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SOS-ZEROPOL2030

D4.4 Case Study Pollutant Factsheets

Public

Authors: Andy M. Booth, Rian Ruhl, Freddy van Hulst, Remco Lameijer, Thomais Vlachogianni

Research Institutes: SINTEF Ocean, GRID Arendal, MIO-ECSDE, Wageningen Research, Wageningen University

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1	31.08.2025	Andy Booth	All listed authors	UCC	Kathrin Kopke, Orla-Peach Power

Authors (alphabetical)	
Name	Organisation
Booth, Andy	SO
Lameijer, Remco	GRID-Arendal
Ruhl, Rian	WR
Van Hulst, Freddy	WU
Vlachogianni, Thomais	MIO-ECSDE

Acknowledgements/contributions (alphabetical)	
Name	Organisation
Cowan, Emily	SO
Del Savio, Linda	RIFS
Fylakis, Georgios	GRIDA
Hansen, Bjørn Henrik	SO
Igartua, Amaia	SO
Maes, Thomas	GRIDA
Nepstad, Raymond	SO
Sørensen, Lisbet	SO
Thoden van Velzen, Ulphard	WR
Van Leeuwen, Judith	WU

Disclaimer

Please note that the following report is under review and awaiting approval by the SOS-ZEROPOL2030 Project Officer on behalf of the European Commission.

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Executive Summary

D4.4 'Case Study Pollutant Factsheets' was developed in collaboration with WP6 and contains the finalised and combined 'Integrated Analysis and Scenario Development' (M4.1 - M4.3). D4.4 comprises a 3-page factsheet about per- and polyfluoroalkyl substances (PFAS) and a 3-page factsheet about tyre wear particles (TWPs). The factsheets have been delivered as part of Task 4.6: 'Case study leads and document preparation' and have been developed with support and contributions from SO, Grid-Arendal, WU, WR, and MIO-ECSDE.

Each case study pollutant factsheet summarises the key information generated in WP4 of the SOS-ZEROPOL2030 project, covering (i) emission sources along the value chain, (ii) an overview of the current environmental risk, (iii) existing value chain and technological actions and strategies, (iv) current governance strategies/efforts/arrangements, and (v) a summary of the scenario development and impact assessment for achieving zero pollution for the regional case studies.

The PFAS and TWP factsheets will be published on the SOS-ZEROPOL2030 website under 'Resources' for download and printing at scale.

1. Introduction

The D4.4 Case Study Pollutant Factsheets deliverable comprises a 3-page factsheet about per- and polyfluoroalkyl substances (PFAS) and a 3-page factsheet about tyre wear particles (TWPs). It is part of Task 4.6: 'Case study leads and document preparation'.

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2. Methods

The text utilised in the development of these factsheets ensures scientific accuracy while also being accessible to multiple audiences. They have been designed to be easily disseminated across digital platforms (e.g. websites, social media) and to be printed out and used at front facing stakeholder-focused events. The production of the factsheets was done using Adobe Illustrator and InDesign. The former was used to design the visual assets (i.e. illustrations, graphics), while the latter was used to produce the layout.

2.1. PFAS Factsheet

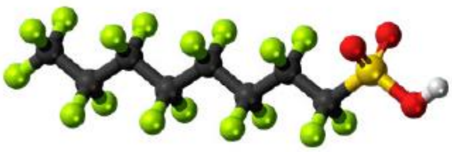
The PFAS factsheet is based on information presented in deliverables D4.1, D4.2 and D4.3. Key statements that can be quickly and easily read by external stakeholders and other members of the SOS-ZEROPOL2030 project consortium were extracted from these documents. As the Living Labs were dedicated to PFAS in the medical sector and to PFAS governance in the Black Sea basin, the scenarios and drivers that are shown on the factsheet were produced by combining those of both Living Labs into a single, more generic table that is representative for the pollutant in general. The text and the table on the factsheet were first developed in a spreadsheet and connected with representative images from D4.1-D4.3 and from slides that are part of presentations that were held in the context of SOS-ZEROPOL2030. These draft documents were then used as a basis for developing the final factsheet using Adobe Illustrator and InDesign. The draft factsheet was reviewed by all partners involved in the development process (WR, MIO-ESCDE, SO, WU) and by the project coordinator (UCC) prior to finalisation and submission. The final page of the TWP factsheet features the outcomes of the scenario development for reducing TWP emissions in the EU. A copy of the TWP factsheet is presented in Figure 1, while the full factsheet is submitted as a standalone Annex to this report (Annex 1).

Understanding PFAS

Usage, emissions, and risks

Funded by the European Union's Horizon Europe programme under grant agreement No. 101060213.

