Understanding Tyre Wear Particles

Emissions, Pathways & Risks

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

SOS ZEROPOL 2030

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.

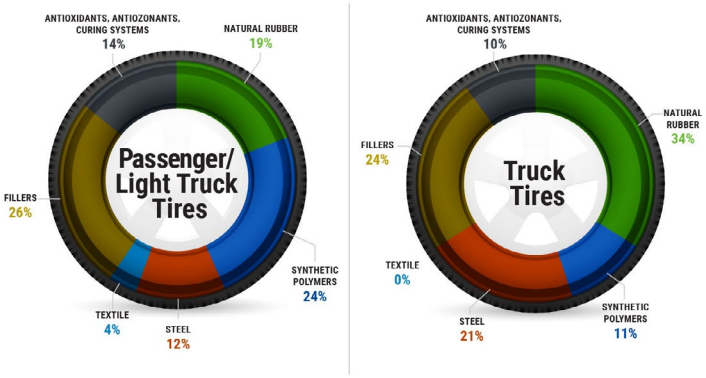

Image from U.S. Tire Manufacturers Association

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

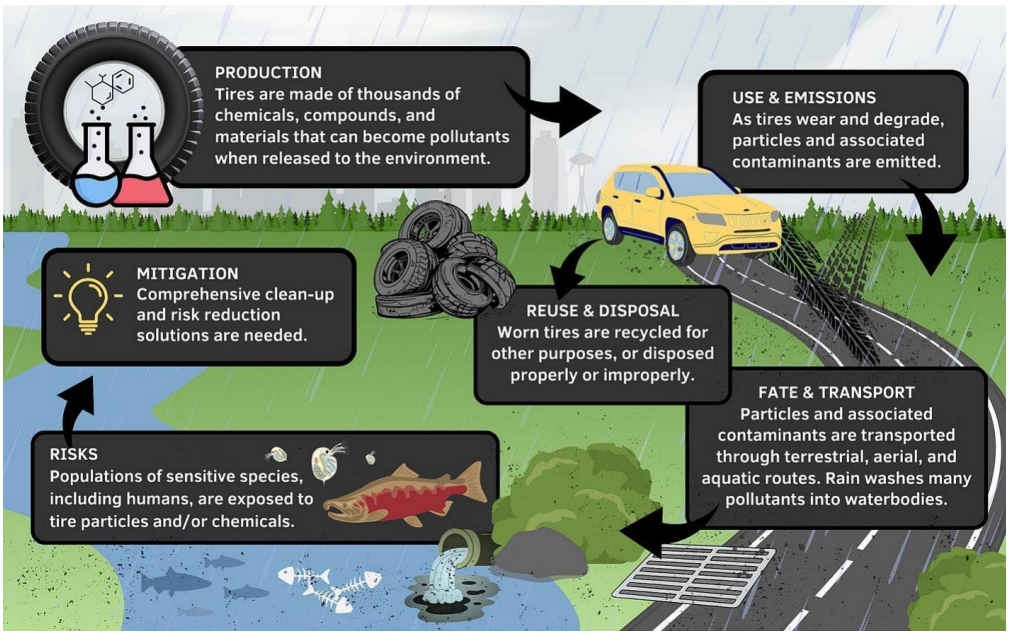

Image from Mayer et al. (2024)

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.

