to consumers in higher prices	
TEX#4: Mandatory prewashing of textiles before placing on the market		854 (96 – 1 613)	1 802 000 (955 000 – 16 102 085)			
TEX#5: Specific wastewater treatment in textile production plants	8%	4 024 (287 – 7 760)	143 000 (74 000 – 2 000 000)	Negative impact on water consumption and CO2 emissions Reduction of microplastic pollution in marine environment, air and soil	Costs are likely to be passed on to consumers in higher prices	
TEX#6: Compulsory filters for washing machines	5%	3 087 (635 – 5539)	2 627 000 (1 464 000 – 12 764 000)	Negative impact on water consumption and CO2 emissions Reduction of microplastic pollution in marine environment	Costs are likely to be passed on to consumers in higher prices	
TEX#1: Standardised methodology to quantify microplastics releases from textiles						

Table 44Table 44 shows the comparison of the impacts of the measures assessed to reduce microplastic emissions from textiles.

Table 44: Summary of impacts for measures for textiles

Policy measure	Environmental impact	Economic impact	Social impact
TEX#8: Raising awareness on best practices for consumers of textiles	The communication campaign will raise awareness about microplastic releases, but it is uncertain how and if it will influence the consumer decision about purchases and washing/drying practices.	Cost estimated to be EUR 449 million per year; it will depend on the level of ambition of the communication campaign.	Job creation in the communication sector
TEX#9: Mandatory label showing textiles' emissions of microplastics	Reduction of microplastic releases if the label would influence the consumer purchase decision in favour of textiles releasing less microplastics.	Between 1.41 and 1.72 billion euros per year, depending mainly on the testing costs. Increase in costs for consumers (EUR 0.06) per clothing put on the market) as the producers might pass it on.	Job creation in labelling and certification companies
TEX#7: Modulated fees in EPR for textiles	Tool to combine with other measures	EPR cost (PRO, MS, companies): The additional cost of this measure might be relatively low since will it only add the inclusion microplastics in the criteria for modulation of textile fees. SMEs Public authorities	Consumers and households
TEX#2: Restrict synthetic fibres for certain applications	Microplastic release reduction (26 353 t/year) Environment (climate change)	Total cost (5.3 billion EUR/year)	Consumers and households
TEX#3: Restrict synthetic fibres & fabrics with high releases of microplastics	Microplastic release reduction (17 168 t/year) Environment (water, biodiversity)	Material cost (3 billion EUR/year) SMEs Public authorities (only short-term) Third countries	Consumers and households

Policy measure	Environmental impact	Economic impact	Social impact
TEX#4: Mandatory prewashing of textiles before placing on the market	Microplastic release reduction (854 t/year) Environment (water, climate change)	CAPEX (washing and drying machines) OPEX (water, energy, detergent, labour) Total cost (1.54 billion EUR/year) SMEs Public authorities Third countries	Consumers and households
TEX#5: Specific wastewater treatment in textile production plants	Microplastic release reduction (4 024 t/year) Environment (water quality, climate change)	CAPEX OPEX (energy) Total cost (594 million EUR/year) SMEs Public authorities Third countries	Consumers and households
TEX#6: Compulsory filters for washing machines	Microplastic release reduction (3 087 t/year) Environment (water, climate change)	CAPEX (filters) OPEX (water and energy) Total cost (8.1 billion EUR/year) Public authorities (only short-term) Already in place France (applicable from 2025)	Consumers and households
TEX#1: Standardised methodology to quantify microplastics releases from textiles	No emission reduction per se but helpful in other measures and knowledge improvement	Administrative cost (expert group and companies): 0.85 million EUR/year Cost of testing the materials between EUR 10 000 and 20 000	There could be new jobs in the R&D sector (private company or research organisations) unless developed by the existing research staff

The impact of each measure is outlined below.

TEX#8: Raising awareness on best practices for consumers of textiles

What would be the costs of the measure?

The cost will be the labour cost to run the communication campaign in the EU.

What would be the benefits of the measure?

The benefit would mainly be raising consumer awareness and may lead to a small reduction of microplastic releases.

Economic impacts

The table below details the data about the administrative cost of the communication campaign.

Table 45: Data to estimate the communication campaign administrative cost

Description	Data	Unit	Source
Days of work to communicate in the EU	1 350	days	Assumption based on expert judgement
Overheads	11	%	Assumption based on expert judgement
Average hourly labour cost in the "Information and communication" sector (EU 27)	39.40	EUR/hour	Eurostat (2020)
Average EU number of working hours per day	8.12	hours/day	

Considering an average of 50 days of work for each Member State in the EU27, the total cost of a communication campaign would be around EUR 449 000 per year. These campaigns could also take place at the Member-State level and be financed by the EPR schemes.

The cost will depend on the level of ambition of the communication campaign. In comparison with other measures, the cost would always be low.

Environmental impacts

The communication campaign will raise awareness about microplastic releases, but it is uncertain how and if it will influence the consumer decision about purchases and washing/drying practices. Research[310] shows that price is the most influencing factor in consumer purchasing decisions. However, according to the Eurobarometer survey[311], more than half of respondents think that educating people on how to reduce their plastic waste is very important (58%). It is expected that the emission reduction potential of this measures is rather low.

Social impacts

No significant social impacts are expected.

<u>TEX#9: Mandatory label showing textiles' emissions of microplastics</u>

What would be the costs of the measure?

The cost of a mandatory label is composed *measure* of three parts:

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[310] For example: Sanad, R. A. (2016). Consumer attitude and purchase decision towards textiles and apparel products. World, 2(2016), 16-30.

[311] Attitudes of European citizens towards the Environment (Eurobarometer 2019).

- Tests
- Audits
- Label

The tests and audits cost to apply to each textile collection while the label to each piece of textile.

This measure will only require the resources of public authorities in the phase of introducing the measure. SMEs will be affected as textile production is not limited to larger companies. The measure will require third-country companies to comply with placing textiles on the EU market. Consumers and households will be affected by this measure as they will likely support the cost of the label.

What would be the benefits of the measure?

The benefits would be a reduction of microplastic releases if the label would influence the consumer purchase decision in favour of textiles releasing less microplastics. Brands would also feel the need to reduce releases in order to improve their rating in terms of microplastic releases and this would have impacts along the textiles value chain.

Economic impacts

Table 46: Assumptions to estimate the costs of a mandatory label

Description	Data	Unit	Source
Total cost of the tests	660	EUR per collection	Assumption based on Bureau Veritas prices in ADEME (2020), Définition de critères d'éco-modulation applicables à la filière REP TLC[312].
	1 440	EUR per collection	
Audit cost for a label	1 700	EUR per collection	EU Ecolabel
	2 000	EUR per collection	EU Ecolabel
Labelling cost (just the label)	0.03	EUR/ pieces	Bilateral discussion with industry.
Administrative cost	11%	%	Assumption based on expert judgement
Number of collections put on the market in the EU	25 157 780 000	pieces	JRC, Environmental Improvement Potential of textiles (IMPRO Textiles), January 2014.
Average number of pieces per collection	100 000	pieces per collection	ADEME (2020), Définition de critères d'éco-modulation applicables à la filière REP TLC[313]

The total average cost of the label is around EUR 1.56 billion per year. The cost range varies between EUR 1.41 and 1.72 billion per year, depending mainly on the uncertainty of the test costs.

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312 https://librairie.ademe.fr/dechets-economie-circulaire/4561-definition-de-criteres-d-eco-modulation-applicables-a-la-filiere-rep-tlc.html

313 https://librairie.ademe.fr/dechets-economie-circulaire/4561-definition-de-criteres-d-eco-modulation-applicables-a-la-filiere-rep-tlc.html

By assuming that the higher bound consumption change would be that 10 % of the population would change their purchase behaviour and therefore reduce the total microplastic releases from textiles by 10 %, even without taking the additional material cost into account, it would correspond to an average cost of 411 000 EUR/t of avoided microplastics.

If the measure TEX#9 "Mandatory microplastic label for textile" is combined with the variation of measure "TEX#1 Create a standardized measure to quantify microplastics emissions on the life-cycle", the cost would be reduced from EUR 1.56 billion per year to EUR 795 million per year. This is due to the fact that the variation of TEX#1 already implies the existence of a standard and respective testing costs.

Environmental impacts

The label will raise awareness about microplastic releases but is it uncertain if the label will influence the consumer decision. Research[314] shows that price is the most influencing factor in consumer purchase decisions. Also, brands would be incentivised to reduce releases to improve their rating and promote their image as sustainable producers.

Assuming that the higher bound consumption change would be that 10 % of the population would change their purchase behaviour and therefore reduce the total microplastic releases from textiles by 10 %, the average microplastic releases reduction would be 3 808 t per year. However, if the switch happens to natural fibres, other impacts (see other measure TEX#2) would increase, in particular, related to land use and biodiversity.

Social impacts

The consumer would bear the label cost in the end. The average label cost per piece of textile put on the EU market is EUR 0.06.

<u>TEX#7: Modulated fees in EPR for textiles</u>

What would be the costs of the measure?

An EPR leads to an administrative cost for several actors:

- Producer responsibility organisations (PROs)
- Companies
- Member States

The EPR would lead to the use of resources for public authorities and to an administrative burden for companies (including SMEs). The consumer will likely support the cost of the EPR system.

What would be the benefits of the measure?

The benefits depend heavily on how the microplastic component of the EPR is implemented.

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[314] For example: Sanad, R. A. (2016). Consumer attitude and purchase decision towards textiles and apparel products. World, 2(2016), 16-30.

The EPR could reduce microplastic releases if the modulated fees provided incentives for companies to reduce microplastic releases and if the EPR fees financed microplastic releases reduction measures.

Economic impacts

The table below details the data for the EPR administrative cost.

Table 47: Data to estimate the EPR administrative cost

Description	Data	Unit	Year	Source
Entities placing on the market				
Number of marketers in the EU – textiles	160 000		2020	Euratex
Number of marketers in the EU - washing machines	27			Gifam
One time shot to organise EPR - companies	0.001	FTE	-	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
Annual FTE for EPR - companies	0.001	FTE	2000	Fost plus study2
Overheads for the companies, EPR	11%		2021	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
PROs				
Number of FTE for the EPR	183	FTE	2021	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
One shot consultancy cost to organise the EPR	1 235 000	EUR		Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
Number of days for financial audit per PROs and of the quality of the declaration and statistics of the PRO members	50	days/ year	-	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
Member State				
Number of days per Member State to control for EPR	20	days/ year	-	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)
General				
Average annual EU FTE admin cost	52 309	EUR/ FTE	2021	Eurostat
Average annual EU FTE financial and insurance activities	82 430	EUR/ FTE	2021	Eurostat

Description	Data	Unit	Year	Source
Average EU number of working hours per day	7.98	h/day	2021	Eurostat
Average EU number of working days per year	230	Days /year	2000	Fost plus study[315]
Amortisation of the one-shot cost	20	years	-	Feasibility of an EPR system for micro-pollutants (070201/2020/837586/SFRA/ENV.C.2)

The total administrative cost of an EPR for textiles would be around EUR 21.1 million per year. PROs and companies would bear most of the cost; respectively EUR 11.2 and 9.8 million per year. The share of the costs of the Members States would be EUR 0.14 million per year. However, this measure is not about setting up a new EPR, but including microplastics in an existing one. To include a cost component, we have estimated that taken into account microplastics would cost 5% of the total cost for the EPR, thus a set up cost of around EUR 1 million. Currently, there is already an EPR for textiles in France. An EPR for textiles is expected in the following years in the Netherlands and Sweden. The cost of the measure could therefore be a bit lower, but it would not change the impact calculations, and the cost of this measure is negligible compared to most of the other measures.

The EU Strategy for Sustainable and Circular Textiles includes proposing of an EU wide EPR with modulated fees. This will be established in the revision of the Waste Framework Directive and evaluated in the respective IA. Therefore the additional cost of this measure might be relatively low since it will only add the inclusion microplastics in the criteria for modulation of textile fees.

Environmental impacts

The environmental impact depends heavily on the way the microplastic release component is included in the EPR. The eco-modulated fee could provide incentives for microplastics reduction and/or the impact of another measure that the EPR would finance.

The environmental impacts are difficult to be estimated, as they will depend on the level of the modulated fees. If textiles with high emissions have higher fees, microplastics emission of those would decrease. In measure TEX#2, we analyse a restriction of synthetic fibers. A modulated fee will always have a much lesser effect than such a total ban (restriction). Supposing a perfect price elasticity, we can assume that cost efficiency would be similar, but the order of magnitude of the reduction much lower and the measure more proportionate.

Fees could be used to improve technology and wastewater treatment. While technology improvement can have a significant effect over the medium to long term, it is to be expected that the level of the fees will be too low to have an important improvement in microplastic capture in wastewater.

Social impacts

No significant social impacts are expected for the administrative costs.

[315] RDC Environment, Emploi et investissements liés aux activités de collecte sélective, tri et recyclage des projets FOST PLUS, 2000

The cost of the EPR system will likely be supported by the consumer, but the administrative cost is very limited (on average less than EUR 0.001 per piece of textile).

TEX#2: Restrict synthetic fibres for certain applications

What would be the costs of the measure?

The economic cost is the cost difference of the switch of fibres (cotton, wool, flax, viscose, polyester, acrylic, polyamide, polypropylene).

When comparing the production costs of textiles made from the different fibres, the significant difference comes from the prices of these fibres. The change in production process is not considered significant for the total cost[316] but investments may be required in some cases.

This measure will only require resources of public authorities in the phase of introducing the measure. SMEs will be affected as textile production is not limited to larger companies. The measure will require third country manufacturers to comply when placing textiles on the EU market.

What would be the benefits of the measure?

This measure acts on the emission of microplastics during production, wearing, washing and drying according to the proportion of synthetic materials in clothing.

Economic impacts

The costs associated with the foregone synthetic fibres were compared to those associated with the additional natural fibres, and the total cost of the measure was computed.

Table 48: Prices of fibres

Fibre	Data	Unit[317]	Source
cotton	2.59	EUR/kg	IndexMundi
wool	10.75	EUR/kg	IndexMundi
flax	3.11	EUR/kg	Indexbox
viscose	3.68	EUR/kg	Fiber2Fashion
polyester	1.23	EUR/kg	Fiber2Fashion
acrylic	2.32	EUR/kg	Fiber2Fashion
polyamide	2.78	EUR/kg	Plasticker
polypropylene	1.40	EUR/kg	Plasticker

316 The yarn represents more than 50 % of the total fabric cost (Handfield, R., Sun, H., & Rothenberg, L. (2020). Assessing supply chain risk for apparel production in low cost countries using newsfeed analysis. Supply Chain Management: An International Journal.).

317 The used exchange rates were taken from the European Central Bank.

The total cost of the measure is EUR 5.3 billion per year. It corresponds to 202 000 EUR/t of avoided microplastics on average (lower bound: 103 000 EUR/t; higher bound: 3 747 000 EUR/t).

In addition, further assessment is still needed on the possible scalability of production and competitiveness.

Environmental impacts

The measure allows an average reduction of 26 353 tonnes per year (lower bound reduction: 1 420 tonnes per year, higher bound reduction: 51 285 tonnes per year).

The environmental analysis carried out on the production of raw materials (fibre production) shows an increase in the impact of water consumption between the baseline scenario and measure 1a (+37%). This increase is linked to the increase in the proportion of cotton. Indeed, cotton production involves intensive use of water (Luján-Ornelas C. et al., A Life Cycle Thinking Approach to Analyse Sustainability in the Textile Industry:A Literature Review, Sustainability 2020, 12, 10193).

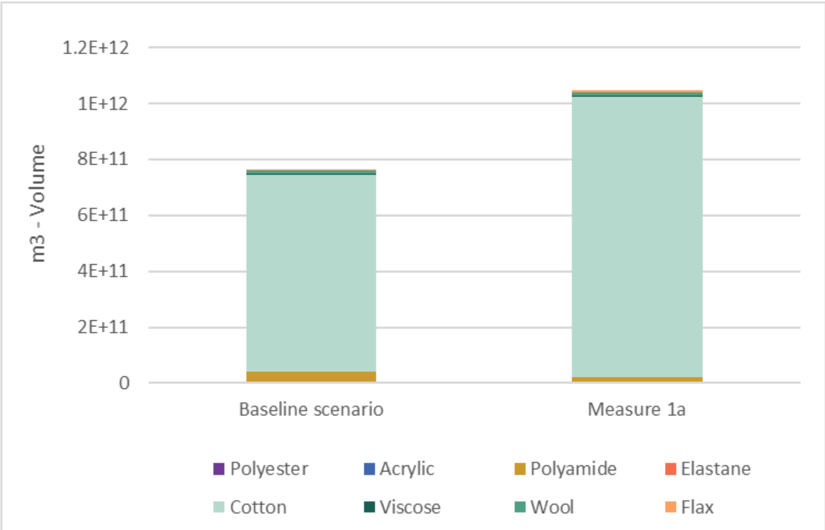

Figure 37: Water use for the production of textile raw materials (quantities of textiles: 9 million tonnes)

The figure only shows the production of fibres. The other stages of the life cycle (production, use, distribution, end of life) are also impacted by the change of raw materials (e.g. different dyeing, different care conditions) but the main impact is the raw material production. (ETC, Microplastic pollution from textile consumption in Europe, February 2022).

