On behalf of Tyres Europe

Executive Summary:

Sector Life Cycle Assessment of a representative European passenger car tyre

Introduction

Tyres play a significant role in daily life, crucial for moving people and goods and essential for economic activities, aviation, and rail transport. In order to get an understanding of the environmental impacts of tyres namely passenger car, Truck & Bus as well as retreaded tyres, Tyres Europe commissioned Sphera to conduct a full life-cycle study covering raw material extraction, manufacturing transport, use, and end-of-life stages.

The full reports can be requested via info@tyreseurope.org.

Goal

This study quantifies potential environmental impacts associated with the life cycle of a sector representative EU passenger car tyre (**summer passenger car tyre (205/55 R16)** produced in Europe) and provide robust insights for regulators, automotive manufacturers, and industry stakeholders.

Scope

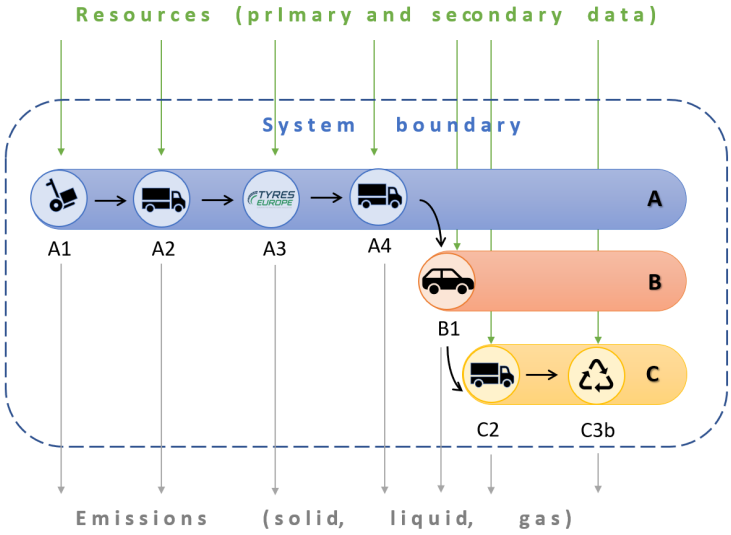
The study is based on the following assumptions and conditions:

- **What:** This study quantifies the potential environmental impacts of a summer passenger car tyre (205/55 R16) produced in Europe
- **Standards:** The work is aligned with the requirements of the Product Category Rules (PCR) "UL 10006 Tyres Version 3.05," which define modelling rules, system boundaries, and mandatory methodological choices for tyre LCA. Impact assessment followed the Environmental Footprint (EF) 3.0 method, as indicated by the reference PCR. A Monte Carlo and sensitivity analysis was performed to evaluate uncertainty and variability in key inputs, including bill of materials, RRc, tyre mass, mileage and end of life scenarios.
- **Data Collection:** The present study started in 2022. The reference time for the present study is 2021, the most recent calendar year for which primary data were available through the involved companies when the study was launched. Data were collected from multiple European manufacturing plants. In the case of raw materials, they are indicative of the specific production country (where available). No cut-off has been applied for this study.
- **Functional Unit:** The functional unit is **"1 tyre driven for 1.000 km".** Table below shows average key performances parameters (collected during the present study) that are considered (see table xx for the relevant data adjusted to the functional unit).

.

- **Boundary Systems:** The study, following the UL Tyre PCR, applies a cradle-to-grave system boundary covering modules A1–A4, B1, and C2–C3, as shown in the picture below.

Data Base: The LCA model was developed using LCA for Experts (Sphera LCA FE), and background data were sourced from the Sphera Managed LCA Content (MLC) Database 2024.1. Where gaps existed, they were filled conservatively using technologically representative proxy datasets