Per- and polyfluorene alkyl substances (PFAS) form a group of thousands of different persistent organic chemicals. PFAS have at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–), following the OECD definition.



PFAS are highly versatile materials that can be solid, liquid, or gaseous. Their properties are useful in a wide range of products in transportation, textiles, healthcare, industrial manufacturing, lubricants, agriculture, and many other sectors.

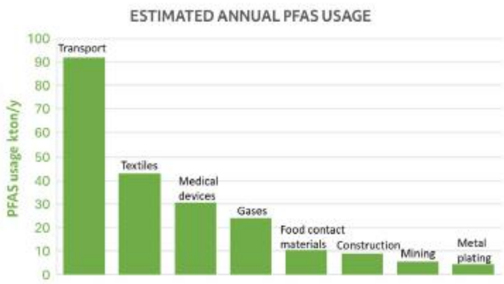
Where are PFAS emitted and how do they move?
PFAS emissions can occur in many stages of a product lifecycle. Fluoropolymers generally don't cause emissions during use, but their production and their end-of-life treatment can create emissions. PFAS used as a manufacturing aid during fluoropolymer production cannot be recycled or recovered completely and may be emitted through flue gas or wastewater.

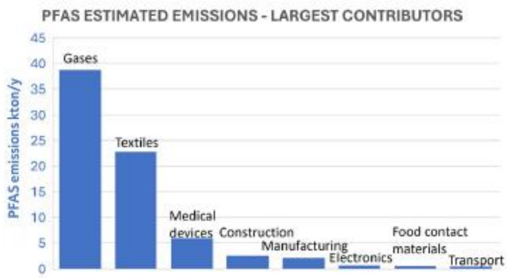
High persistence is among the main concerns related to PFAS. For some, the degradation in a natural environment is very slow, while others transform into other PFAS that barely degrade. Many PFAS are mobile and bioaccumulative, some are toxic. Not all PFAS have been proven to cause adverse health effects, in part related to the existence of thousands of different molecules that are a PFAS.

Even if a PFAS is not harmful by itself, manufacturing and end-of-life processing of that material could lead to emissions of other PFAS that are harmful.

Usage and emission volumes of PFAS were estimated in the restriction proposal under REACH. These numbers give an idea about the disconnect between the amount of PFAS used and the amounts emitted per sector.

PFAS usage in 'Transportation' is much higher than under 'Gases', but emissions show the opposite. Gases are often emitted upon use, while sealings or cable hoses last for decades. The estimations do not include emissions during end-of-life, the lifecycle stage in which solid products are expected to cause emissions.





There are large differences between PFAS in how they move through the environment. Some are relatively volatile and travel long distances through the atmosphere, while others are highly water-soluble, and again others adhere easily to hydrophobic substances such as organic matter or microplastics. Rivers typically bring the highest volumes of PFAS to the sea or lake into which they discharge, and 'legacy' PFAS, which should not be used anymore, still form a significant fraction of these.

Towards minimal PFAS emissions

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Incineration or upcoming PFAS destruction technologies cannot avoid emissions from manufacturing and use. Avoiding PFAS where possible is thus the main route to minimize PFAS pollution.

Replacement of PFAS by alternatives is possible in a wide variety of products (e.g. using propane instead of a fluorinated refrigerant in A/C systems, or using a PFAS-free coating to make apparel water-repellent). Sometimes, using a different product or approach is more feasible than replacing PFAS in an existing product. For example, for some patients it is feasible to use a powder inhaler instead of one that contains a fluorinated gas as propellant.

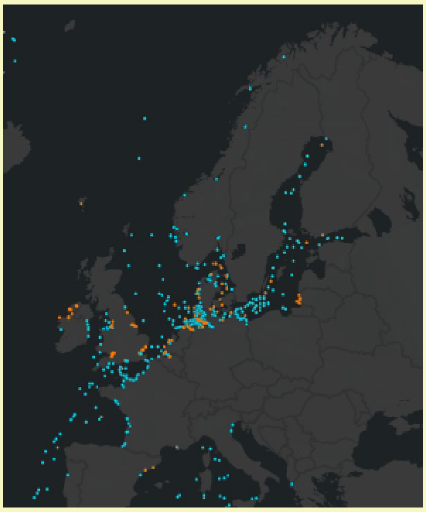
For some PFAS-containing products there is no PFAS-free alternative available yet, emissions associated with production, use and end-of-life of these products should be minimized. In PFAS production, improved wastewater treatment, flue gas scrubbing, and thermal oxidation of byproducts and flue gases can help to minimize emissions.