The following figure shows the global warming impact of clothing production (including the production of raw materials).

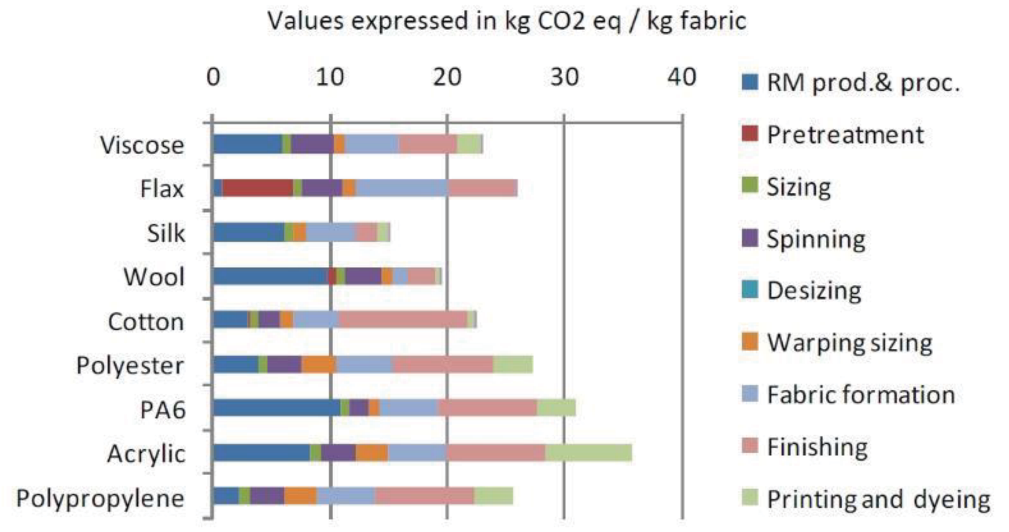

Figure 38: Impact on climate change due to the production of fabric from different fibres types

For the production of raw materials, cotton and polyester have a similar impact on climate change. Cotton has a lower impact than polyester in the production of the fabric (pretreatment to printing and dyeing). Thus, cotton fabric has a lower impact than polyester fabric.

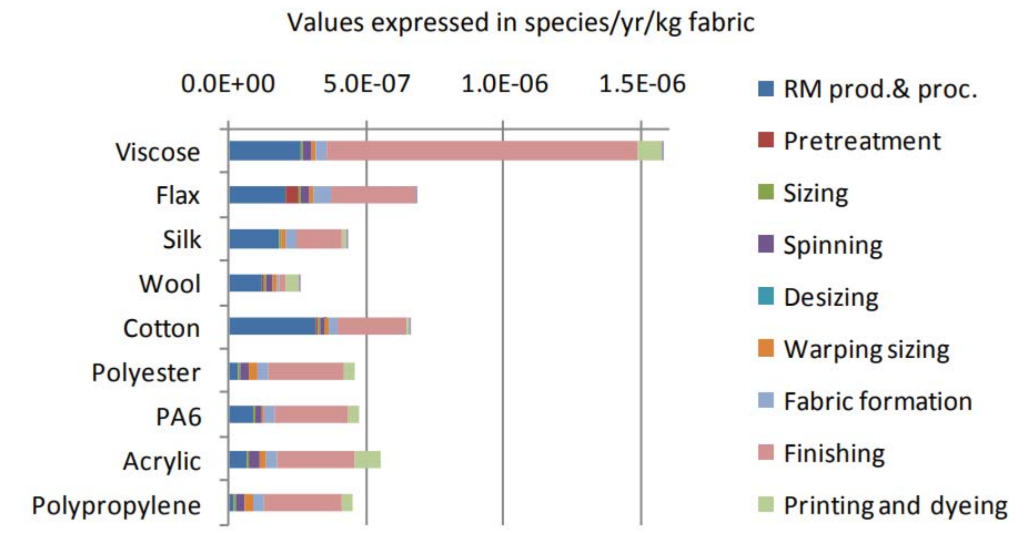

Figure 39: Impact on ecosystem diversity due to the production of fabric from different fibre types

The impact on ecosystem diversity is bigger for most natural fibres (viscose, flax and cotton) than for synthetic fibres.

Biodiversity was assessed qualitatively in the T-shirts PEFCR pilot[318] as there is currently no adequate indicator to express impacts on biodiversity[319].

[318] Sandrine Pesnel, Jérôme Payet (Cycleco) on behalf of the Technical Secretariat of the T-shirts PEFCR pilot, Product Environmental Footprint Category Rules (PEFCR) T-shirts, February 2019.

[319] Technical Helpdesk, Mark Goedkoop, Issue Paper - Addressing biodiversity in the Environmental Footprint pilots, May 2015.

Activities related to clothing production contribute to the impact on biodiversity. Mainly, it focuses on raw material extraction and production of natural and synthetic fibres. Five potential pressures constitute an important effect on biodiversity: loss and degradation of natural habitats, overexploitation of biological resources, pollution and excessive nutrient loads, climate change and invasive alien species on the ecosystem[320].

The relations between raw material and their consequences on biodiversity are described in the following list:

Raw material for natural fibres (from crops) as cotton, hemp, flax, etc.:

- extensive area cropland could cause degradation and fragmentation of habitats;
- use of large amount of water with a significant impact on the ecosystem, for instance cotton production uses more water consumption than flax or hemp;
- chemical product as fertilizers or pesticides and other agricultural chemicals contributing to excessive nutrient lead in soil and water.

Raw material for natural fibres (from animals) as wool, silk, etc:

- impact from multiple land uses affect to degradation and fragmentation of natural habitats, however, for the production of silk the area extension impact is limited by way of cultivation;
- the livestock production pollution impact could come from pesticides used to protect animals from parasites (for wool);
- climate change impact has as its source the fossil fuel used in the agrochemicals production, the farming and distribution of feed crops, as well as the own livestock.

Raw material for artificial or regenerated fibres as viscose:

- lack of management of natural forests and plantations could occasion degradation and fragmentation of habitats;
- utilisation of agrochemical in forest plantations and the pulp mill could discharge pollutants into soil and water;
- loss of forest and use of energy contribute to the climate change impact.

Raw material for synthetic fibres as polyester: only the areas exploitation for non-renewable sources and energy use contribute to impact the pressures mentioned before.

There are different production processes to obtain viscose. The impact on global warming and human toxicity varies greatly depending on the production method (production of the wood pulp and chemical process to obtain the viscose) (Li Shen et al., Environmental impact assessment of man-made cellulose fibres; Changing Markets Foundation, Dirty Fashion – How pollution in the global textiles supply chain is making viscose toxic, June 2017).

Social impacts

The economic cost of the measure per piece of clothing is approximately EUR 0.21 which is likely to be passed on to consumers in price rises.

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[320] IUCN (International Union for Conservation of Nature), Biodiversity Risk and Opportunities in the Apparel Sector, 2016

There are also potential health impacts from reduced emissions of microplastics.

<u>TEX#3: Restrict synthetic fibres & fabrics with high releases of microplastics</u>

What would be the costs of the measure?

The economic cost is the cost difference of the switch of fibres (cotton, wool, flax, viscose, polyester, acrylic, polyamide, polypropylene) like for measure TEX#2: Restriction of all synthetic fibres for certain applications. The price of the fibres is detailed in Table 48.

When comparing the production costs of textiles made from the different fibres, the significant difference comes from the prices of the fibres. The change in the production process is not significant.

This measure will only require the resources of public authorities in the phase of introducing the measure. SMEs will be affected as textile production is not limited to larger companies. The measure will require third-country manufacturers to comply when placing textiles on the EU market.

What would be the benefits of the measure?

This measure acts on the emission of microplastics during production, wearing, washing and drying according to the proportion of synthetic materials in clothing.

Economic impacts

The costs associated with the foregone synthetic fibres were compared to those associated with the additional natural fibres, and the total cost of the measure was computed. The assumption taken is thus a complete switch from these "high release synthetic fibres" by natural fibres. Hereunder is a variation with a switch from these fibres to "low release synthetic fibres".

The total cost of the measure is around EUR 3 billion per year. It corresponds to 176 000 EUR/t of avoided microplastics on average (lower bound: 90 000 EUR/t; higher bound: 3 265 000 EUR/t).

Environmental impacts

The measure allows an average reduction of 17 168 tonnes per year (lower bound reduction: 923 tonnes per year, higher bound reduction: 33 412 tonnes per year).

The environmental analysis carried out on the production of raw materials (fibre production) shows an increase in the impact of water consumption between the baseline scenario and measure 1b (+23%). The explanation is the same as for measure TEX#2: Restrict synthetic fibres for certain applications.

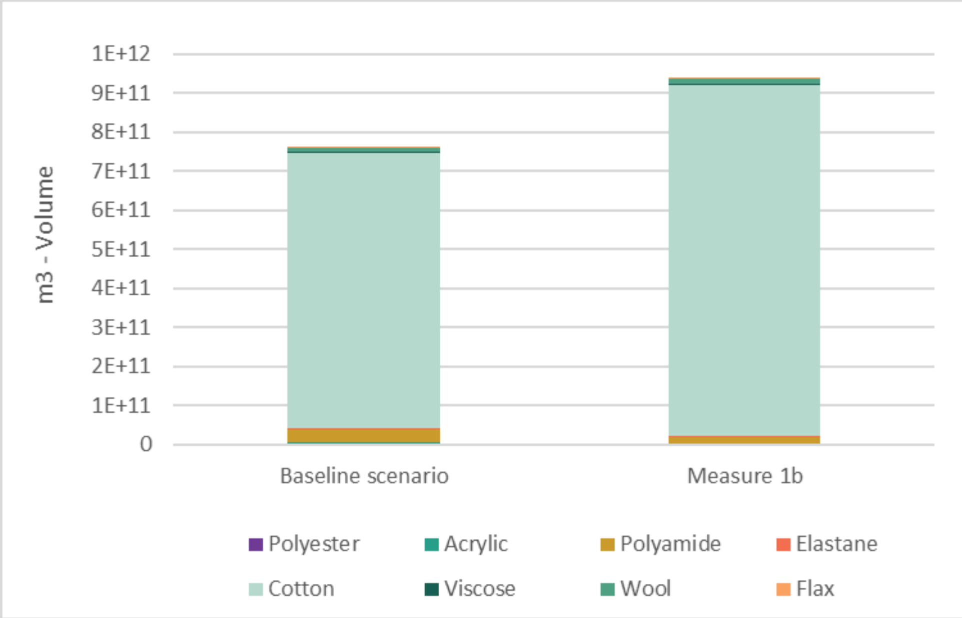

Figure 40: Water use for the production of textile raw materials (quantities of textiles: 9.0 million tonnes)

As for measure TEX#2: Restrict synthetic fibres for specific applications, the other stages of the life cycle are also impacted by the change of raw materials, but the main impact is the raw material production.

Social impacts

The economic cost of the measure per piece of clothing is approximately EUR 0.12 which is likely to be passed on to consumers in price rises.

There are also potential health impacts from reduced emissions of microplastics.

Variation of the measure

For the type of clothes with high releases of microplastics, synthetic fibres could be replaced by synthetic fibres with lower microplastic releases (instead of natural or artificial ones). The total economic cost to replace knitted polyester with acrylic for those clothes would be EUR 670 million per year. The measure variation allows an average reduction of 1 249 tonnes of microplastics per year (lower bound reduction: 134 tonnes per year, higher bound reduction: 2 365 tonnes per year). The microplastic release reduction is low because there is no reduction for production and wearing as there is no specific emission data per synthetic fibre despite the fact that these life-cycle steps are significant in terms of microplastic releases. This variation measure is not cost-effective as it leads to EUR 536 000 per of avoided microplastics on average (lower bound: 283 000 EUR/t; higher bound: 4 998 000 EUR/t).

If we assume that the microplastic release reduction for production and wearing would be the same as for washing (around 15 %) by replacing knitted polyester with acrylic, the measure variation will allow an average reduction of 5 877 tonnes of microplastics per year (lower bound reduction: 318 tonnes per year, higher bound reduction: 11 436 tonnes per year). It corresponds to an average cost of 114 016 EUR/t of avoided microplastics (lower bound: 58 592 EUR/t and higher bound: 2 109 597 EUR/t). This estimation is not based on scientific evidence but on an approximate extrapolation.

If we assume that the microplastic release reduction for production and wearing would be the same as for washing (around 15 %) by replacing knitted polyester with acrylic, the measure variation would allow an average reduction of 5 877 tonnes of microplastics per year (lower bound reduction: 318 tonnes per year, higher bound reduction: 11 436 tonnes per year). It corresponds to an average cost of 114 000 EUR/t of avoided microplastics (lower bound: 59 000 EUR/t and higher bound: 2 110 000 EUR/t). This estimation is not based on scientific evidence but on an approximate extrapolation.

TEX#4: Mandatory prewashing of textiles before placing on the market

What would be the costs of the measure?

The main costs would be the operating cost and conduct of business (CAPEX and OPEX) to prewash the textiles before placing them on the market.

This measure will require the resources of public authorities in the phase of introducing the measure and to organise the audits to control the certification schemes. SMEs will be affected as textile production is not limited to larger companies. The measure will require third-country manufacturers to comply when placing textiles on the EU market.

What would be the benefits of the measure?

This measure acts on the emission of microplastics during washing and drying with an assumed reduction of microplastic releases of 11% (assumption based on Textile Mission (2021) Textiles Mikroplastik reduzieren - Erkenntnisse aus einem Interdsziplinären Forschungsprojekt).

Economic impacts

The main cost impacts are:

Capital expenditures:
- o industrial washing machines
- o dryer machines

Operational expenditures:
- o energy consumption (gas, electricity)
- o water consumption
- o labour

Table 49: Data to estimate the costs of prewashing

Description	Data	Unit	Source
Number of production plants in the EU	160 000	plants	Euratex (2019)
Number of production plants outside the EU for the EU market	201 739	plants	Assumption based on European Environment Agency and Statista data
EU textile production	6 900 000	tonnes/year	European Environment Agency (2020)
Worldwide textile fibres production	109 000 000	tonnes/year	Statista (2020)

Description	Data	Unit	Source
Textiles imported into the EU in 2020	8 700 000	tonnes/year	European Environment Agency (2020)
Industrial washing machine price (capacity of 50kg)	7 200	EUR	Taizhou Haifeng Machinery Manufacturing Co,. Assumption based on expert judgement - Running time of 30 minutes
Water consumption - washing machine	15	l/kg of textiles	
Gas consumption - washing machine	1.925	MJ/kg of textiles	
Electricity consumption - washing machine	0.08	kWh/kg of textiles	
Dryer machine price (capacity of 50kg)	54 000	EUR	Taizhou Haifeng Machinery Manufacturing Co,. Assumption - running time of 30 minutes
Gas consumption - washing machine	4	MJ/kg of textiles	
Electricity consumption - washing machine	0.42	kWh/kg of textiles	
Average lifetime - Industrial dryer and washing machine	12	years	Assumption based on literature
Water price (EU)	4.01	EUR/m³	Economic Information and Forecasting Office(BIPE), French Federation of Water Enterprises (FP2E), 7th edition of the study on public water and sanitation services in France and abroad (2020)
Water price (Asia)	0.68	EUR/m³	CEIC, Price monitoring center
Electricity price (EU)	0.14	EUR/kWh	Eurostat (2020) for EU27, IA electricity consumption without taxes
Electricity price (Asia)	0.11	EUR/kWh	Global petrol prices
Gas price	0.00695	EUR/MJ	Eurostat (2019)
FTE	0.000050	per washing/drying cycle	Assumption based on expert judgement - 5 minutes per washing/drying cycle
Average yearly labour cost for manufacturing sector (EU)[230]	51 091	EUR/year	Eurostat (2020
Average yearly labour cost for manufacturing sector (non-EU)	11 590	EUR/year	Trading economics
Detergent consumption	10	g/kg	European Commission - Best Environmental Management Practice (2017)
Detergent price	0.15	EUR/kg	

The energy cost (including gas and electricity) represents the biggest part of the cost, 40% for EU plants and 56% for plants outside the EU.