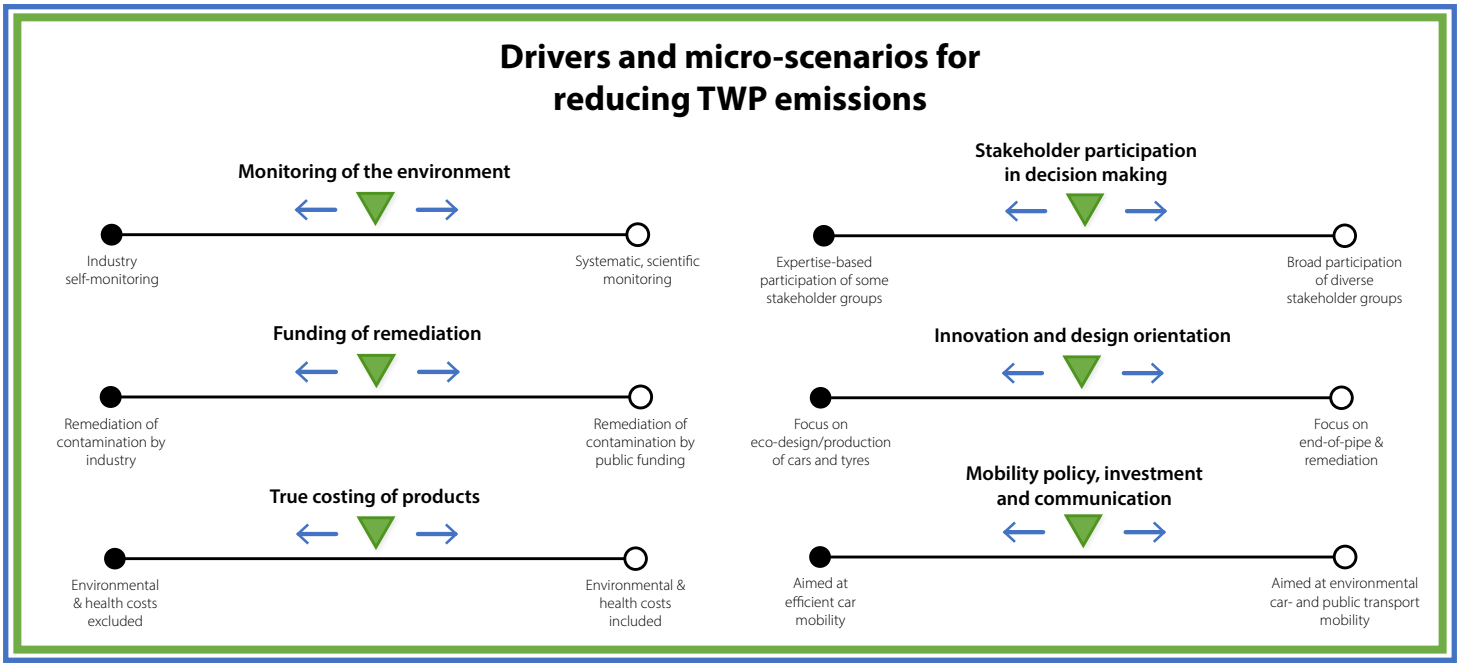
Stakeholder-driven evaluation of scenarios for achieving zero pollution

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.

Drivers and micro-scenarios for reducing TWP emissions



Scenarios for reducing TWP emissions in the Mediterranean Sea

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Public sector

Responsibility

Private sector

Reactive

Approach

Proactive

Economy of Safety

The **public sector**, at EU, national and regional levels, takes responsibility with a **reactive approach** for an economy that aims to manage most TWP risks. Through **science-based monitoring** of particle abrasion, TWP and TWC concentrations in the environment, **hotspots can be identified** and addressed. The **public sector funds any remediation of TWP pollution**, and environmental and health **costs are excluded** in the costing of tyres. Decision-making is supported by **broad societal participation** of many stakeholder groups. The innovation and design orientation **prioritises end-of-pipe solutions**, including vehicle mounted capture devices for TWPs and other civil engineering solutions. Mobility policy, incentives and communication are **aimed at efficiency** in vehicle, tyre and road designs to minimise TWP emissions.

Economy of Care

The **public sector**, at EU, national and regional levels, takes responsibility with a **proactive approach** for a circular, zero pollution economy for tyres and cars. Through **science-based monitoring** of particle abrasion, TWP and TWC concentrations in the environment, **environmental and health impacts** are identified and addressed. The **public sector funds any remediation** of TWP pollution, and environmental and health **costs are included** in the costing of tyres. Decision-making is supported by **broad societal participation** of many stakeholder groups. The innovation and design orientation **prioritises the eco-design of both cars and tyres** and developing novel materials. Mobility policy, incentives and communication are aimed at **boosting public transport** and encouraging **environmental driving behaviour** to minimise TWP emissions.

Economy of Compliance

The **private sector**, at EU, national and regional levels, takes responsibility with a **reactive approach** for an economy that aims to manage most TWP risks. Through **statutory self-monitoring by industry** of particle abrasion, TWP and TWC concentrations in the environment, **hotspots** can be identified and addressed. Tyre **producers pay a remediation fee** as EPR, but additional **environmental and health costs are excluded** in the costing of tyres. Decision-making is supported by **expertise-based participation** of a few stakeholder groups. The innovation and design orientation **prioritises remediation**, including vehicle mounted capture devices for TWPs and other civil engineering solutions. Mobility policy, incentives and communication are **aimed at efficiency** in vehicle, tyre and road designs to minimise TWP emissions.

Economy of Innovation

The **private sector**, at EU, national and regional level, takes responsibility with a **proactive approach** for a circular, zero pollution economy for tyres and cars. Through **statutory self-monitoring by industry** of particle abrasion, TWP and TWC concentrations in the environment, **environmental and health impacts** are identified and addressed. Tyre **producers pay a remediation fee** as EPR and remaining environmental and health **costs are included** in the costing of tyres. Decision-making is supported by the **expertise-based participation** of a few stakeholder groups. The innovation and design orientation **prioritises the eco-design of both cars and tyres**, as well as developing novel materials. Mobility policy, incentives and communication are aimed at **boosting public transport** and encouraging **environmental driving behaviour** to minimise TWP emissions.