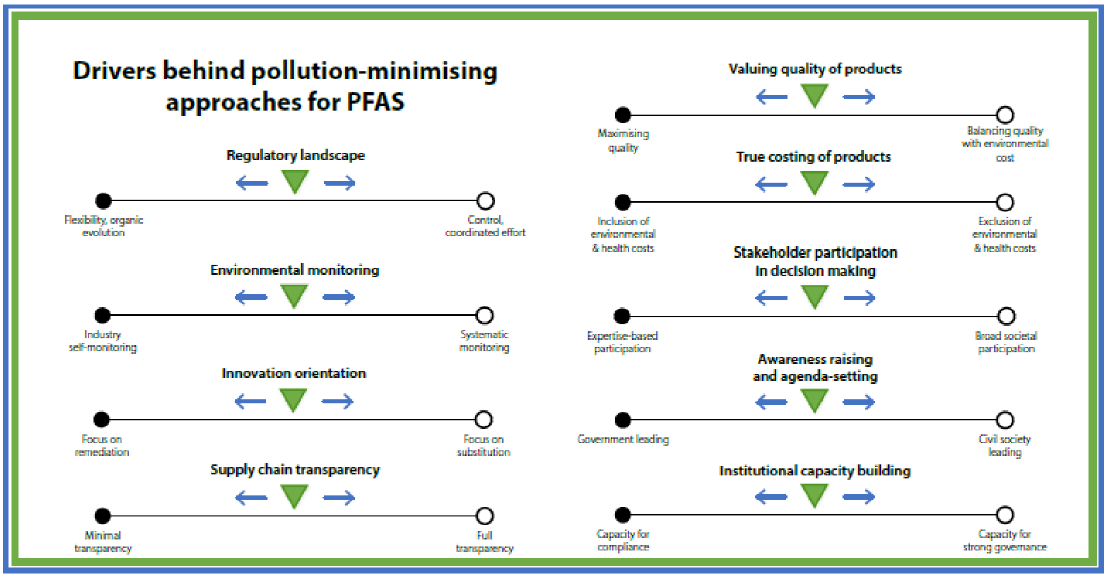
Working towards zero pollution can be achieved through different strategies. Stakeholder-led participatory workshops (Living Labs) were used to build a holistic overview of strengths and weaknesses of these strategies. In the North-East Atlantic region, the LLs focused on reducing PFAS emissions from the medical sector throughout the product chain. The LLs in the Black Sea region focused on aspects such as future PFAS governance in the region, the role of the EU, and how to improve monitoring in the region.

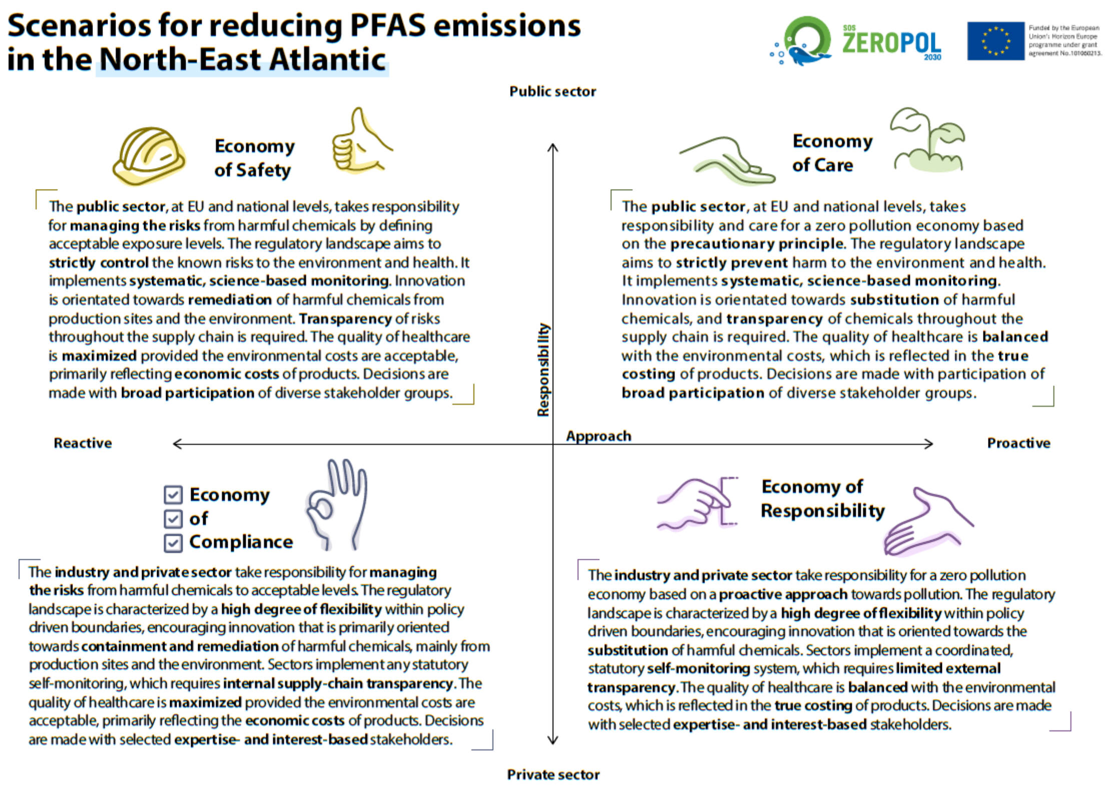
Each LL worked with a specific set of four scenarios, based on the same principles: who takes **responsibility** (public-private or EU-region) and the **approach to minimise pollution** (reactive-proactive). The graph below lists the drivers that formed the basis for the Living Lab scenarios, which are shown on the next two pages.