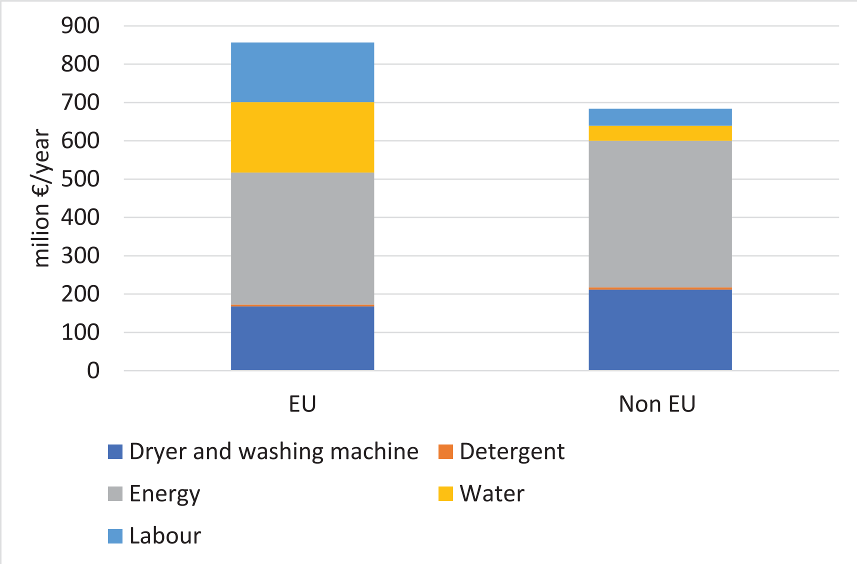

Figure 41: Prewashing step costs

The total cost of a prewashing step would be around EUR 1.54 billion per year. It would cost around EUR 856 million per year for plants in the EU and EUR 684 million per year for plants exporting to the EU from outside of the EU.

This cost is a higher bound cost because we supposed that textiles are not prewashed in the baseline as we do not have data about the numbers of plants and the amount of textiles that is already prewashed before placing on the market.

It corresponds to an average cost of 1 802 000 EUR/t of avoided microplastics (lower bound: 955 000 EUR/t and higher bound: 16 102 085 EUR/t).

Environmental impacts

The measure equates to an average reduction of 854 tonnes per year (lower bound reduction: 96 tonnes per year, higher bound reduction 1 613 tonnes per year).

The main impacts on global warming are related to energy consumption (electricity and heat) for washing and drying[321]. Considering a European consumption of 9 million tonnes of textiles, the impact on GHG emissions for prewashing is 8 364 kt CO_2 eq. It corresponds to around 0.93 kg CO_2 eq/kg of clothing. For the whole life cycle, this represents an increase of about 2% of the climate change impact of textiles.

321 Electricity mix of Asia is used to model prewashing outside Europe. Heat is produced from natural gas.

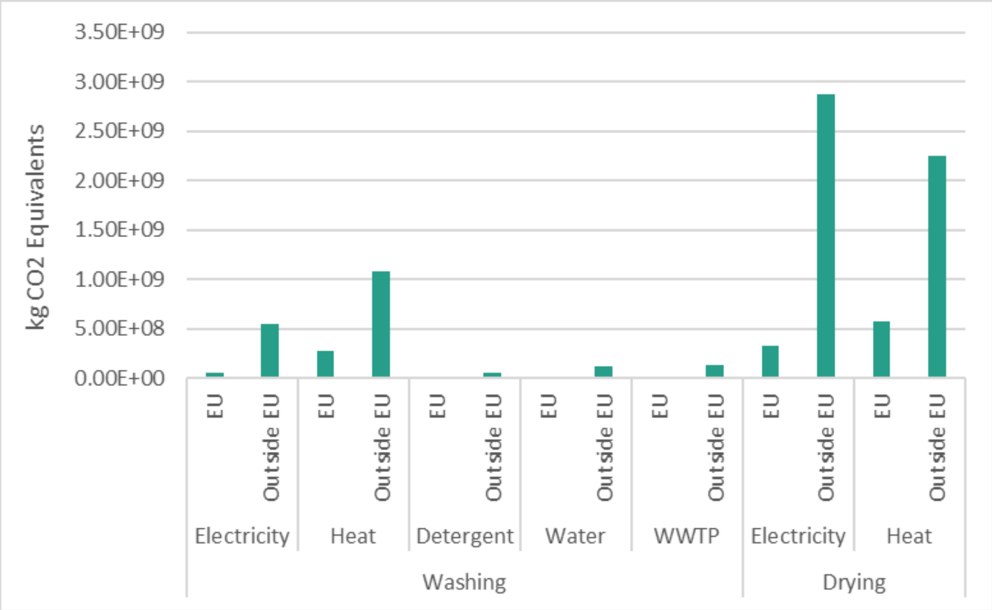

Figure 42: Impact of prewashing on climate change

The main impact on water use is related to water consumption during the washing. Considering a European consumption of 9 million tonnes of textiles, the impact on water use for prewashing is 1.44 billion m³. It corresponds to around 160 l/kg of clothing.

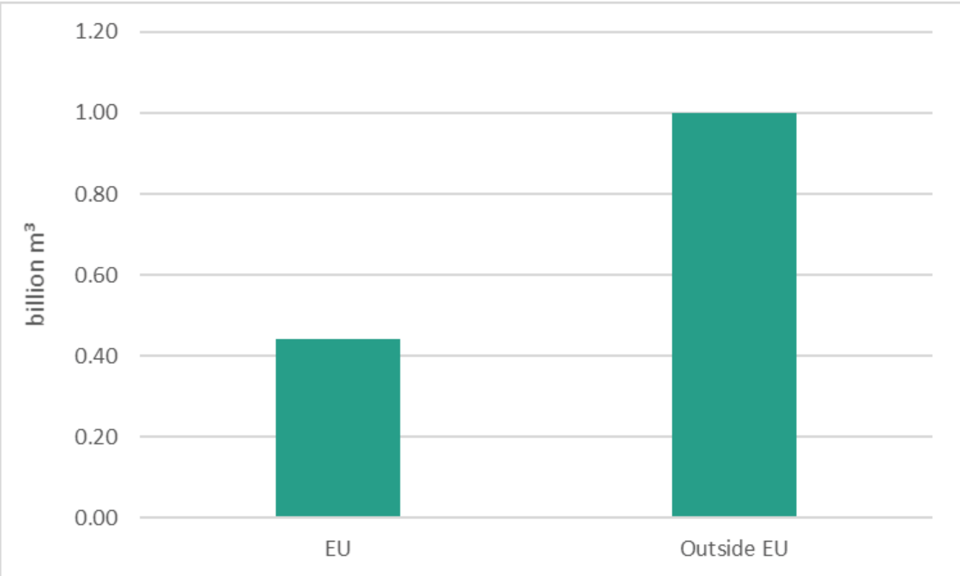

Figure 43: Impact of prewashing on water use (measure 3)

Social impacts

The average economic cost of the measure per piece of clothing is EUR 0.06 which is likely to be passed on to consumers as a price increase.

There are also potential health impacts from reduced emissions of microplastics.

TEX#5: Specific wastewater treatment in textile production plants

What would be the costs of the measure?

The main costs would be the operating cost and conduct of business (CAPEX and OPEX) to have a wastewater treatment tackling microplastics in textile production plants.

We do not have data about the number of plants that already have a wastewater treatment system that is effective in limiting microplastic releases. The costs and benefits of this measure are higher bound estimations because we assumed that none of the plants is equipped with wastewater treatment to limit microplastic releases.

This measure will require the resources of public authorities in the phase of introducing the measure and to organise the audits to control the certification schemes. SMEs will be affected as textile production is not limited to larger companies. The measure will require third-country manufacturers to comply when placing textiles on the EU market.

What would be the benefits of the measure?

This measure acts on the emission of microplastics during production and is assumed to reduce emissions of microplastics by 25% during production (assumption based on expert judgement).

Economic impacts

The table below details the data to compute the costs of this measure.

Table 50: Data to estimate the costs of wastewater treatment in production plants

Description	Data	Unit	Source
Number of production plants in the EU	160 000	plants	Euratex (2019)
Number of production plants outside the EU for the EU market	201 739	plants	Assumption based on European Environment Agency and Statista data
EU textile production	6 900 000	tonnes/year	European Environment Agency (2020)
Worldwide textile fibres production	109 00 000	tonnes/year	Statista (2020)
Textiles imported into the EU in 2020	8 700 000	tonnes/year	European Environment Agency (2020)
CAPEX - Textile wastewater machine price	21 420	EUR	Gongyuan Environmental Equipment
Average lifetime of the machine	15	years	Assumption based on review of literature
Electricity	29 000 000	MJ/year	WP08, E. N. E. A. Life Cycle Assessment of silk-and charged silk yarn in I09 company.
Electricity price (EU)	0.14	EUR/kWh	Eurostat (2020) for EU27, IA electricity consumption without taxes
Electricity price (Asia)	0.11	EUR/kWh	Global Petrol prices

The total cost of introducing specific wastewater treatment in textiles production plants would be EUR 594 million per year. It would cost EUR 267 million per year for plants in the EU and EUR 327 million per year for plants exporting to the EU from outside the EU.

The cost for the plants in the EU is a higher bound as some plants may already have a wastewater treatment plant that is effective in limiting microplastic releases.

It corresponds to an average cost of 143 000 EUR/t of avoided microplastics (lower bound: 74 000 EUR/t and higher bound: 2 000 000 EUR/t).

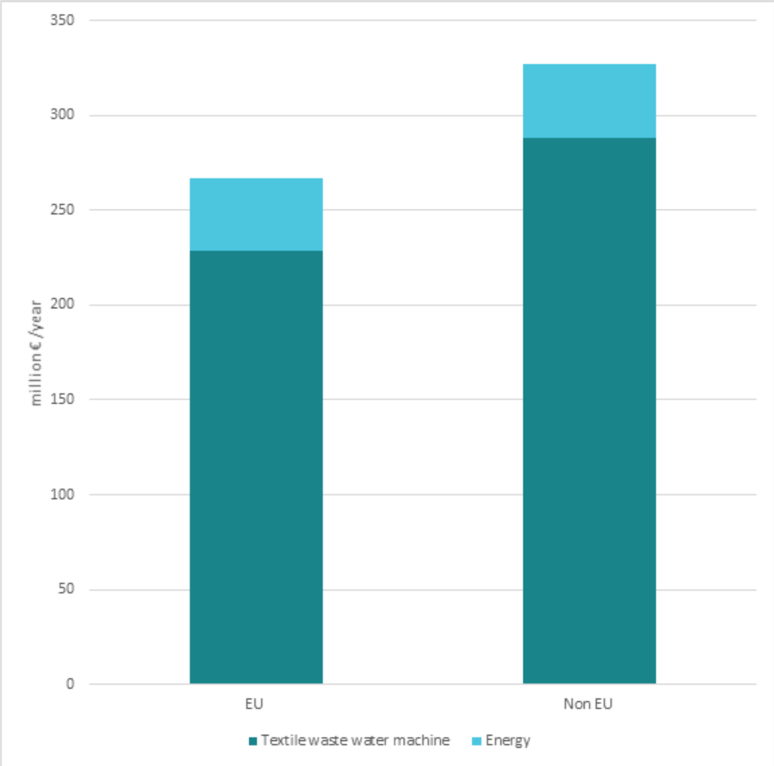

Figure 44: Specific wastewater treatment in production plants cost

The CAPEX of a wastewater treatment represents more than 85% of the total annual cost.

Environmental impacts

The measure equates to an average reduction of 4 024 tonnes per year (lower bound reduction: 287 tonnes per year, higher bound reduction: 7 760 tonnes per year).

In addition to reducing the microplastic releases from the textile industry, adding a new filter system in textile plants could also improve water quality by removing other pollutants from, for example, the textile dyeing process.

Introducing additional wastewater treatment will incur additional energy usage. Considering a European consumption of 9 million tonnes of textiles, the impact on global warming for wastewater treatment is 1 044 kt CO_2 eq. It corresponds to 0.12 kg CO_2 eq/kg of clothing.

For the whole life cycle, this represents an increase of about 0.2% of the climate change impact of textiles.

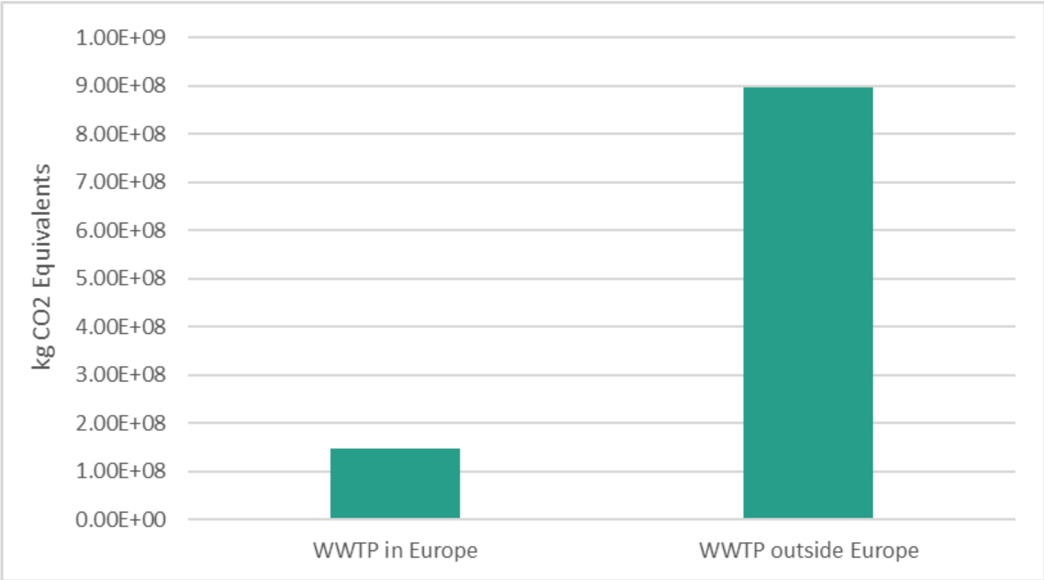

Figure 45: Impact of wastewater treatment in production plants on GHG emissions

Social impacts

The economic cost of the measure per piece of clothing is estimated to be EUR 0.02 which is likely to be passed on to consumers as a price increase.

There are also potential health impacts from reduced emissions of microplastics.

TEX#6: Compulsory filters for washing machines

What would be the costs of the measure?

The main cost would be the cost to equip the washing machines with microplastic filters.

Filters will be mandatory on new washing machines in France from 2025, but this was not considered in the baseline. Therefore, the benefits and costs would be around 15 % smaller by taking the French policy measure into account.

This measure will only require the resources of public authorities in the phase of introducing the measure. SMEs will not be affected as washing machine producers are larger companies. The measure will require third-country washing machine producers to comply when placing washing machines on the EU market. This measure will also require communication to consumers in order to avoid inadequate filter maintenance. This is complementary with measure TEX#8: Raising awareness on best practices for consumers of textiles.

What would be the benefits of the measure?

This measure acts on the emission of microplastics during washing with an assumed efficiency of an external filter of 89%.