Schematic representation of the tyre life cycle system boundaries

Impact category list

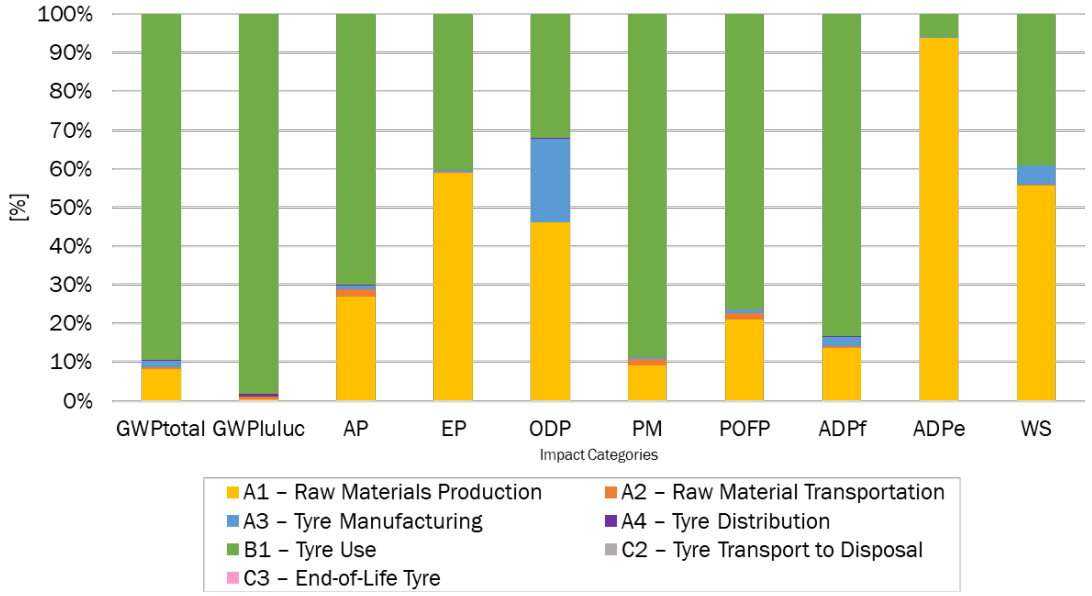
Impact Category	Unit	Reference
Climate change (GWP)	kg CO_2 eq.	(IPCC, 2013)
Climate change, land use and land use change (GWP-luluc)	kg CO_2 eq.	(IPCC, 2013)
Acidification Potential, terrestrial (AP)	moles H^+ eq.	(Seppälä J., 2006; Posch, 2008)
Eutrophication (freshwater) (EP)	kg P eq.	(Seppälä J., 2006; Posch, 2008; Struijs, 2009)
Ozone Depletion (ODP)	kg CFC-11 eq.	(Guinée, et al., 2002)
Photochemical Ozone Formation (POFP)	kg NMVOC eq.	(Van Zelm R., 441-453)
Resource use, minerals and metals (ADPe)	kg Sb eq.	(Guinée, et al., 2002)
Resource use, energy carriers (ADPf)	MJ	(Guinée, et al., 2002; van Oers, de Koning, Guinée, & Huppes, 2002)
Particulate matters (Respiratory inorganics) (PM)	Disease incidence	(Fantke, 2016)
Water Scarcity (WS)	m3 world eq.	(Boulay, 2017)

Results

The table below shows the results of the LCA (Life Cycle Assessment) for average passenger car tyre, based on functional unit (1.000 km). The absolute environmental impacts of this tyre are based on the information modules (A1-C3) as required from the reference PCR.

The use phase (B1) is the dominant life cycle stage across most impact categories due to fuel combustion emissions and consumption resulting from rolling resistance. Upstream raw material production (A1) is the second most influential contributor, driven by synthetic rubber, natural rubber, carbon black, silica, and steel reinforcement materials. Manufacturing (A3) contributes moderately, primarily due to electricity and thermal energy demand in mixing, extrusion, calendaring, and curing processes.

Distribution (A4) has a minor contribution due to relatively short transport distances within Europe. End-of-life (C2–C3) has low impacts, as only the landfill fraction is modelled under the UL PCR cut-off rules, which exclude energy recovery and recycling credits.



Relative contributions LCIA results

Conclusions

The current Life Cycle Assessment (LCA) study calculated and illustrated the potential environmental impacts of a 205/55 R16 Summer passenger car tyre. The results are representative of the European market.

The main takeaways from this study are as follows:

- **The use phase is the main driver of impacts** across almost all categories. Rolling resistance and vehicle weight strongly influence fuel consumption, and most impacts come from fuel-combustion emissions.
- **Raw material impacts depend heavily on mileage.** Lower mileage means more tyre mass allocated per 1,000 km, increasing impacts in the raw material and manufacturing stages (A1–A3).
- **Raw material production plays a major role** in several indicators—especially Eutrophication (EP), Ozone Depletion (ODP), Abiotic Depletion (ADPe), and Water Scarcity (WS).
- **Different materials influence different indicators.**
    - Natural rubber strongly affects GWP-luluc, EP freshwater, and WS.
    - Synthetic rubber and carbon black contribute most to total GWP.
    - Phenolic resin mainly affects Acidification (AP) and Photochemical Ozone Formation (POFP).
    - Overall, **rubber (natural and synthetic) and phenolic resins are major contributors** across many categories.
- **Transport of raw materials** noticeably affects AP, POFP, and PM.
- **Manufacturing impacts are limited** and mainly influence ODP and WS. Thermal energy use has about **three times** the GWP impact of electricity.
- **Sensitivity analysis shows that Rolling Resistance, mileage, and tyre weight** significantly affect results. The precision and accuracy of the data collected from all participating companies lend robustness to the created LCA model, rendering the calculated results reliable and trustworthy