What data are available for PFAS concentrations in marine matrices?

The Risk Assessment Tool developed within SOS-ZEROPOL2030 shows PFAS concentrations in marine matrices (see image). Concentrations above the Environmental Quality Standard (EQS) for 'other surface waters', 0.03 ng/L are shown in orange.







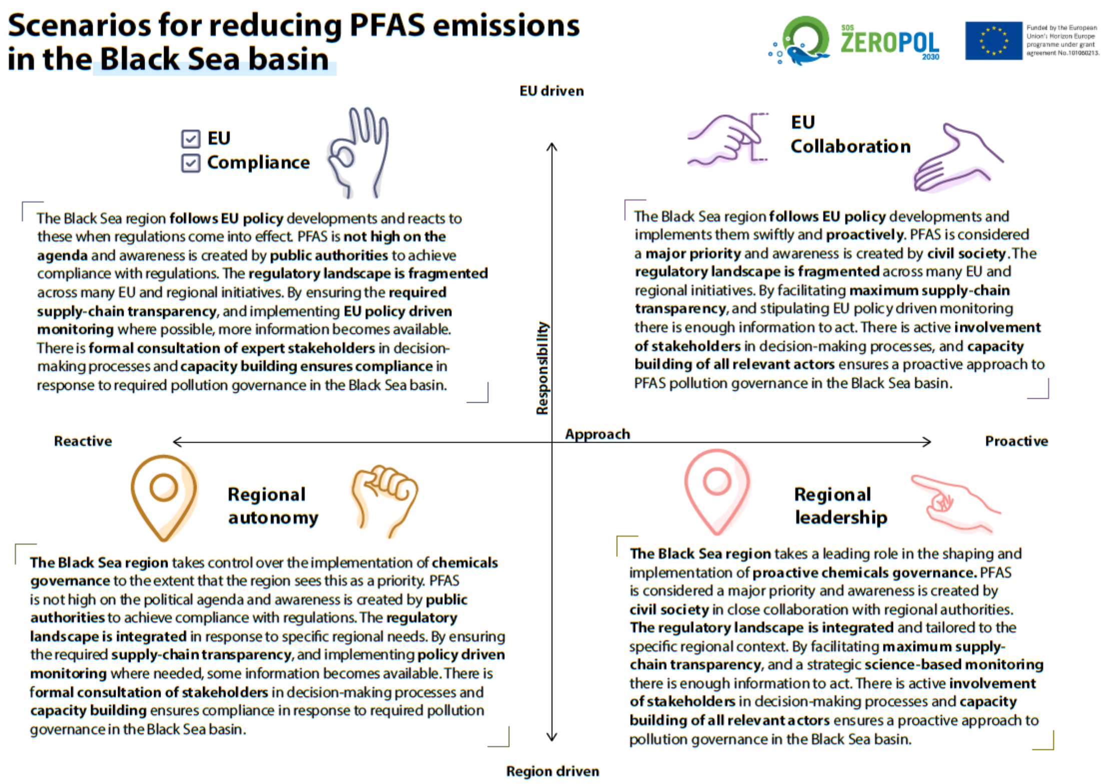


Figure 1. PFAS factsheet (4 pages in total).

2.2. TWP Factsheet

The TWP factsheet was compiled from information summarised in deliverables D4.1, D4.2 and D4.3. The main outcomes and information generated in that work have been condensed and summarised into key statements that can be quickly and easily read by external stakeholders and other members of the SOS-ZEROPOL2030 project consortium. The text was first developed in Word and PowerPoint documents, and connected with representative images from D4.1-D4.3. These draft documents were then used as a basis for developing the final factsheet using Adobe Illustrator and InDesign. The draft factsheet was reviewed by all partners involved in the development process (WR, MIO-ESCDE, SO, WU) and by the project coordinator (UCC) prior to finalisation and submission. The final page of the TWP factsheet features the outcomes of the scenario development for reducing TWP emissions in the EU. A copy of the TWP factsheet is presented in

Understanding Tyre Wear Particles

Emissions, Pathways & Risks

Funded by the European Union's Horizon Europe programme under grant agreement No. 101060213.