Economic impacts

Table 51: Data to estimate the cost of washing machine filters

Description	Data	Unit	Source
Number of washing machines sold in the EU per year (2018/2019)	27 700 000	pcs	Applia (2019)
Number of washing machines in the EU	195 000 000	pcs	Eurostat (2019)
Cost of an internal filter - Xfiltra	100	EUR	Industry assumption during a bilateral interview
Efficiency - Xfiltra	78%	%	Napper, I. E., Barrett, A. C., & Thompson, R. C. (2020). The efficiency of devices intended to reduce microfibre release during clothes washing. Science of The Total Environment, 738, 140412.
Lifetime - Xfiltra	12.5	years	Assumption - the lifetime is equal to the washing machine one
Cost of an external filter - Guppyfriend washing bag	30	EUR	OECD (2021), Policies to Reduce Microplastics Pollution in Water: Focus on Textiles and Tyres, OECD Publishing, Paris.
Efficiency - Guppyfriend washing bag	54%	%	Napper, I. E., Barrett, A. C., & Thompson, R. C. (2020). The efficiency of devices intended to reduce microfibre release during clothes washing. Science of The Total Environment, 738, 140412.
Lifetime-washing bag	0.25	year	The washing bag can last for a minimum of 50 cycles, and there are on average of 20 cycles per month per household
Cost of an external filter - Filtrol 160	141	EUR	Filtrol
Replacement Filter Bag	13.4	EUR	Filtrol
Efficiency - Filtrol 160	89%	%	Microfiber Policy Brief 2019 - Rochman Lab
Lifetime - Filtrol	1	year	For 253 cycles
Yearly electricity consumption for laundry washing	160	per household in kWh	Pakula, C., & Stamminger, R. (2010). Electricity and water consumption for laundry washing by washing machine worldwide. *Energy efficiency*, *3*(4), 365-382.
Yearly water consumption for laundry washing	10	per household in m3	
Water consumption for one cycle	60	Litres	Assumption based on literature
Energy consumption for one cycle	1	kWh/cycle	Assumption based on literature
Additional water use	39	%	Association of Home Appliance Manufacturers (AHAM)
Additional run time	15	%	

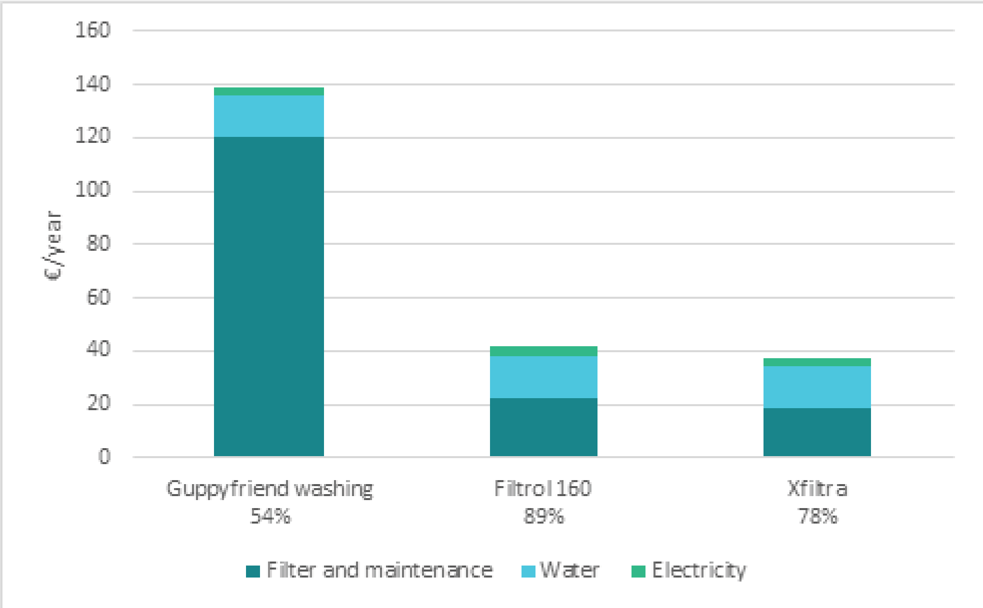

Figure 46: Cost of microplastic filters for washing machines

It would cost around EUR 8.1 billion to equip all washing machines with an internal microplastics filter based on current costs. It corresponds to an average cost of 2 627 000 EUR/t of avoided microplastics (lower bound: 1 464 000 EUR/t and higher bound: 12 764 000 EUR/t).

The costs are likely to decline as the technology is relatively new. There is probably improvement potential to reduce the filter production cost and also to reduce the increased consumption during its use (water and electricity).

Environmental impacts

The measure equates to an average reduction of 3 087 tonnes per year (lower bound reduction: 635 tonnes per year, higher bound reduction 5 539 tonnes per year)) based on a filter efficiency of 89 %.

The microplastic release reduction is relatively low because the microplastic releases of washing are small compared to those at the other life-cycle steps (mainly production and wearing).

The following figure shows the impact on GHG emissions associated with 1 wash[322]. The increase in the impact on GHG emissions is mainly related to the increase in electricity consumption (linked to the additional run time)—the impact increases by 18%.

According to the IMPRO Textile study, the use phase accounts for 45% of the life cycle impact of the product on global warming. The washing accounts for 56% of climate change impact for the use phase. Washing, therefore, accounts for 25% of the product's life cycle impact on global warming. For the whole life cycle, the use of a filter represents an increase of about 1 to 2% of the climate change impact of textiles (increase depending on the number of wash cycles).

[322] Depending on the product, there can be up to 104 washes (Impro Textiles)

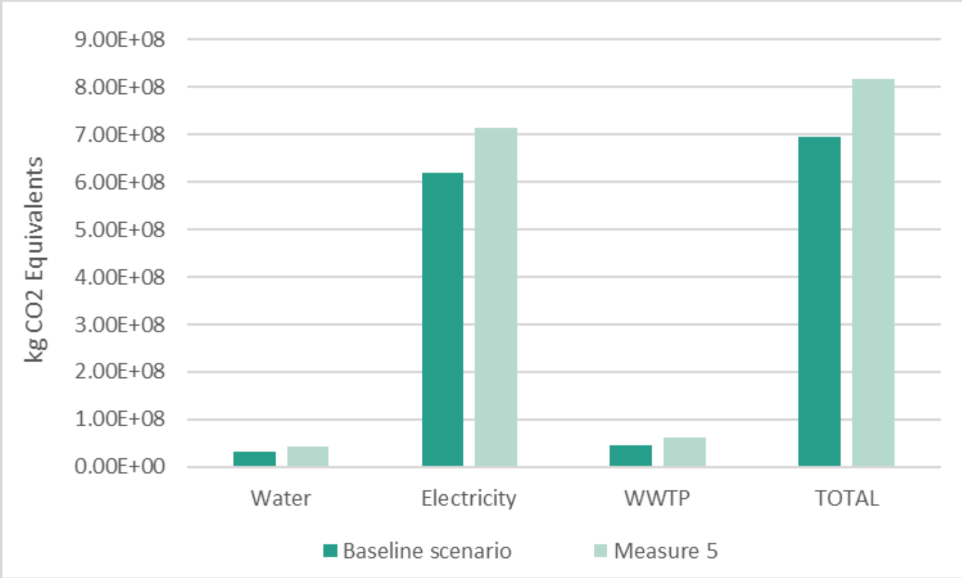

Figure 47: Impact of microplastic filters for washing machines on GHG emissions

The following figure shows the impact on water use associated with 1 wash. The increase in the impact is mainly related to the increase in water consumption. The impact increases by 27%.

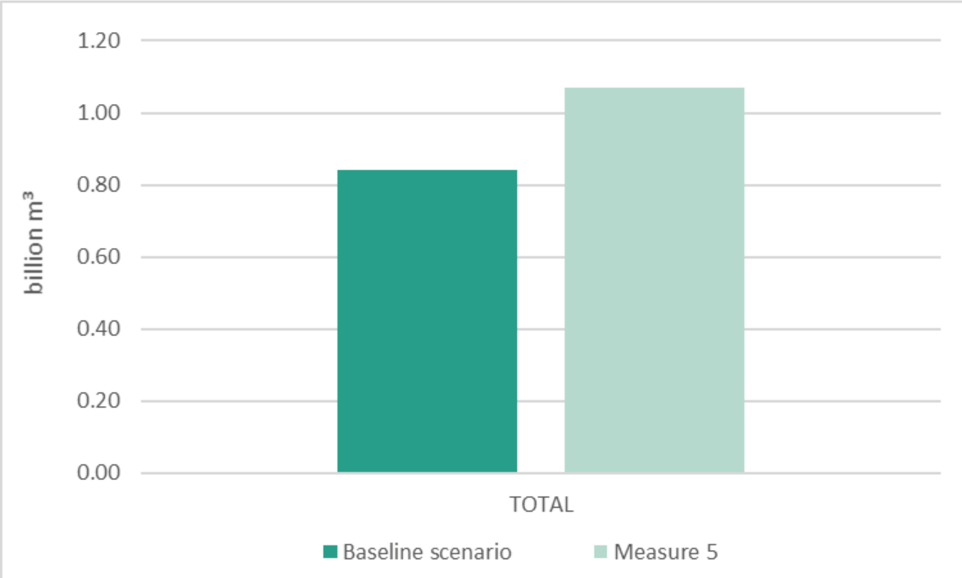

Figure 48: Impact of microplastic filters for washing machines on water use

Social impacts

The economic cost would lead to an additional cost of EUR 0.24 per washing cycle supported by consumers.[323]

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[323] Based on 174 washing cycles per year (AISE).

The cost of the filter would represent between 28 and 40 % of the average price of a 7 kg washing machine[324]. As mentioned previously, the cost of the filters is likely to decline as the technology is relatively new.

There are also potential health impacts from reduced emissions of microplastics.

TEX#1: Standardised methodology to quantify microplastic releases from textiles

This measure was developed in response to the knowledge gaps we identified around the precise measurement of microplastic emissions. Developing a standardised measurement methodology will enable the development of reduction-specific measures at a later stage.

What would be the costs of the measure?

The one-shot costs of creating a standard are divided into two parts:

- The administrative costs of elaborating the standard (EUR 850 000)
- The costs of conducting tests for companies (EUR 10 000-20 000)

This measure will only require the resources of public authorities in the phase of introducing the measure.

What would be the benefits of the measure?

This measure will benefit all other measures on textiles as the release of microplastics during the life cycle of synthetic textile is a critical knowledge gap. The indirect benefits will also include the awareness-raising of the textile value chain actors and consumers. If an EPR system is implemented, the eco-fee can also be modulated according to the volume of microplastic release and respective actors' contributions. It is already a necessary step to measure any reduction measure's success rate. This measure would be necessary to support other measures (TEX#9 Mandatory label showing textiles' emissions of microplastics).

Economic impacts

The table below details the data to compute the cost of developing the standard.

Table 52: Assumption and data to estimate the costs of developing and implementing a standard

Description	Data	Unit	Source
Number of people working full time necessary to elaborate the standard between 8 and 36 months[325]	7.25	People	ISO website
Mean cost of labour in EU of one engineer working full-time	39.5	EUR/hour	Eurostat
Number of hours per week in a full-time job	40.6	hours/week	Eurostat
Number of marketers in the EU - textiles	160 000	Number	Euratex
Number of marketers in the EU - washing machines	27	Number	Gifam

[324] Based on an average 7 kg wahsing machine price of EUR 360. ADEME. F. Michel, T. Huppertz, J. R. Dulbecco et J. Lhotellier, RDC Environment. décembre 2019. Evaluation économique de l'allongement de la durée d'usage de produits de consommation et biens d'équipements– Rapport. 148 pages.

[325] The ISO technical committee on the environmental aspects of plastics is comprised of 29 members (the national standardization organisation). We assume that each member contributes 0.25 FTE to work on the committee.

Description	Data	Unit	Source
Fraction of companies conducting tests for elaborating the standard	5	%	Assumption
Number of engineers necessary per company to conduct the tests	1	person	Assumption
Mean worked hours per day in the EU by a full-time employee	8.12	hours/day	Eurostat
Number of hours necessary per company to conduct the tests	24	Hours	Assumption based on expert judgement

The total cost of the measure on average, is one-shot cost of EUR 8.5 million. The methodology would be relevant for at least 10 years. This would lead to an annualised cost of EUR 0.85 million.

Once the standard is developed, there will be the additional cost of testing the materials (only once per material). This cost was evaluated to range between **EUR 10 000 and 20 000** by expert judgement.

Environmental impacts

No significant environmental impacts are foreseen.

It will raise awareness on microplastic release for the companies that participate to the elaboration of the standard.

Social impacts

No significant social impacts are foreseen[326].

Variation

In addition to the development of a methodology to quantify microplastic emissions on the life-cycle, a variation of the measure would be to make the application of the standardized methodology mandatory for the companies putting a lot of pieces of textiles on the EU market. This would imply tests, audits and reporting on the microplastic emissions on the whole life-cycle.

Focussing on the companies putting a lot of pieces of textiles on the market is more cost effective as those companies usually have a large number of pieces per collection. This implies that the cost is spread on more textile pieces compared to smaller companies with have usually a lower number of pieces per collection. This would also spare SMEs.

In France, based on producer responsibility organisation for textile (Refashion/Eco TLC) data, the 14% of the biggest companies based on the number pieces of textiles put on the market put 95% of the textile's pieces[327]. If we apply this proportion to pieces put on the market in the EU with an average number of pieces by collection of 100 000, the average cost of the test to quantify microplastic emissions of the life-cycle stage and the audits would be EUR 769 million per year.

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326 The total cost of the measure per piece of clothing is EUR 0.0003.

327 ADEME (2020), Définition de critères d'éco-modulation applicables à la filière REP TLC (https://librairie.ademe.fr/dechets-economie-circulaire/4561-definition-de-criteres-d-eco-modulation-applicables-a-la-filiere-rep-tlc.html)

Seen the huge number of piece, a sampling approach seems to be warranted. A sample of 10% of the market (biggest companies) could be tested every year, leading to a cost of EUR 77 million per year.

If the tests would be realised on all the textiles put on the market, the cost would be like the labelling measure as the cost of the label itself is insignificant (EUR 1.56 billion). It seems however disproportioned to apply this measures to all.

Table 53: Assumption and data to estimate the costs of tests, audits and reporting of microplastic emissions

Description	Data	Unit	Source
Total cost of the tests	660	EUR per collection	Assumption based on Bureau Veritas prices in ADEME (2020), Définition de critères d'éco-modulation applicables à la filière REP TLC[328].
	1 440	EUR per collection	
Audit cost for a label	1 700	EUR per collection	EU Ecolabel
	2 000	EUR per collection	EU Ecolabel
Administrative cost	11%	%	Assumption based on expert judgement
Number of pieces put on the market in the EU	25 157 780 000	pieces	JRC, Environmental Improvement Potential of textiles (IMPRO Textiles), January 2014.
Average number of pieces per collection	100 000	pieces per collection	ADEME (2020), Définition de critères d'éco-modulation applicables à la filière REP TLC[329].

7.4 Impact of measures for paints

Table below shows the comparison between all measures evaluated to reduce microplastic emissions from paints.

[328] https://librairie.ademe.fr/dechets-economie-circulaire/4561-definition-de-criteres-d-eco-modulation-applicables-a-la-filiere-rep-tlc.html
[329] https://librairie.ademe.fr/dechets-economie-circulaire/4561-definition-de-criteres-d-eco-modulation-applicables-a-la-filiere-rep-tlc.html

Table 54: Comparison of measures for paints

Measure	Estimated reduction potential		Estimated Cost-effectiveness (EUR/tons reduced/year)	Other environmental impacts	Other economic impacts	Social impacts
	%	Ktons/ year				
PNT#2a: Mandatory label on paint lifetime and plastic content	1-2.5%	3.5 – 6.5	190–354 EUR/kg (1 240 million EUR/ 3.5-6.5 kt)	Potential other negative impacts, e.g. CO_2 emissions	Cost for paint producers that may be borne by customers	
PNT#3a: Promote mineral paint in the architectural sector	Not relevant	0kt	-	Reduction of microplastics released into environment	Negative impact on paint costs for paint producers that may be borne by customers. Minimal impact expected is because most polymer-based producers will not switch to mineral-based products through a voluntary scheme	
PNT#5: Good practices for paint application in all sectors	Low	Low	Low	Reduction of microplastics released into environment		
PNT#4: Deposit-return scheme for paint containers	0%	0 kt (increase in circularity)	- 54 -1 000 million EUR/year / 0 kt	Positive impacts in terms of circularity of paints (increased reuse and recycling)	Negative impact on paint cost for paint producers that may be borne by customers	
PNT#2b: Threshold on lifetime and plastic content for paints		Not quantified		Reduction of microplastic release into environment	Cost for paint producers that may be borne by customers	
PNT#3b: Restrict polymer-based paints in the architectural sector		Not quantified				
PNT#1: Standardised methodology of paint lifetime		-				

The table below shows the comparison of the impacts of the measures assessed to reduce microplastic emissions from paints.

Table 55: Summary of impacts for measures for paints

Policy measures	Environmental impact	Economic impact	Social impact
PNT#2a: Mandatory label on paint lifetime and plastic content	Reduction of microplastic releases as the label would raise the knowledge of paint-related microplastics pollution and it would encourage the consumers to take a better decision.	Negative impact on paint cost for paint producers that may be borne by customers	Job creation in labelling and certification companies
PNT#3a: Promote mineral paint in the architectural sector	Microplastic release reduction (71 kt, non-incremental) Risk of increased CO_2 emissions	Material costs limited if applied through ecolabel/GPP. If implemented through a ban, very high material costs due to complete change of production line, for >95% of architectural paint sector. SMEs	Consumers and households
PNT#5: Good practices for paint application in all sectors	Reduction of microplastics release from paints into environment		
PNT#4: Deposit-return scheme for paint containers	1.5 kt reduction of microplastics release	Limited economic impact	No social impact
PNT#2b: Threshold on lifetime and plastic content for paints	Reduction in microplastic emissions Potential increase in paint toxicity, negative CO2 impacts and increase in waste generation	Negative impact on paint cost for paint producers that may be borne by customers	No social impact
PNT#3b: Restrict polymer-based paints in the architectural sector	Reduction in microplastic emissions Proper LCA needed to assess environmental footprint	Negative impact on paint cost for paint producers that may be borne by customers	Job creation, albeit limited

PNT#1: Standardised methodology of paint lifetime	No emission reduction per se but helpful in other measures and knowledge improvement	Material cost 100-500 k EUR	There could be new jobs in the R&D sector (private company or research organisations) unless developed by the existing research staff

The impact of each measure is outlined below.

PNT#2a: Mandatory label on paint lifetime and plastic content

The measure can be associated with a product authorization to enter the EU market, or it can be just left as a labelling requirement (see measure PNT#2b).

The overall economic impact is related to the standardization of the assessment methodology of paint lifetime and plastic content. The R&D departments of the paint producers should already be aware of the lifetime of their product in various conditions. This is the kind of information generally used for issuing a warranty of the paint product when requested by the client, which guarantees, for example, that the paint will not blister or peel from properly prepared and primed surfaces and will not wear down or weather to expose the previously painted surface. See, for example https://www.dunnedwards.com/products/lifetime-warranty/. Seemly, as the paint producers know the composition of their paint formulations, they should be able to report the plastic content once the definition of plastic in paint is released.

The real difficulty and potential cost are associated with the necessity of having standard protocols for the lifetime assessment and a unique/unambiguous definition of plastic content in paint so that different products can be compared to each other. This could entail some scientific research costs but mostly should be administrative.

The labels though, should be changed to comply with the new regulation. The labelling could be managed as part of the continuous ongoing redesign from product innovation so the costs could be reduced.

To provide some indications, we refer to *Assessment and Review of Directive 2004/42/EC, Annex 26*, an estimate of re-labelling cost for decorative paint done by CEPE, which estimates a total re-labelling cost for decorative paints to be **740 million euros**, considering 4000 companies in the EU with 1,000-2,000 sku's (Stock keeping units) each.

This estimate could be lowered if the compliance deadline to the measure would be set within a couple of years (and not immediate), because the relabelling would be facilitated by the normal life cycle of the products.

The amending of the proper legislation and the cost for monitoring compliance and reporting should be minor.

What would be the costs of the measure?

- Cost of developing the standard methodology for assessment of paint plastic content
- Cost for paint producers to change the design of their label

What would be the benefits of the measure?

The emission pathways and sources that are indirectly targeted by this measure are:

1) paint used on the architectural exterior (by substitution with mineral-based paint),
2) paint used on the architectural interior (by substitution with less plastic-intense paint).
3) improper disposal of unused paint (for non-industrial applications, i.e., marine leisure DIY and architectural),

Point 1)

Currently, mineral paint covers 10% of the architectural paint market in Germany and Austria. In comparison, in all other European countries, the share is likely to be between 0.5 and 2% (from communication with a producer of silicate-based paints).

Mineral paint is used on the mineral substrate but not on wood and metal since it breaks under tensile forces.

We currently estimate that there is 171 kt of plastic used in architecture paint applied on the exterior concrete or mineral substrate; of these, 49 kt are leaked to the environment.

According to a mineral-based paint producer, the main hurdles to further market penetration are reputation (silicate-based paint used to be a two-component system that was difficult to apply), and price, as they are on average 10-20% more expensive than organic polymer-based paints.

In order to understand how plastic content labelling will impact consumer behaviour, we can look at the packaging and textiles sectors.

70% of European consumers are actively taking steps to reduce their use of plastic packaging[330][331]

Plastic packaging consumption in EU-28 + NO/CH was 20.3 Mt in 2017 (*PlasticsEurope, 2018),* 20.4 Mt in 2018 (*PlasticsEurope, 2019*), and 20.1 Mt in 2019 (*PlasticsEurope, 2020*). Therefore, there has been a decrease in plastic packaging consumption of 1% in 2018-2019. Packaging paper & board consumption in Europe also decreased by 0.4% in 2018-2019, from 41.51 Mt in 2018 to 41.35 Mt in 2019 (*CEPI, 2020)*

In the textile sector, the use of fossil-based fibres has increased in recent years, while the use of cotton has remained constant[332]. In the textile sector, the use of fossil-based fibres has increased in recent years, while the use of cotton has remained constant.

Based on these figures from the packaging and textiles industry, it is unlikely that more than 2% of consumers will switch to mineral-based paint within a year, based solely on the plastic content information. Mineral-based paints have almost twice the lifetime of regular paint, which should also affect consumer behaviour, but we cannot assess the impact on sales. Overall, given the fact that the current market share of mineral-based paint is 0.5-10% in Europe, we could estimate that 0% to 3% of consumers would switch from plastic-based to mineral-based paint based on labelling information only in a year.

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330 https://www.twosides.info/documents/research/2020/packaging/European-Packaging-Preferences-2020_EN.pdf
331 https://www.twosides.info/documents/research/2020/packaging/European-Packaging-Preferences-2020_EN.pdf
332 https://textileexchange.org/wp-content/uploads/2021/08/Textile-Exchange_Preferred-Fiber-and-Materials-Market-Report_2021.pdf

In conclusion, the plastic reduction demand for exterior paint on the mineral substrate could be a maximum of 5.1 kt in a year (3% of 171 kt), and the related plastic pollution would decrease by **1.5 kt** (3% of 49 kt). Over the years, given the longer lifetime, one should also see a reduction in paint demand as a whole, and it would be more or less of the same order of magnitude.

Point 2)

Currently, we assume 719 kt of plastic is used every year for architectural interior paint. Of these, 42 kt are released to the environment in the form of microplastic

For interior paint, we have not investigated specific alternatives to standard polymer-containing paints, but it should be possible to decrease the paint lifetime by decreasing the plastic content, and this should not affect the paint demand since interior paint in currently repainted instead for aesthetic reasons.

If we assume that products are available that have half of the plastic content and that 0-3% of the consumer would prefer them to the current formulations (based on assessment at point 1), we obtain a maximum leakage reduction of **0.6 kt**.

The benefits assessed above are minimal, as they lead, at most, to a 3% of the Architectural paint microplastic leakage (yearly).

Point 3)

The amount of plastic contained in unused paint from the architectural sector is 58.1 kt, while from marine leisure DIY, it is around 3 kt. In the baseline assessment, we assumed that unused paint is never improperly disposed of in Europe. However, a stakeholder from the architectural paint industry considered that disposal of unused architectural paint in the drainage system has a high probability for DIYers and a medium probability for professionals.

We make the following assumptions:

- If the plastic content label is sufficiently visible, 50% to 90% of the consumers will become aware of the fact that there is plastic in paint
- 90%-100% of the consumers that are aware that paint contains plastic will not improperly dispose of it. In fact, at the European level, the littering rate of disposable plastic items is around 7%[333], while the littering rate of multi-use items is much lower <0.01%.

As a result, between 45% and 90% of the unused plastic in the paint targeted by the measure, i.e., 61kt, would not be improperly disposed of, for a range of 27 – 55 kt. At the moment, though, we consider in our baseline assessment that this paint is already properly disposed of.

[333] Timothy Elliott, R. B., Chiarina, D., Laurence, E., Chris, S., Ayesha, B., Mathilde, B., & Hilton, M. (2018). Assessment of measures to reduce marine litter from single-use plastics. ICF Consulting Services Limited and Eunomia, M. European Commission, Brussels

Economic Impact

Table 56: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Paint producer	Cost of testing the products with the standard methodology. Cost relative to the design and implementation of new label
Administrative burdens on businesses	-	Paint producers/importer	Some costs might be due to changes in the internal policy of the companies due to the necessity to be compliant with the labelling regulations.
Operation / conduct of SMEs	-	Small paint producers	Performing the assessment with the standardized methodology might be an economic burden for small producers who might not have adequate equipment. Providing open access or special agreements with testing facilities at the EU (or member state) level might be a valuable strategy to ensure compliance with the rules.
Functioning of the internal market and competition	+	Paint producers/ importers	The measure will probably favour the paint producers and importers who provide more environmentally friendly products.
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities or European Commission	Cost of amending the existing regulation or creating a new one Monitoring and reporting: at this stage is unclear whether the monitoring will be run at the EU or Member State level.
Innovation and research	+	Paint maintenance professionals	The measure will be an incentive to develop more environmentally friendly paint products.
Third countries and international relations	-	Paint producers in third countries	Will be affected as only the paints which are compliant with the EU regulation on the labels can enter the market.
Consumers and household	+	Paint maintenance professionals and DIYers	The potential impacts on paint prices are uncertain, but it is possible that the economic burden of product testing at the producer’s level might be reflected in the cost of the paint itself.

Environmental Impact

Without enforcement (thresholds and fee system) is challenging for the measure to have a substantial environmental benefit. But in the best-case scenario, the label would raise the knowledge of paint-related plastic pollution (mostly for the DYI sector), and it would encourage the consumers to use the best paint system for their needs maximising the lifetime minimizing plastic content when possible.

There could be an increase in CO_2 emissions if the reduction of plastic content happens through substitution with material with a higher CO_2 footprint. Similarly, we cannot exclude that the substituting materials will be more toxic.

Finally, there could be an increase in waste generation due to the testing needed to assess the paint properties.

Social impact

No social impact is expected.

<u>PNT#3a: Promote mineral paint in the architectural sector</u>

This measure can be applied with a voluntary scheme such as ECOLABEL or GPP.

What would be the costs of the measure?

- The costs related to the amendment of the ECOLABEL regulation or the GPP
- The costs for the producers of mineral paint to apply for the label and include it on their product

What would be the benefits of the measure?

In measure PNT#2a an estimate is proposed to assess the impact of label showing plastic content of paint on the sales of mineral based paint, which has polymeric content below 5%. This estimate is based on consumer purchasing trends in the past years of plastic products in favour of an alternative material. We cannot use the same estimate here as the ECOLABEL would not display information regarding plastic content, furthermore the ECOLABEL is a voluntary label.

Overall, we envision minimal impact as most polymer-based producers will not switch to mineral-based products through a voluntary scheme.

Economic Impact

Table 57: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Mineral paint producer	Cost of inserting the new label on the paint can
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	European Commission	Cost of changing the ecolabel Regulation

Environmental Impact

No impact expected.

Social impact

No impact foreseen.

PNT#5: Good practices for paint application in all sectors

This measure is not dependent upon any measure. This measure is voluntary.

What would be the costs of the measure?

The costs of the measure are:

1. The cost of researching good practices for the various paint sectors is estimated to be around EUR 100k - 500k, based on the level of ambition.
2. The cost for the paint professionals and relevant stakeholders of implementing those good practices (e.g., by purchasing a different type of paint removal machinery, etc.)

The latter depends on changes made, but as it is a voluntary measure, we assume that a professional will undertake it only if it leads to an economic advantage (e.g., an increase in business volume due to stronger appeal for costumer of less polluting techniques). So the actual economic impact is expected to be minimal.

For the marine sector, in particular, good practices for ship maintenance could be more expensive in terms of technology (e.g., water treatment to capture microplastic, robotic vacuum technology for paint removal), the time required to adopt them (e.g., vacuum cleaning of the drydock before re-floating is more time consuming than just re-floating without cleaning), and training of the paint maintenance professionals. The costs would ultimately be bear by the ship owners and by the paint maintenance professionals.

In the last 10 years, only 1-3% of the commercial world fleet was built in Europe, but 36% of the world fleet belongs to Europe (UNCSTAD). If ship-building capacity is taken as a proxy for ship-maintenance capacity, the implication is that European commercial ships undergo maintenance overwhelmingly outside of Europe. Conversation with stakeholders from the shipping sector concurs with this assessment.

Estimating the monetary cost of this measure is very difficult as it depends entirely on the actual list of good practices – and relative technologies – that will be set up, but to make an estimation one can say that the main cost that overshadows all other costs will be that of upgrading the current technologies in shipyards in order to capture microplastic releases during paint removal (the last two voice costs). There are two options:

1. Blasting is done with vacuuming technologies that prevent paint emissions

2. Blasting is done with wet technologies, without dust formation, and then membranes are used to filter the paint residues from the water

Option 1.

There are already technologies that do vacuum blasting, and the cost of the technology itself is competitive. The main challenge vacuum technologies are facing, especially for dry-docking, is productivity, i.e. how many square meters per hour they clean from paint residues. According to exchanges with stakeholders that develop vacuuming technology, the best way to have high productivity is using a robotic solution, which currently is able to clean 10 m^2/h (but could go up to 30-40 m^2/h).

On the other hand, hydro blasting technologies (no capturing) can clean up to 300 m^2/h [334]

In the table below, we summarise the key figures impacting the costs of drydocking.

Table 58: Factors impacting the costs of drydocking.

	min	max	units
Dry-docking cost	30'000	60'000	€/day
Productivity of standard technology	-	300	m2/h
Productivity of capturing technology	-	10	m2/h
Rental of standard technology	-	60	€/day
Rental of capturing technology	-	100	€/day
Ship surface area to treat	10'000	60'000	m2/day

The part of the boat that needs more intense cleaning and repainting is the one below the waterline. The below-water surface area can vary from 10,000 m^2 for a Panamax, to 60,000 m^2, for an Ultra Large Crude Carrier.

This means that with one hydro-blasting machine, the ship can be cleaned in 33-200 h, or 3.3-20 days, assuming a 10h working schedule. Drydocking usually lasts 10-20 days[335], meaning that paint maintenance lasts all throughout the drydocking period. Since the current vacuuming technologies are 30 times slower, it would take them 1 000-6 000 h to clean a ship. If this was done by a single machine, on a 10h shift, the drydocking would last 100-600 days. Data collected from one of the biggest shipyards in the Persian Gulf show that dry-docking costs varied from 30 000-60 000 $/day in 2008-. Given the high daily drydocking cost, it is imperative in order for paint vacuum capturing technologies to be competitive, to use more machines in parallel. The main cost would be renting additional machines, at a cost of EUR 100/day each. Considering the scenario that 30 machines would be needed (to compensate for the 30x lower productivity), the cost increase would be EUR 3 000/day. Since maintenance would last 3.3-20 days[336], the overall cost increase per drydocking period would be EUR 10 000 – 60 000. This excludes the cost of having a person operating the machine; given that the technology is robotic, it is not clear what the impact would be. On the other hand, we are assuming a working schedule of 10 h a day, which with robotic technology could (is) probably higher, reducing the number of days needed for the rental.

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334 (http://www.gimsid.ro/aplicatii/Industria%20navala/Hammelmann/Shipcleaning.pdf).

335 Apostolidis, A., Kokarakis, J., & Merikas, A. (2012). Modeling the Dry-Docking Cost-The Case of Tankers. Journal of Ship Production & Design, 28(3)

336 2012 (Apostolidis, A., Kokarakis, J., & Merikas, A. (2012). Modeling the Dry-Docking Cost-The Case of Tankers. Journal of Ship Production & Design, 28(3).)

Considering that there are 1.8 million commercial ships (*UNCTAD, 2017*), that 36% belong to EU-27 countries and that 3% undergo maintenance in EU-27 every 4 years, there would be around 5000 ships undergoing maintenance in the EU every year.

The total costs would be at least **50-300 million EUR/year**, with the current productivity.

Option 2

If hydro-blasting is used instead, then the water should be filtered from the paint residuals before re-emitting it to surface water. Sending to a wastewater treatment plant should be discouraged since the paint would end up in oil.

Ultrafiltration units exist that filter particles in the range of 0.01-0.1 microns. Their operating costs is 0.235-0.338 $ per m^3 of water filtered[337].

Ultra-high water jetting technologies that can operate at around 300 m^2/h use 85 l/min of water [338]Therefore, filtering the water emitted in one hour would cost from 1,200-1,700 $/h. Since it takes 33-200 h to clean the bottom of a ship during dry-docking with this technology, the overall operating cost would be 40-340 k EUR/ship.

Using the same estimate of the number of ships maintained in EU-27, the total operating costs would be between **200-1 700 million EUR/year,** depending on the boat size and the number of boats.

A further cost would be the creation of a European certification for those paint professionals that follows the guidelines. This cost is expected to be a bit minimal with respect to the rest.

What would be the benefits of the measure?

The benefits in terms of microplastic pollution reduction are potentially high, as the good practices would cover losses at both applications, removal (maintenance) level, and surface preparation, which impacts wear & tear. Nevertheless, since this is a voluntary measure, the expected compliance is low.

For the marine sector, there are 40 kt/year of microplastic emissions to ocean and waterways due to maintenance of EU commercial vessels. Since only 1-3% of the maintenance takes place in EU-27, the measure could potentially tackle 0.4 – 1.2 kt of micro-plastic emissions. Nevertheless, we estimate that applying this measure only at EU-27 level (with either a voluntary or a mandatory approach) will not lead to any change in the status quo, as commercial ship will choose to dock outside of the EU where maintenance will be cheaper.

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[337] Drouiche, M., Lounici, H., Belhocine, D., Grib, H., Piron, D., & Mameri, N. (2001). Economic study of the treatment of surface water by small ultrafiltration units. Water SA, 27(2), 199-204
Yoo, S. S. (2018). Operating cost reduction of in-line coagulation/ultrafiltration membrane process attributed to coagulation condition optimization for irreversible fouling control. Water, 10(8), 1076.).

[338] Shipcleaning.pdf (gimsid.ro)

Economic Impact

Table 59: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Public authorities: Change in costs to the Commission	-	European Commission / and EU institutions	Cost for the European Commission of defining the good practices.

Environmental Impact

The implementation of good practices would also reduce the emission of biocides contained in antifouling paint.

On the other hand, the use of more advanced technologies or better water management filters and systems could lead to an increase in CO_2 emissions.

Social impact

No social impact is foreseen by this measure.