What are tyres made of?

Vehicle tyres are more than just rubber. In fact, natural rubber accounts for just 19% of a car tyre, with synthetic polymers accounting for 24%, fillers for 26% and additive chemicals 14%. Tyre design is optimized to deliver high performance in key areas such as safety, (wet)grip, rolling resistance, and noise reduction.

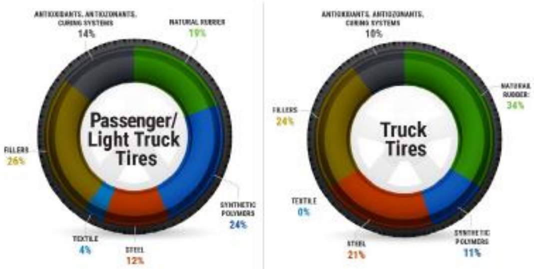


Image from U.S. Tire Manufacturers Association

Tyre wear particles (TWPs) are tiny fragments that are released from tyres as they wear down and have been recognized as a significant source of microplastics, small plastic particles less than 5 mm in size, in at least two dimensions. The amount of TWPs released and their concentration in the environment are highly variable, both spatially and temporally.

Vehicle tyres and the emitted TWPs are known to contain a high amount and diversity of potentially hazardous chemicals, many of which have been shown to partition or leach into environmental matrices. These are called **tyre wear chemicals (TWCs)**, with nearly 800 additives and non-intentionally added substances (NIAS) known to be used or present in tyres and TWPs.

TWPs and TWCs emissions and risk

TWPs are primarily produced through the friction and wear of tyres upon driving vehicles, meaning that urban, highway and rural roads are the main point sources of TWP emissions, with a direct link between increasing traffic volumes and higher TWP emissions. Heavier vehicles emit more particles by distance travelled, while braking, accelerating and turning further increase emissions.

The available evidence strongly suggests that it is the TWCs and their associated leachates that are the drivers of TWP toxicity to (marine) organisms. Despite the scarcity of environmental concentration and effect data for TWCs and leachates, we expect adverse ecological effects to occur in the marine environment.

TWPs and TWCs transport and accumulation

Roadside soil receives 45-80% of TWPs and surface waters receive 6-26%, while the smaller TWPs can remain airborne for long periods. TWPs and low mobility TWCs will accumulate in marine sediments, while smaller TWPs and mobile TWCs may be transported away from deposition sites. Estuaries and coastal zones are the primary accumulation zones, especially those closest to urban areas that act as a point source of TWPs.

Image from Wikimedia Commons by TaurusEmerald

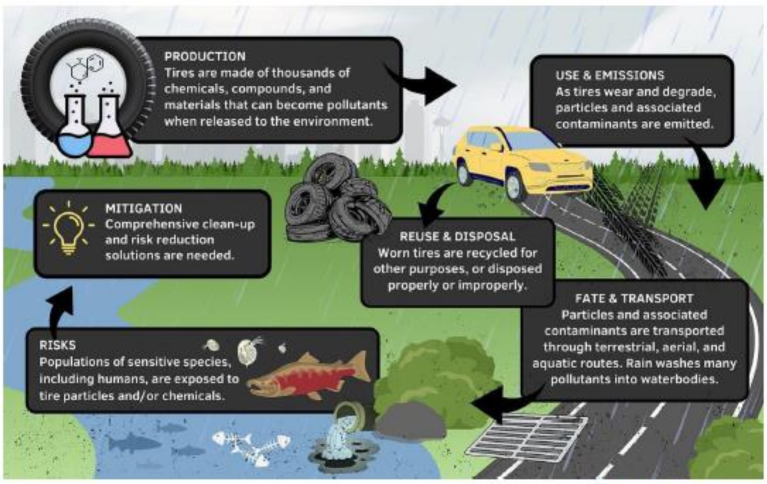


Image from Mayer et al. (2024)

Towards Minimal TWP Emissions

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The EU Ecodesign Regulation

The Ecodesign for Sustainable Products Regulation (ESPR), replacing the Ecodesign Directive, establishes a comprehensive framework for setting ecodesign requirements, across specific product groups. These requirements include aspects such as energy use and efficiency, durability, and reliability. The ESPR 2025-2030 working plan covers priority products, including tyres.