PNT#4 Deposit-return scheme for paint containers

What would be the costs of the measure?

- Cost for paint producers and importers who should pay the development and maintenance of the system
- Cost of reporting paint quantities put on the market and collected
- Cost of funding research and study to assess improper disposal of paint and related microplastic pollution
- Cost of setting up improved collection schemes such as DRS scheme (e.g., cost of economic analysis to set up the financial scheme behind the EPR scheme - financial incentives, how much is the fee, how much is the reward, how much are the running costs) or door-to-door collection.
- Running cost of the organization managing the collection scheme: cost for establishing collection systems; collection and transport, administrative costs, public communication, and awareness-raising on waste prevention and collection, appropriate surveillance of the system
- Cost of promoting recycling of unused paint

Unused paint is often considered as special/hazardous waste and like waste oil, chemicals and spent batteries; for example, in several countries (e.g. Belgium and Denmark), it is successfully being collected with the goal of proper disposal or recycling [339]The overall cost of running EPR scheme for unused paint could be estimated, making a parallel with waste oil. The two products are similar at

[339] Formation Gestionnaires de déchets, module 2b, Déchets dangereux, Alain Vassart, Mike Van Acoeyen (Arcadis), Environment Brussel and GOOD PRACTICE ODENSE: Hazardous Waste Collection October 2014,

several levels: hazardous waste, and liquid, used both in professional and household settings, hold some intrinsic value but might need to be treated to be used again.

For waste oils, EPR schemes already exist for several European countries[340], from their review we can estimate that the cost of measure PNT#4 in EU will be between **54 million** and **1 billion** euros per year

To that, the administrative costs, the costs to perform for economic analysis and to develop the framework of the EPR itself have to be added. Drawing a parallel with the costs estimated for an EPR scheme for the Pharmaceutical and Cosmetic Industry in Europe, we can assume they will be in the order of 16 million euros at the EU level.

What would be the benefits of the measure?

It will be possible to compute the benefits of the measures solely in terms of microplastic pollution reduction once phase one is completed and a better understanding exists especially on the improper disposal of unused paint. Then depending on the effectiveness of the measures put in place (e.g. citizens awareness campaign, collection scheme), it will be possible to assess the reduction in microplastic pollution[341].

Based on the current estimates, the measure would target around **85 kt** of plastic from unused paint in EU-27.

Even if the fee is applied to the plastic content, it is expected that this will not drive change in the product design, as the fee would be too low to drive change.

Economic Impact

Table 60: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Paint producer/importers	Pay the fee to the PRO (running economic impact) to finance knowledge creation, as well as the collection and management of unused paint and the reduction of improperly disposed paint
Administrative burdens on businesses	-/0	Paint producers/importers	Cost of reporting the plastic content input on the market.

340 Development of Guidance on Extended Producer Responsibility (EPR)", 2014 by BIO by Deloitte, in collaboration with Arcadis, Ecologic, Institute for European Environmental Policy (IEEP), Umweltbundesamt (UBA). https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/sustainability-services/deloitte_sustainability-les-filieres-a-responsabilite-elargie-du-producteur-en-europe_dec-15.pdf

341 https://www.akzonobel.com/en/media/latest-news---media-releases-/akzonobel-launches-recycled-paint-to-help-close-loop-on-waste

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Functioning of the internal market and competition	-	Paint producers/ importers	The paint producers/importers that input more plastic on the market are penalized (pay more through the fee payment scheme).
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities or European Commission	Running cost of the EPR operator (including monitoring and reporting).
Public authorities: Change in costs to the Commission	-	European Commission / and EU institutions	This measure will only require resources in the phase of introducing the measure.
Third countries and international relations	-	Paint producers in third countries	Will be indirectly affected because importers have to pay based on how much plastic they import.
Consumers and household	0	Paint maintenance professionals and DIYers	The potential impacts on paint prices are uncertain but are expected to be limited.

Environmental Impact

If a deposit-return scheme is put in place, there could be a CO_2 impact related to the transport of the recovered paint, but it could be minimised by matching purchases of new paint with taking back of removed paint.

A potential positive environmental impact could be the development of recycling technologies for unused paint and an increase in circularity.

Social impact

There are no social impacts foreseen for this measure.

PNT#2b: Threshold on paint lifetime and plastic content for paints

This measure depends on measure PNT#2a to be implemented first.

Product authorisation in the European market depends on compliance with thresholds to regulate an upper bound for plastic content and a lower bound for paint lifetime.

Once it becomes clear, by paint sector (marine, architectural, road markings, etc.) and its sub-categories (e.g., architectural interior, exterior-concrete, exterior-wood), what are the ranges of plastic content (%) and lifetime for the different paint formulations available for the market, regulators can decide to ban from the market products that have a high plastic content and/or a lifetime much shorter than that of the painted object.

What would be the costs of the measure?

Additional cost with respect to measure PNT#2a:

- Cost of defining thresholds based on paint properties for entering EU markets and creating appropriate legislation
- Cost of defining and applying a fee system for non-compliant products

Besides the costs which are common to both the application framework of the measure, we can indicate the cost of defining thresholds as the one of a highly qualified consulting company: **100-500 k EUR, one time.**

Cost for paint producers of adapting the **paint formulation** to match the new requirements: **500 k EUR** per paint formulation[342] or 0.4% of sales value[343], i.e. EUR **500 million**.

What would be the benefits of the measure?

The benefits of the measures will depend on which types of paint formulations are currently available on the market.

Road markings - case study

For example, in the case of road markings, there are currently 4 main paints formulations: solvent-based (17.3% plastic, 1-2 years lifetime), water-based (16.6% plastic, 1-2 years lifetime), thermoplastics (16% plastics, 3-5 years lifetime) and cold plastics (35% plastic, 3-5 years lifetime). Here, the plastic contents are taken from the Eunomia report *Hann, et al. (2018)*, while the lifetime are taken from *Barbara, K. R., & Nicholas, D. O. D. D. (2018). Development of the EU Green Public Procurement (GPP) Criteria for Paints, Varnishes and Road Markings. Technical Report with final criteria.* If these values were to be confirmed, once the standardised methodology is established, the preferred road marking type would be thermoplastics, as it has the lowest plastic content and the longest lifetime.

Currently, given the market distribution of the different road markings formulations (*Hann et al. 2018)*, the polymer content in (dry) road markings paint is 16.6%, and the lifetime – weighted by the plastic content – is 3.3 years. If only thermoplastics were used, the polymer content would be 16% and the lifetime 4 years.

The microplastic leakage reduction can be approximated as: Leakage reduction = $leakage_{old}$ * reduction rate,

$$\text{Reduction rate} = (1 - \text{repaint\%}) * (1 - plastic_{new} / plastic_{old})$$

$$+ \text{repaint\%} * (1 - plastic_{new} / plastic_{old} * lifetime_{old} / lifetime_{new})$$

In this case: $leakage_{old}$ = 20 kt, $plastic_{new}$ = 16%, $plastic\%_{old}$ = 16.6%, $lifetime_{old}$ = 3.3 years, $lifetime_{new}$ = 4 years. The "repaint %" indicates how much of the paint put on the market is used for

[342] https://circabc.europa.eu/sd/a/2d163ccc-f496-44af-9b6a-8fd2006a4d5e/Final
[343] https://ec.europa.eu/environment/archives/air/pdf/paint_solvents/decopaint.pdf),

re-paint jobs. We don't currently have this quantity, but we could estimate it to be at least 50% in Europe, given the road lifetime versus the paint lifetime.

The leakage reduction in this case would be 20 kt * 12% = 2.4 kt.

Architectural exterior – case study

If we apply the equation above to a scenario in which all exterior architectural paint is replaced with silicate-based paint, we will obtain:

$Leakage_{old}$ = 49 kt, $plastic_{new}$ = 5%, $plastic\%_{old}$ = 20%, $lifetime_{old}$ = 10 years, $lifetime_{new}$ = 20 years, (repaint % = 50%)

Leakage reduction = 49 kt * 81% = 39 kt

Total estimate

Let us assume that through legislation, it would be possible, every few years, to decrease the plastic content by 5%, and increase the lifetime by 5%, on all paint formulations besides antifouling paint, which has been excluded from the measure. In this case, the reduction rate could be:

Reduction rate = (1 - repaint %) * (1 – 0.95) + repaint % * (1 – 0.95 * 1/1.05)

Let us assume the repaint share varies between 0% and 100%, then the range in reduction rate would be between 5% and 10% every year.

Currently, the total microplastic leakage from paint is estimated at 482 kt, but 50kt comes from antifouling paints, and another 154 kt comes from other marine paint applied on European ships outside the EU. Therefore, this measure could target 278 kt of microplastic leakage by reducing it by 5% to 10%. The corresponding leakage reduction would be **14–26 kt**. Every year, the label requirements are made more stringent by 5%, and the leakage would be further reduced by 5-10%. According to CEPE, it took 4 years to develop a new paint formulation in 2009 [344] ; therefore, we could assume thresholds to become more stringent every 4 years.

Economic Impact

The specific costs for measure #2b are the ones of #2a with the addition of the following:

Table 61: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Technological development / digital economy	--	Paint producers	The threshold imposed for market authorisation will require paint companies to adapt their production lines.

[344] *European Commission Service Contract N°070307/2007/483710/Mar/C3 Implementation And Review Of Directive 2004/42/Ec (European Directive Limiting The Voc Content In Certain Products – Current Scope: Decorative Paints And Varnishes, Vehicle Refinishing Products) Final Report http://ec.europa.eu/environment/air/pollutants/pdf/paints_report.pdf*

Environmental Impact

It is possible that the measure will have adverse environmental impacts if, for example, a paint has a longer lifetime, a smaller plastic content, but higher toxicity or higher CO_2 impact.

The enforcement provided by the thresholds and fee system will most definitely have an environmental benefit in terms of microplastic pollution reduction.

But, if the thresholds on maximum plastic content were imposed, the compositions of the paints would need to change to provide the same (or improved) performances, by definition. Therefore, since we are talking about new formulations that may not exist at the moment, there is no way to predict how those would look like in terms of environmental impact (one possibility out of many: lower plastic content, same lifetime but more toxic degradation products once released in the environment).

We state here that a different (not quantifiable) environmental impact is a possibility, such as increased toxicity.

There could be negative CO_2 impacts and an increase in waste generation due to the testing needed for the assessment of the paint properties.

Social impact

No social impact is expected.

PNT#3b: Restrict polymer-based paints in the architectural sector

What would be the costs of the measure?

- Administrative and legal costs associated with the creation of the limitation regulation or ban
- Costs for the paint producers to produce more mineral paint (investments and shift in production volumes)
- Increased costs for asset owners or managers (the ones that buy the paint products) because the mineral paint is more expensive than the dispersive one (based on organic polymer binders)
- Cost of a monitoring and reporting protocol to verify compliance with the new regulations
- Costs for asset owners in the form of a fee if found non-compliant

From discussions with mineral paint producers, it appears that silicate-based paint (which is by far the kind most available on the market) is 10-20% more expensive than dispersion paints. Their cost definitely influences their usage, and it will represent a burden on the consumers. Nevertheless, the lifetime is significantly elongated with respect to dispersion paint (almost twice as much). The life-cycle cost seems thus to be lower for silicate-based than polymer-based paints.

Another cost to consider is the market development for such paints. In Europe, the market share of mineral paint appears to be, on average, between 0.5 - 2% (both and value), with the highest value in Germany at 10%.

What would be the benefits of the measure?

The microplastic leakage reduction can be approximated as:

Leakage reduction = leakage_{old} * reduction rate,

Reduction rate = (1 - repaint%) *(1 – plastic_{new} / plastic_{old})

+ repaint% * (1 - plastic_{new} / plastic_{old} * lifetime_{old} / lifetime_{new})

In this case: leakage_{old} = 49 kt, plastic_{new} = 5%, $\text{plastic\%}_{old}$ = 20%, lifetime_{old} = 10 yrs, lifetime_{new} = 20 years, (repaint % = 50%). The “repaint %” indicates how much of the paint put on the market is used for re-paint jobs. We don’t currently have this quantity, but we could estimate it to be at least 50%.

Therefore, the leakage reduction of exterior architectural paint (excl. wood and metal substrates) would be:

Leakage reduction = 49 kt * 81% = **39 kt**

If the measure was to be extended to interior paint as well, we could compute the leakage reduction using the following parameters:

Leakage reduction = 49 kt * 81% = **39 kt**

Leakage_{old} = 42 kt, plastic_{new} = 5%, $\text{plastic\%}_{old}$ = 20%

We remove from the equation the part related to the increased lifetime because repaint practices on interior paint are not due to paint system failure.

Reduction rate = (1 – 5%/ 20%) = 75%

Leakage reduction = **32 kt**

Total leakage reduction = **71 kt**

Economic Impact

Table 62: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Paint producer	Cost related to product design and investments for improving or adding production of mineral paint to their list of products.
Functioning of the internal market and competition	+	Paint producers/ importers	The paint producers/importers that already produce mineral paint will have an economic advantage.

Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities or European Commission	Cost of the creation of the regulation/ban.
Technological development / digital economy	--	Paint producers	The ban on mineral paint will require paint companies to adapt their production lines.
Innovation and research	+	Paint maintenance professionals	The measure will be an incentive to develop and use mineral paint in place of the more plastic intensive dispersion paint.
Consumers and household	0	Paint maintenance professionals and DIYers	There will be potential impacts on paint prices due to the higher cost of the mineral paint, but they are most likely balanced by the longer lifetime of the paint layer itself.

Environmental Impact

This measure will most definitely have an environmental benefit in terms of microplastic pollution reduction as it promotes the use of less plastic-intensive paint for one of the biggest sectors in terms of paint consumption, the architectural one. The environmental footprint of shifting the production from polymer-based paint should be assessed through a proper LCA (Life Cycle Assessment).

Social impact

Product design will also be incentivised. This might create new job positions in R&D, although this impact is estimated to be quite small.

PNT#1: Standardised methodology of paint lifetime

This measure was developed in response to the knowledge gaps we identified around the precise measurement of microplastic emissions. Developing a standardised measurement methodology will enable the development of reduction-specific measures at a later stage.

This measure does not depend upon any other measure but it is necessary for the application of the measures PNT#2a and PNT#2b.

What would be the costs of the measure?

Cost of a scientific task force to define paint lifetime and how to measure it in a consistent way for various types of applications

The cost then should be relative to the hiring of a scientific committee and/or consultancy firm to define the guidelines for the standard methodology of testing. Considering a highly qualified consultancy firm, this cost could be EUR **100k-500k.** Once the standard is developed, there will be the additional cost of testing the materials (only once per material). This cost was evaluated to range between **EUR 10 000 and 20 000** by expert judgement.

What would be the benefits of the measure?

This measure will benefit all other measures on paints as the release of microplastics during the life cycle of paints is a critical knowledge gap. The indirect benefits will also include the awareness-raising of the paints value chain actors. If an EPR system is implemented, the eco-fee can also be modulated according to the volume of microplastic release and respective actors' contributions. It is already a necessary step to measure any reduction measure's success rate. This measure is essential to the implementation of measure PNT#2.

Economic Impact

Table 63: Impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	0	Paint producer	No cost
Administrative burdens on businesses		Paint producers/importers	No cost
Operation / conduct of SMEs	0	Paint producers	No cost
Functioning of the internal market and competition	0	Paint producers/ importers	No cost
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	European Commission	Cost related to the creation of the scientific task force and remunerating their job.
Public authorities: Change in costs to the Commission	0	European Commission / and EU institutions	No cost
Innovation and research	+	Paint maintenance professionals	No cost
Technological development / digital economy	0		No cost
Macroeconomic environment	0		No cost
Third countries and international relations	+	Paint producers in third countries	No cost
Consumers and household	0	Paint maintenance professionals & DIYers	No cost

Environmental Impact

Mildly positive indirect environmental impact is foreseen due to the fact that the discussion around the plastic definition can help clarify important points for other scientific studies and policy creation on the microplastic pollution issue as well.

Social impact

No social impact is foreseen.

7.5 Impact of measures for detergent capsules

Table below shows the comparison between all measures initially evaluated to reduce microplastic emissions from capsules.

Table 64: Comparison of measures for capsules

Measure	**Estimated reduction potential**		**Estimated Cost-effectiveness (EUR/tons reduced/year)**	**Other environmental impacts**	**Other economic impacts**	**Social impacts**
	%	**Ktons/ year**				
CAP#2: Apply current biodegradability standards to detergent capsules	Uncertain, with possibly high potential	5 060 (4 140 – 5 980)	2 207 (1 739-2 676)	Full biodegradation is ensured and reduction of microplastic pollution	Negative impact on industry, depending on the applicable standard (Costs associated with the effort to redesign their products to comply with new standards)	
CAP#1: Standardised methodology to quantify microplastics released from detergent capsules						
CAP#3: Redesign biodegradability standards for detergent capsules						

Table below shows the comparison of the impacts of the measures assessed to reduce microplastic emissions from capsules.

Table 65: Summary of impacts for measures for capsules

Policy Option	Environmental impact	Economic Impact	Social impact
CAP#2: Apply current biodegradability standards to detergent capsules	Reduction of plastic emissions from water-soluble plastics are difficult to estimate, but possible high potential	Estimated increased production cost of EUR 7.2 - 16 million/year (initial assessment)	
CAP#1: Standardised methodology to quantify microplastics released from detergent capsules	No emission reduction per se but helpful in other measures and knowledge improvement	EUR 100k-500k	There could be new jobs in the R&D sector (private company or research organisations) unless developed by the existing research staff
CAP#3: Redesign biodegradability standards for detergent capsules	Reduction of plastic emissions from water-soluble plastics	Standard development costs of EUR 500 000 - 1 million, and increased production cost (likely higher than CAP#2). Other impacts not assessed	Possible jobs in the R&D sector. Other impacts not assessed

The impact of each measure is outlined below.

<u>CAP#2: Apply current biodegradability standards to detergent capsules</u>

This measure will enable ultimate biodegradation of PVOH and related mixtures during and after wastewater treatments.

What would be the costs of the measure?

Applying the measure may come at a certain cost as water-soluble plastic producers will have to adapt some of their products to the biodegradation standard. The exact costs are difficult to assess, because it depends on the exact application of the standard. The standard could for example be applied according to its adaptation for polymers (i.e. without the application of the 10-day window).

Some of the additional costs to redesign their products could be estimated to be around 20% of the actual prices of detergent capsules based on technical discussions with some stakeholders (AISE members).

Knowing that the actual price of water-soluble plastics derived from PVOH for detergent capsules is around 2-4 EUR/kg and the annual volume of PVOH put on the market is at the low end 18 000 tons, thus the total cost to redesign their products would be EUR 7.2 million, or at the high end, the volume being 20 000 tons, the total cost would be EUR 16 million in order to comply with this measure. It might be expected that this cost would decrease due to innovation.

Therefore: 2EUR/kg * 18 000 tons * 20% = 7 200 000 EUR

Emission reduction potential: 4 140 – 5 980 tons

Cost efficiency, low end: 7 200 000 EUR / 4 140 tons= 1739 EUR per tonne
Cost efficiency high end: 16 000 000 EUR / 5 980 tons = 2676 EUR per tonne

This is thus only an initial assessment. As mentioned above, economic costs are difficult to assess and depend on the exact application of the standard.

What would be the benefits of the measure?

As soon as this measure is enforced, PVOH pollution is expected to reduce. While the exact extend of the reduction of microplastic releases is unknown, the maximum potential is full biodegradation, this would then result in an emission reduction potential of 4140 – 5980 tons/year.

Economic impacts

Table 66: Economic impact of the measure CAP#2

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	-	Water-soluble plastic producers	EUR 7.2 – 16 million / year (initial assessment)
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities or European Commission	Costs associated with the effort to implement these standards at the national level

Further analysis is also needed to estimated possible other economic impacts.

Environmental impacts

This measure is expected to have a positive impact on the environment in terms of the reduction of microplastic releases from water-soluble plastics. Adopting good practices for water-soluble plastics can give a real chance to properly manage the water-soluble plastics during wastewater treatment.

Social impacts

There are no social impacts foreseen.

CAP#1: Standardised methodology to quantify microplastics releases from detergent capsules

This measure was developed in response to the knowledge gaps that were identified around the precise level of microplastic emissions. Developing a standardised measurement methodology will enable the development of reduction-specific measures at a later stage.

This measure aims to increase the knowledge about PVOH's pathway to the different environmental compartments it may reach after being released from households. Currently, there is a lack of understanding regarding the compartment (sludge or water bodies) in which PVOH finally ends up and the repartitioning between them. This is an issue specifically when it comes to testing for the biodegradability of PVOH because the complete biodegradation of PVOH in natural conditions and after WWTP has not been demonstrated yet. Its degradation depends on environmental conditions as well as on the microorganisms present, and it is important to identify in which environmental compartments PVOH end up.

What would be the costs of the measure?

Its cost would be that of developing a sampling procedure as well as performing the sampling and analysing it. This cost would be borne by the Commission and should be then relative to the hiring of a scientific committee and/or consultancy firm to define the guidelines for the standard methodology of testing. Considering a highly qualified consultancy firm, this cost could be **EUR 100 000-500 000.** Once the standard is developed, there will be the additional cost of testing the materials (only once per material). This cost was evaluated to range between **EUR 500 and 1000** per sample.

What would be the benefits of the measure?

This measure will provide information on the release of microplastics by using detergent capsules since this is a critical knowledge gap that has been identified. The indirect benefits will also include raising awareness of the detergent capsule value chain actors and consumers. It is already a necessary step to measure any reduction measure's success rate. It would further increase our knowledge and understanding of PVOH's degradation.

Economic impacts

Table 67: Economic impact of the measure

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	0	Detergent manufacturers	The use of optimized/enhanced compositions used for water-soluble films will probably come at a neutral cost as detergent manufacturers are innovating to improve their products because of the demand of sustainable products. However, they need to contribute for the development of the method which would entail minor costs.
Operating costs and conduct of business	0	Water-soluble plastic producers	Having a measurable harmonised method will enable them to design better water-soluble films.
Operating costs and conduct of business	0/-	Wastewater management companies	The method itself will not impact the wastewater treatment companies but would enable them to estimate better the proportion of soluble plastics in the waste water.
Public authorities: Change in costs to authorities for administrative, compliance and enforcement activities	-	Member State competent authorities or European Commission	Public authorities could finance or supervise the development of the method, e.g. through national standardisation bodies.
Public authorities: Change in costs to the Commission	-	European Commission & EU institutions	Cost for the European Commission to fund the research for the development of the method.

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Innovation and research	+	Scientific community	The measure will deepen the understanding of the release of PVOH through detergent capsules.

Environmental impacts

This measure is expected to offer a better understanding about the impact of water-soluble films in the real environment. It will enable to select the most appropriate water-soluble plastic compositions with no adverse impact.

Social impacts

There are no social impacts foreseen.

CAP#3: Redesign biodegradability standards for detergent capsules

Here, a biodegradability standard would be re-designed, which would reflect the different environmental compartments and the associated conditions that PVOH coming from detergent capsules may encounter after it is released from WWTP. It would reflect the varying temperature conditions, presence (or absence) of the required microorganisms, and selectivity of the microorganisms (will it still degrade PVOH when in the presence of other competing food sources?).

What would be the costs of the measure?

The cost of setting up this measure would be borne by industry. It would consist in developing other testing procedures reflecting the natural environmental conditions met by PVOH once it is released. The cost was evaluated to be comparable to that of other similar measures and range between EUR 500 000 and 1 million. (For geotextiles (GEO#1), the cost of developing a standard would be EUR 0.63 million and EUR 2.85 million. For, CAP#1, this cost would be EUR 100 000-500 000.)

The above described measure (CAP#2: Apply current biodegradability standards to detergent capsules) is expected to have an impact on producers. It is likely that the impact of this measure (CAP#3) would be larger, as biodegradability criteria would be more stringent. This measure (CAP#3) can for instance lead to a ban of products already on the market. As at this moment, it is not clear how much such a new biodegradability standard would affect which PVOH grades would be compliant, it is also difficult to estimate the cost and other impacts, such as on the SMEs that produce these capsules.

What would be the benefits of the measure?

After the protocol has been developed and declared the right standard to evaluate PVOH's biodegradability, the standard has a potential for a full emissions reduction. However, the development of the standard alone will have a limited impact.

Economic impacts

A summary of the impacts is given in the table below.

Table 68: Economic impact of the measure CAP#3

Impact category	Qualitative scoring of impact	Affected stakeholders	Description of impact
Operating costs and conduct of business	--	Water-soluble plastic producers	Water-soluble plastic producers will have to set up new standards and replace their PVOH grades were needed.
Public authorities: Change in costs to the Commission	-	European Commission and EU institutions	Cost for the European Commission to support the development of the new standards
Innovation and research	+	Scientific community	The measure will deepen the understanding of the fate of PVOH grades in the different natural compartments.

Environmental impacts

This measure is expected to have a positive impact on the environment in terms of the reduction of plastic emissions from water-soluble plastics. The adoption of this measure for water-soluble plastics can give a real chance to the collection and good management of water-soluble plastics.

Social impacts

There are no social impacts foreseen.

7.6 Impact of measures for geotextiles

Table below shows the comparison between all measures evaluated to reduce microplastic emissions from geotextiles.

Table 69: Comparison of measures for geotextiles

Measure	**Estimated reduction potential**		**Estimated Cost-effectiveness (EUR/tons reduced/year)**	**Other environmental impacts**	**Other economic impacts**	**Social impacts**
	%	**Ktons/ year**				
GEO#2: Guidelines for geotextile use	18 – 74%	2 880 – 11 840	15 – 272 EUR/t	No impact on already installed geotextiles	Negative impact on costs for geotextiles users (municipalities, construction companies)	
GEO#3: Use biodegradable geotextiles for specific applications	Not quantified					

GEO#4: Establish geotextile classes according to emissions of microplastics	25 – 85%	8 340 (3 360 – 13 320)	27.5 (20 – 351 EUR/t)	No impact on already installed geotextiles Reduction of microplastic pollution in marine environment, air and soil	Negative impact on costs for geotextiles users (municipalities, construction companies)	
GEO#1: Standardised methodology to quantify microplastics released from geotextiles						

Table 70Table 70Table below shows the comparison of the impacts of the measures assessed to reduce microplastic emissions from geotextiles.

Table 70: Summary of impacts for measures for geotextiles

Policy Option	Environmental impact	Economic Impact	Social impact
GEO#2: Guidelines for geotextile use	Microplastic release reduction by 2 880 tonnes and up to 11 840 tonnes	Between EUR 174 000 - 785 000 for developing the guidelines	No social impact
GEO#3: Use biodegradable geotextiles for specific applications	Reduction in microplastics released from the use of polymer-based geotextiles in short-term applications	Increased product prices for end-users	No social impact
GEO#4: Establish geotextile classes according to emissions of microplastics	Reduction in microplastics released, especially combined with 2c	Increased burden for geotextile manufacturers leading to higher prices	No social impact
GEO#1: Standardised methodology to quantify microplastics released from geotextiles	No emission reduction per se but helpful in other measures and knowledge improvement	One-shot cost of developing the standard 0.63- 2.85 million euros. Cost of testing the materials is between EUR 2 500 per test	There could be new jobs in the R&D sector (private company or research organisations) unless developed by the existing research staff

The impact of each measure is outlined below.

GEO#2: Guidelines for geotextile use

This measure would be for the EC to support the development of guidelines by the industry regarding how to properly install geotextiles to achieve a certain goal while minimising microplastic releases. These guidelines would cover three main areas:

- What should be the polymer used for certain applications?
- What should be the manufacturing process?
- How should the geotextile be installed?

This could take the form of a decision tree accompanied by a set of guidelines specific for each case

What would be the costs of the measure?

The cost of this measure is expected to be mostly borne by the entity that will develop the guidelines (European Commission or the industry). The cost of this measure is expected to be between **EUR 174 000 -785 000.**

Indirectly, the cost of geotextile solutions may be increased due to the additional requirements for installing them to reduce microplastic releases while still achieving the desired mechanical properties. So an indirect impact of this measure would be to increase the cost of coastal erosion protection systems for municipalities, for example.

What would be the benefits of the measure?

This measure would enable the use of geotextiles for coastal erosion protection applications (and others, although this is the application expected to release most microplastics) in optimal conditions, which would reduce the microplastic releases significantly from newly installed geotextiles.

When the guidelines are in place, the reduction in microplastic releases may not be significant as it depends on the will of users to follow or not the guidelines. The industry estimate it to range between 60 and 80% but we consider it will be much lower 20-30%. However, this reduction would only concern the newly installed geotextiles; the previously installed materials exposed to the environment would continue to release microplastics. Therefore, we estimate that it would reduce microplastic releases by **2 880 tonnes and up to 11 840 tonnes.**

Economic impacts

The economic impacts are expected to be twofold:

- Economic impact for the industry: they will be the ones developing the guidelines; this would require full-time equivalents from the industry association (the EAGM[345] in the EU or the IGS[346] if the guidelines are developed at a scale broader than the EU). Additional costs would be incurred by testing the materials and installing said materials together with the sampling of microplastics to ensure that the guidelines effectively reduce microplastic releases.
- Economic impacts for consumers / users: it is expected that these guidelines will require that higher quality materials are used and that they are adequately protected. This will most likely increase the cost of using geotextile solutions instead of their alternatives (rocks,

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345 European Association of Geotextile manufacturers

346 International Geotextile Society

concrete structures, etc.). However, these economic impacts are expected to be reduced.

Environmental impacts

Environmental benefits are expected from this measure. Indeed, the guidelines will be designed with the goal of reducing microplastic releases. Thus, once they are in place, the emissions are expected to be significantly decreased. However, there are two caveats to this positive effect:

- It is possible that the guidelines may suffer from a significant delay from the industry during development, which would postpone the potential reduction of microplastic releases from this measure.
- All geotextiles which were installed before the publication of these guidelines will still release microplastics into the environment. Even more so, after they have been weathered by the environment, there is currently no scheme to remove geotextiles when they reach their end-of-life.

Social impacts

No social impact

GEO#5: Use biodegradable geotextiles for specific applications

Some geotextile materials are used to keep plants in place while they root. These materials are used for applications which are by definition short-lived and which will be impossible to recover once the plants have grown through them. Therefore, enforcing the mandatory use of biodegradable and bio-based materials made of jute, coco fibres, or others should significantly reduce microplastics from these materials.

What would be the costs of the measure?

This measure would increase the cost of the materials used for vegetation placement because biodegradable fibre geotextiles are more expensive than their non-biodegradable counterparts. In most cases, a biodegradable fibre has a natural origin, although not always. So, the cost for municipalities would increase. Moreover, members of the industry would suffer losses from the inability to sell their products, so an adaptation period will be necessary.

What would be the benefits of the measure?

There would be a reduction of microplastic releases from the use of polymer-based geotextile for short-term applications.

Economic impacts

The main economic impact will be on the end users as they will bear the additional costs of the biodegradable material, compared to the non-biodegradable ones.

Environmental impacts

This measure is expected to have a good positive impact on the environment in terms of the reduction of microplastic release as biodegradable in natural environment. Biodegradation will have to be supported by an appropriate standard.

Social impacts

There are no social impacts foreseen.

GEO#4 Establish geotextile classes according to emissions of microplastics

In the Construction Products Regulation (CPR), material classes can be defined through delegated acts depending on the quality/strength requirements for a given construction product. A similar system could be used for geotextiles: geotextile materials, depending on their manufacturing method, polymer type, and additive content (type of additive and concentration), could be classified according to quality standards based on the measurement protocols developed under 5f. Then, requirements regarding the minimum material class to use depending on the application would be made available, and only the accredited materials could be used for these applications.

What would be the costs of the measure?

The measure would need GEO#1 to be implemented before, in order to quantify the microplastic releases from geotextiles. The measure's cost would be due to developing the different material classes as well as testing the geotextiles to determine their class and defining for what application can a certain class of geotextile be used.

What would be the benefits of the measure?

This measure is expected to reduce microplastic releases from the installation of new geotextiles, and it is expected to reduce the emission faster than 2c (guidelines for geotextile applications) because it is expected to be implemented faster through a regulatory action than what the industry could do. The geotextiles may still be exposed to harsh environmental conditions, especially to weather events of unpredictable scale such as storms and could release some microplastics.

Economic impacts

It is expected to increase the impact on manufacturers to fulfil the class labelling obligations of the CPR. Increase costs of geotextile will also impact the cost for installing geotextiles for final users (e.g. municipalities, public works companies, landfill management companies etc. However, during the stakeholder consultation on levels and classes of performance (Article 27, Article 60) of the CPR, 64% of the respondents indicated no impact for establishing classes of performance and threshold levels in relation to the essential characteristics of construction products, some stakeholders believed that the process for establishing classes will be more time consuming and onerous.[347]

Environmental impacts

The reduction of microplastic releases is expected to be higher than 2c but in combination with 2c the reductions will be higher.

Social impacts

There are no social impacts foreseen for this measure.

GEO#1: Standardised methodology to quantify microplastics released from geotextiles

This measure was developed in response to the knowledge gaps that were identified around the precise measurement of microplastic emissions. Developing a standardised measurement methodology will enable the development of reduction-specific measures at a later stage.

This measure aims to develop a protocol to effectively measure microplastics released from geotextiles over the life cycle. There is evidence that microplastics are emitted from geotextiles; however, the quantification of such emissions still eludes researchers. Indeed, a systematic approach

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[347] RPA (2015) Analysis of implementation of the Construction Products Regulation, DG GROW, European Commission

to microplastic sampling for geotextile particles in the environment currently does not exist. Moreover, since geotextiles are installed in various ways and for a wide range of applications, there would be some value in systematically taking samples to measure microplastic releases to the environment from different materials and installation methods.