Image from Ecodesign for Sustainable Products Regulation (ESPR), European Commission (2024)

The EU Urban Wastewater Treatment Directive

The revision of the Urban Wastewater Treatment Directive (UWWT) includes new measures to tackle microplastics, such as advanced wastewater treatment technologies and improved monitoring of microplastic levels. Additionally, an Extended Producer Responsibility scheme requires manufacturers of microplastic-contributing products, like textiles and tyres, to help fund these wastewater treatment upgrades.

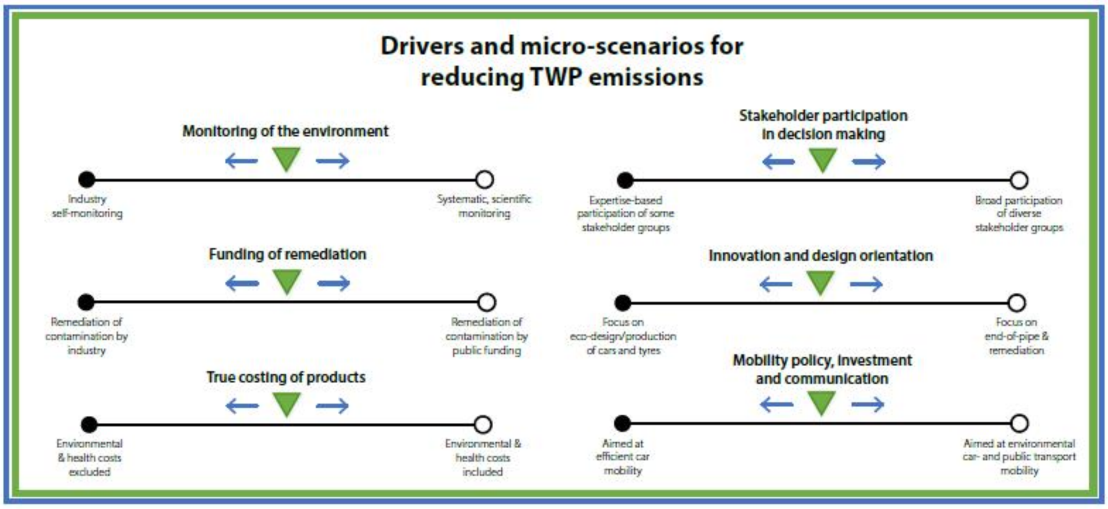
Stakeholder-driven evaluation of scenarios for achieving zero pollution

Stakeholder engagement is key to achieving zero pollution. At the heart of SOS-ZEROPOL2030, Living Labs co-created science-based, purpose-fit solutions. Two rounds of Living Labs in the Mediterranean basin led to the development and evaluation of four scenarios. These scenarios were structured around two critical axes: **responsibility**—ranging from private-sector-led to public-sector-driven solutions—and **approach**, spanning from reactive measures to proactive interventions. The drivers behind these scenarios are shown below.

Measures to tackle TWPs

Tackling TWPs requires a mix of regulatory, technological, and social engagement measures, deploying a three-tiered approach that focuses on source control, process control, and end-of-pipe management. This integrated strategy addresses emissions across the entire life cycle of tyres, from design and use to runoff and particles capture and removal, ensuring more effective and sustainable pollution reduction.

A three-tiered approach to tackling TWPs



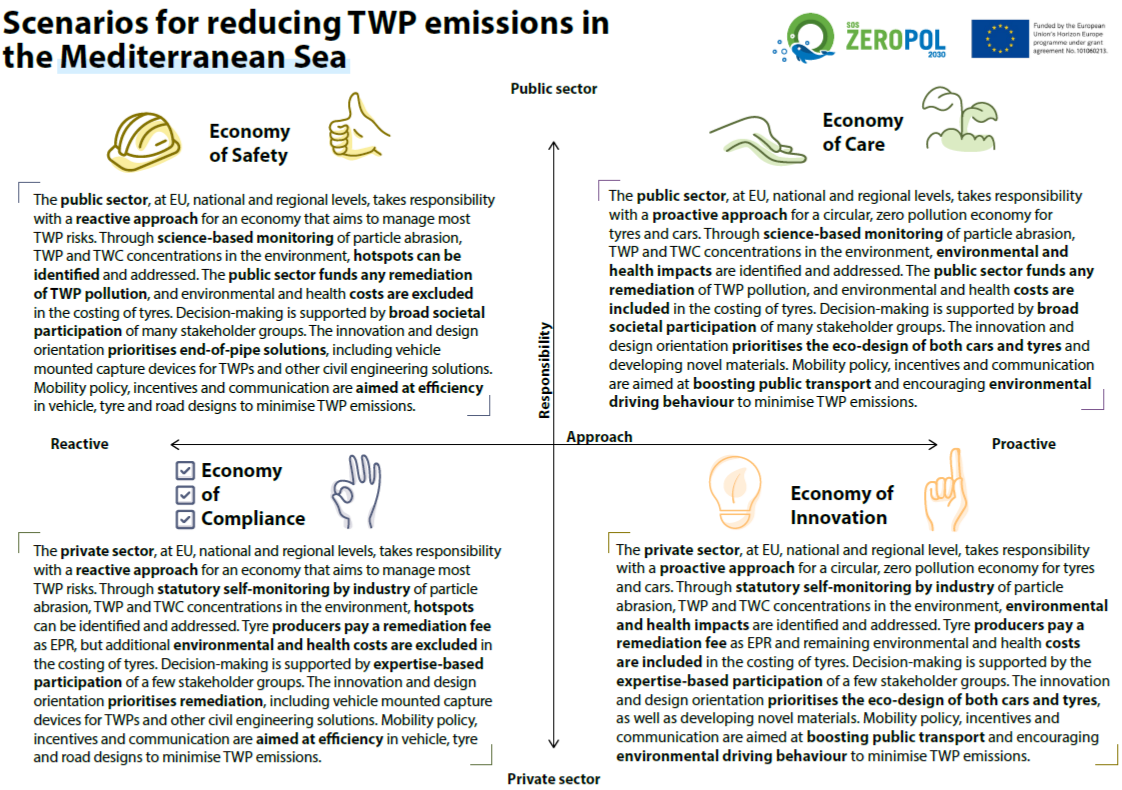


Figure 2, while the full factsheet is submitted as a standalone Annex to this report (Annex 2).

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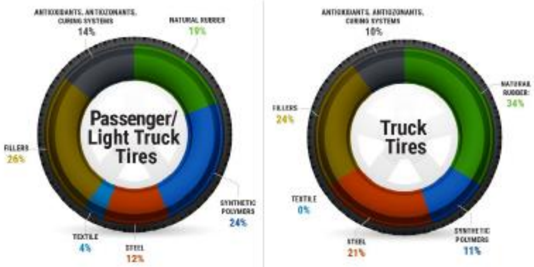

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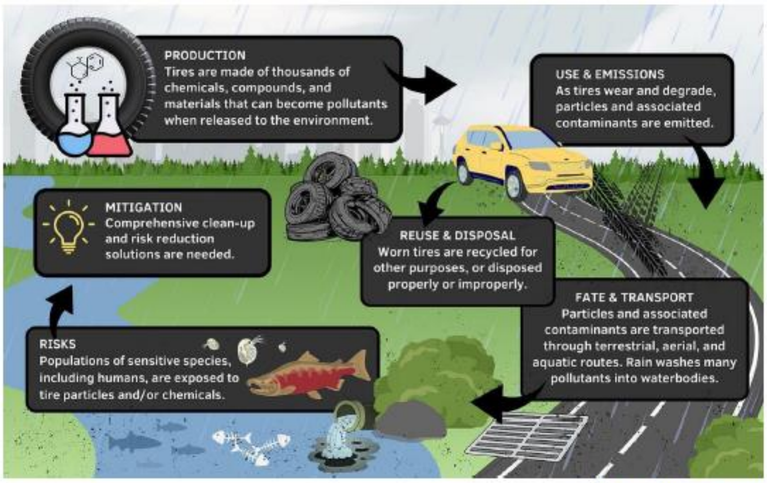

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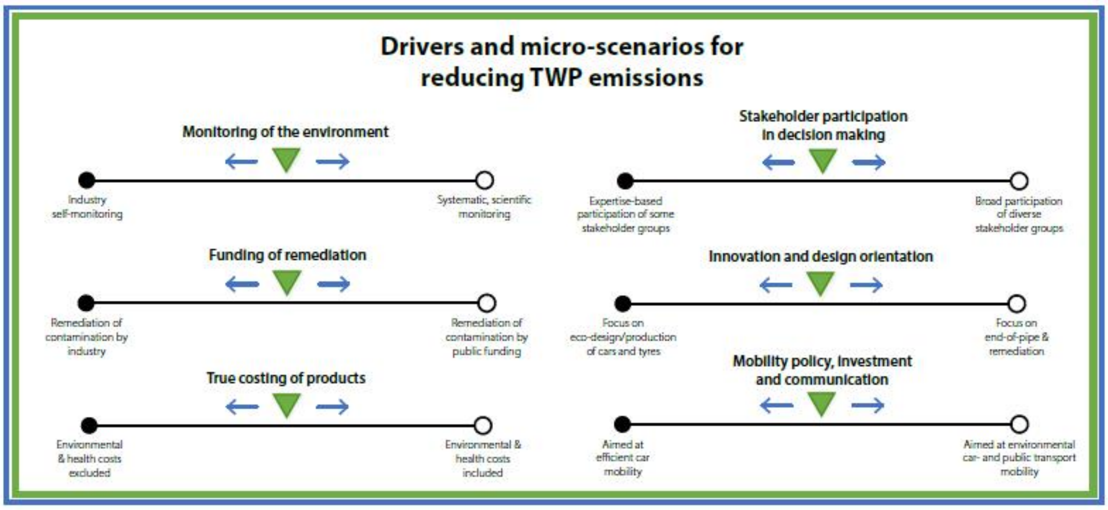

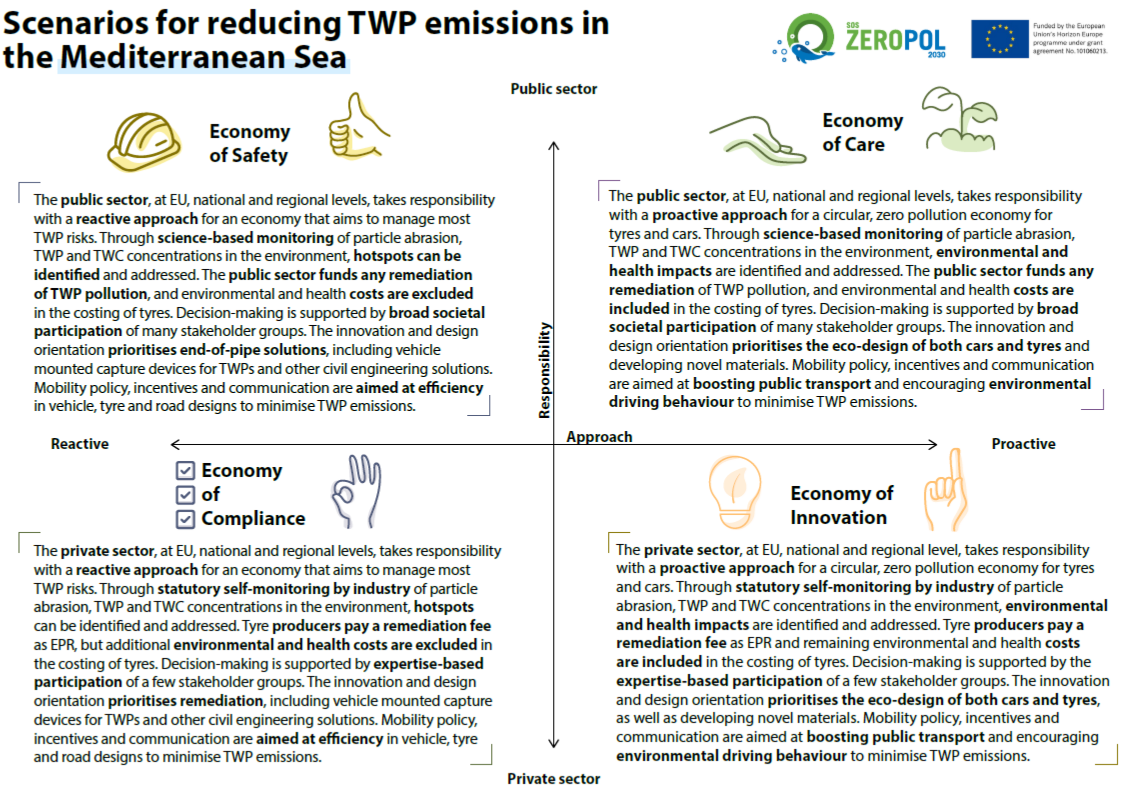

Figure 2. TWP factsheet (3 pages in total).

3. Conclusions

The two factsheets represent an 'easy to digest' summary of the work conducted and outcomes generated in WP4 of the SOS-ZEROPOL2030 project, which comprised an integrated case study pollutant assessment for both PFAs and TWPs.

These factsheets will be published on the project website's Resources page (https://soszeropol2030.eu/resources/) and made available for download and printing at scale. They will also be included in the project's Zero-Pollution Online Hub (D6.8) which was developed under WP6 (Task 6.4) This hub will operate as a multi-language centralised online repository that works as a directory to educational and outreach resources centred on current and pressing pollution topics, and will continue after project conclusion to ensure ongoing access to materials developed during the project lifecycle.

Annexes

Annex 1 – Standalone PFAS factsheet submitted as pdf.

Annex 1 – Standalone TWP factsheet submitted as pdf.