The main goal of this measure would be to increase our understanding of the issue by developing a measurement methodology valid for measuring microplastic releases from different geotextile sources. E.g., different materials (PET, PP, etc.), different manufacturing processes (woven, non-woven, etc.). This should cover the complete life-cycle, i.e. producing geotextiles, their use in applications and end-of-life management.

Currently, there are tests used to evaluate the degradation of geotextiles from different weathering agents (UV light, temperature variation, water/saltwater,[348] oxygen exposure[349] or abrasion[350]).[351,352,353] The ISO 22182 test method simulates abrasion impacts on geotextiles and geotextile-related products such as that caused by the movement of rocks in an embankment or transport of sediment in rivers. This test can be used as a performance test by comparison of mechanical and/or additionally hydraulic properties before and after abrasion impact. Though not intended for assessing microplastic release, it could potentially simulate the development of abrasion-resistant geotextiles.[354] These methods do yield results which are currently used for the determination of geotextiles' lifetime expectancy. Still, they may not reflect the weathering power of the natural environment, especially when these affect the geotextiles conjointly. A recently published study highlighted the destructive effect that interacting weathering agents could have on geotextile aging:[355] "*The results, among other findings, showed the existence of relevant interactions between the degradation agents and showed that the reduction factors obtained by the traditional methodology were unable to represent accurately (by underestimating) the degradation occurred in the geotextile.*"

What would be the costs of the measure?

The costs would be split into two:

First, there would be the cost of developing the methodology (EUR 630 000-2 850 000).

Second, there would be the cost of testing the materials (EUR 2500/sample).

The estimated cost of developing the standard is shown in the below.

348 EN 12447, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Hydrolysis in Water, European Committee for Standardization, Brussels, Belgium, 2001.

349 EN ISO 13438, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Oxidation, European Committee for Standardization, Brussels, Belgium, 2004.

350 ISO 22182 :2020, Geotextiles and geotextile-related products — Determination of index abrasion resistance characteristics under wet conditions for hydraulic applications

351 EN 14030, Geotextiles and Geotextile-Related Products-Screening Test Method for Determining the Resistance to Acid and Alkaline Liquids, European Committee for Standardization, Brussels, Belgium, 2001.

352 EN 12224, Geotextiles and Geotextile-Related Products-Determination of the Resistance to Weathering, European Committee for Standardization, Brussels, Belgium, 2000.

353 EN 12226, Geosynthetics—General Tests for Evaluation following Durability Testing, European Committee for Standardization, Brussels, Belgium, 2012.

354 Maisner et al. (2019) Geosynthetics in traffic infrastructure construction in contact with groundwater and surface water – Environmental aspects. Georesources Journal (special issue)

355 Carneiro, José Ricardo et al. "Laboratory Evaluation Of Interactions In The Degradation Of A Polypropylene Geotextile In Marine Environments". Advances In Materials Science And Engineering, vol 2018, 2018, pp. 1-10. Hindawi Limited, doi:10.1155/2018/9182658. Accessed 2 May 2022.

Table 71: Assumptions and data to estimate the costs of developing and implementing a standard

Description	Data	Unit	Source
Number of people working full time necessary to elaborate the standard between 12 and 36 months[356]	7.25	people	ISO website
Mean cost of labour in EU of one engineer working full-time	39.5	EUR/hour	Eurostat
Number of hours per week in a full-time job	40.6	hours/week	Eurostat
Number of Geotextile manufacturers in the EU	34	Number	Total EU members of the IGS and EAGM
Fraction of companies conducting tests for elaborating the standard	5	%	Assumption

Therefore, the **one-shot** cost of developing the standard would be in the range of **EUR 0.63 million and EUR 2.85 million** depending on the time it takes to develop the measurement standard.

In addition, once the standard is developed, there will be the additional cost of testing the materials (only once per material). This cost will be about 2,500 euros per test[357] according to ISO 22182.

What would be the benefits of the measure?

This measure will benefit all other measures as the release of microplastics during the life cycle of geotextiles is a critical knowledge gap. The indirect benefits will also include the awareness-raising of the geotextile value chain actors and users of geotextiles. If an EPR system is implemented, the eco-fee can also be modulated according to the volume of microplastic release and respective actors' contributions. It is already a necessary step to measure any reduction measure's success rate. Such information will also be useful in restricting the use of specific geotextiles in certain applications, such as coastal erosion, navigable waterways, etc.

This could be used to support further legislative development based on the evidence of microplastic releases from geotextiles. Another development could be to increase the industry's awareness about the emissions of microplastics from their materials. This would be exhibited by the industry focusing their efforts on developing new materials releasing fewer microplastics as well as considering microplastic releases whenever they develop geotextiles. Finally, this increased knowledge could be used to improve any type of recommendation regarding which material and manufacturing process to use for certain geotextile applications, as well as their installation requirements, as the results of this measure's test could point towards certain combinations releasing more than others.

Economic impacts

The economic impacts are expected to be limited because the cost of developing the sampling and testing protocols would be borne by the Commission.

[356] The ISO technical committee on the environmental aspects of plastics is comprised of 29 members (the national standardization organisation). We assume that each member contributes 0.25 FTE to work on the committee.

[357] https://materialtestinglab.org/

Environmental impacts

The direct environmental impacts are expected to be very limited, given that this measure is targeted at increasing our understanding of the issue. However, the secondary environmental impacts could be significant, especially if the industry takes up the practice of designing their products with the reduction of microplastic releases in mind.

Social impacts

There are no social impacts foreseen.

7.7 Overview of possible measures to improve source characterisation

The study of the six sources of unintentional microplastics has shown that many knowledge gaps still exist in the precise measurement of emissions. These knowledge gaps make the implementation of several measures impossible in the short term as it's not possible to define them (e.g. reduction targets) or evaluate their impact adequately.

Consequently, several measures that aim at increasing the knowledge of microplastic releases through the development of standards and methodologies in all sectors but tyres are recommended and presented in the table below.

These measures do not allow any reduction of microplastic releases per se; therefore, their cost-effectiveness cannot be assessed. Unlike other measures, the cost would be one-shot. They should be seen as enablers for other measures.

Table 72: Horizontal measures

Measure	Estimated cost
TEX#1: Standardised methodology to quantify microplastics releases from textiles	EUR 850 000 Testing cost EUR 10 000-20 000
PNT#1: Standardised methodology of paint lifetime	EUR 100 000 - 500 000 Testing cost EUR 10 000 -20 000
CAP#1: Standardised methodology to quantify microplastics released from detergent capsules	EUR 100 000 – 500 000 Testing cost: EUR 500-1000 per sample
GEO#1: Standardised methodology to quantify microplastics released from geotextiles	EUR 630 000 - 2 850 000 Testing cost about EUR 2 500 per sample

7.8 Abatement curve of assessed measures

The cost-effectiveness of individual measures was assessed as far as possible with the best available data. This has allowed for a ranking of the measures in terms of the cost to abate a tonne of microplastics. The abatement curve for all measures evaluated is shown in the figure below. The average or most plausible value is used for each measure, knowing that there is uncertainty about the data, depending on the source and measure, as explained in the annexes.

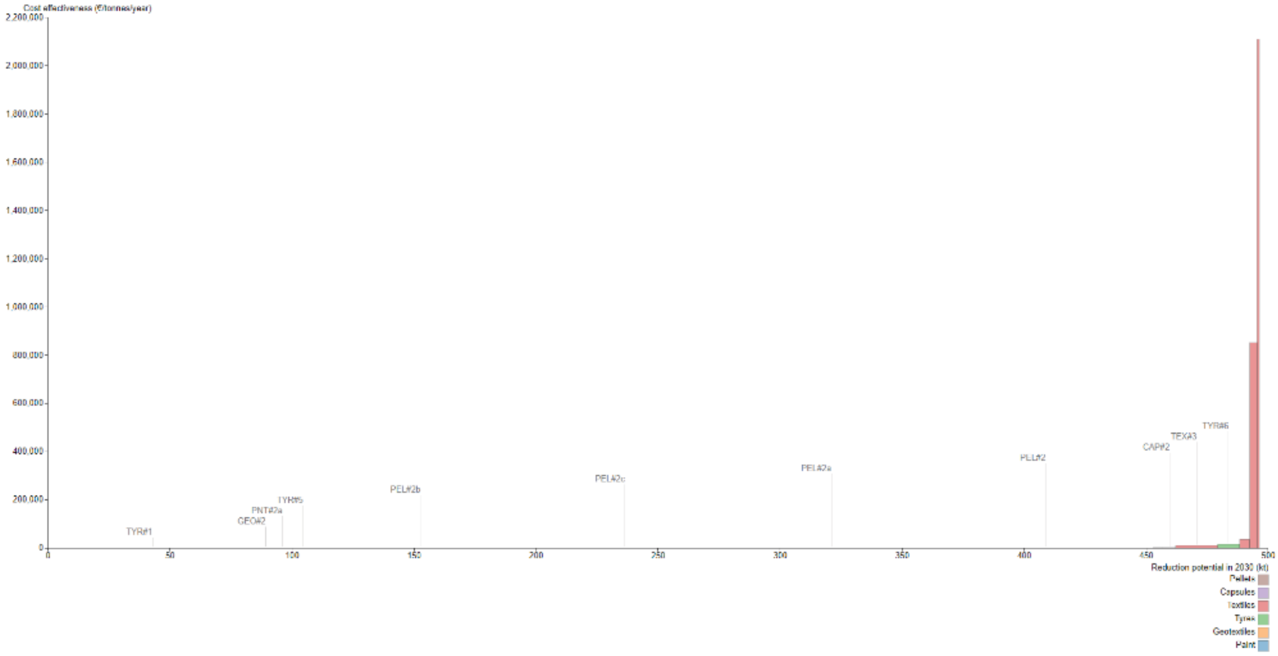

***Figure 49: Abatement curve of all evaluated measures*[358]**

As the order of magnitude of the cost-effectiveness of the measure is different, a zoom of selected measures is displayed in the figure below.

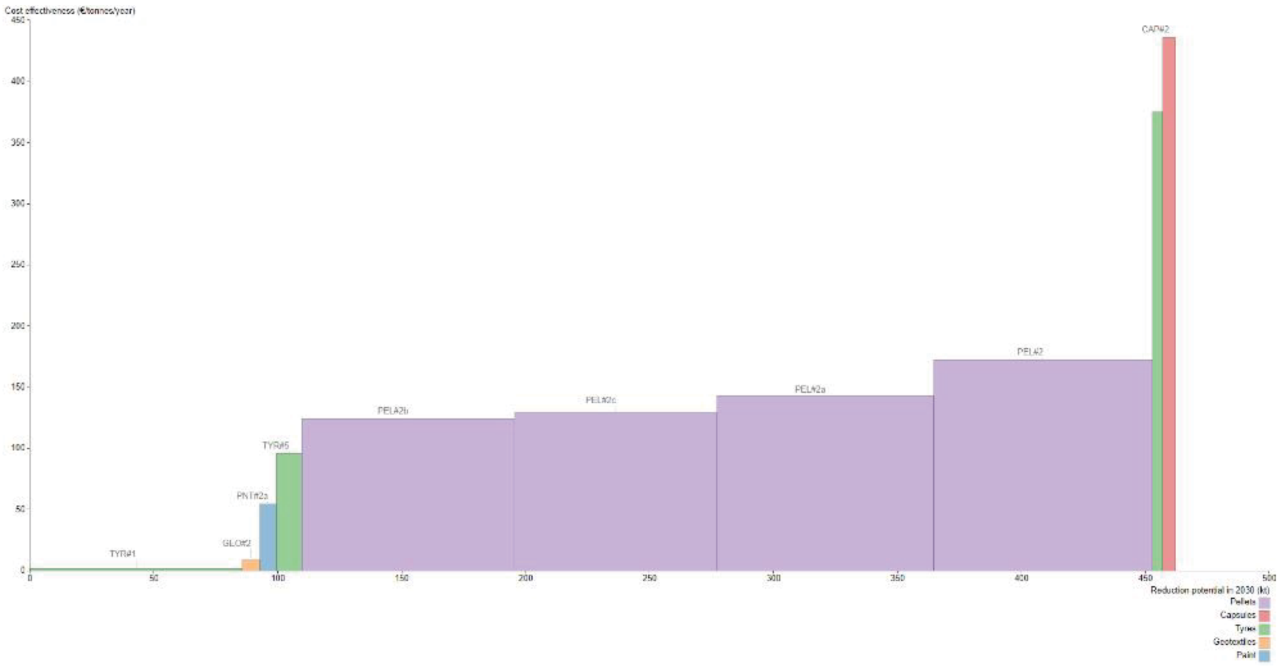

Figure 50: Abatement curve of evaluated options with cost effectiveness inferior to 6 k EUR/t microplastics/year

[358] TYR#5 and TYR#6 may have positive impacts in terms of fuel savings for customers.

8. Rationale for not yet pursuing the measures for sources: paints, tyres, textiles, detergent capsules, geotextiles

This section explains why the analysis of policy measures targeting five of the major sources of unintentional releases of microplastics were not pursued in this SWD. Indeed, the Commission's original mandate when this exercise begun was to assess all major sources of unintentional releases of microplastics. For this reason, these sources were examined and measures were identified. The preliminary analysis presented in Annex 15 shows that there is potential to reduce and prevent unintentional microplastics releases from sources such as paints, tyres, synthetic textiles, detergent capsules and geotextiles. However, the analysis also demonstrates that existing and upcoming policy instruments are better suited to tackle the unintentional microplastics releases from some of these sources, subject to additional information on cost-effectiveness, more sustainable alternatives, and the impacts and footprint of alternative actions. On a number of other sources, more information is needed in order to better understand their patterns and frame the most appropriate interventions.

Paints – Paints are widely used and on average 37% plastic polymer-based, making them a significant source of microplastic releases. While shifting towards mineral paints would help reduce microplastic releases, it is not clear yet if this would lead to an increase of other environmental impacts. The full environmental profile andlife-cycle assessments of polymer and mineral paints are not available yet. Once this information is obtained, requirements on microplastics in paints could be introduced via the Ecodesign for Sustainable Products Regulation (ESPR)[359], where paints is one of the twelve priority products.

Tyres – Tyre abrasion leads to the release of microplastics. It emerged during our analysis that these releases are already being targeted in the EURO 7 Regulation proposal[360] and may be addressed by a delegated act under the Tyre Labelling Regulation.[361]

Synthetic textiles – Most apparel is now made out of plastic fibres and releases microplastics. Some key challenges encountered in the course of the assessment are that microplastic releases from synthetic fibres occur throughout the value chain, that most of their production takes place outside of the EU, and that there is not sufficient data regarding the profiles of different synthetic fibres and fibre combinations in terms of microplastic releases. Subject to a better understanding of releases from synthetic textiles thanks to a standardised measurement methodology, along with more life-cycle data of alternatives' impacts, relevant measures could be introduced in the framework of the Ecodesign for Sustainable Products Regulation as announced in the EU Strategy for Sustainable and Circular Textiles. Such an approach will ensure the environmental sustainability challenges of textiles are addressed in a coherent and integrated way.

Detergent capsules – Laundry and dishwasher detergent capsules often rely on a dissolvable plastic film to dispense their product during the wash. However, this film could cause microplastic pollution if not completely biodegradable. More information on this possible lack of biodegradation is needed. Subject to scientific evidence pointing towards a need for biodegradability criteria, future action could be taken under the proposed Detergents Regulation through the adoption of delegated acts.

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359 Proposal for a regulation of the European Parliament and of the Council COM/2022/142 final establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC.

360 Proposal for a regulation of the European Parliament and of the Council COM/2022/586 final on type-approval of motor vehicles and engines and of systems, components and separate technical units intended for such vehicles, with respect to their emissions and battery durability (Euro 7) and repealing Regulations (EC) No 715/2007 and (EC) No 595/2009.

361 Regulation (EU) 2020/740 on the labelling of tyres with respect to fuel efficiency and other parameters, amending Regulation (EU) 2017/1369 and repealing Regulation (EC) No 1222/2009.

Geotextiles – Geotextiles are a source of microplastic releases as they are mostly synthetic, used in harsh conditions and not removed at the end of their service life. However, data on their uses and profile in terms of degradation and microplastic releases is scarce. Once more data is available, future action could be taken in the framework of the Construction Products Regulation.[362]

Horizontal measures for all five sources – In order to bridge the data gaps on the unintentional release of microplastics from the above five sources, standardised measurement measures could be pursued through Research and Innovation Programmes by funding relevant research projects or under the Standards Regulation.[363] In particular for sources of microplastics that were already relatively known such as for tyres and textiles, this process is already ongoing.

[362] Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.

[363] Regulation (EU) No 1025/2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC.