On behalf of Tyres Europe

Executive Summary:

Sector Life Cycle Assessment of two representative European truck tyres for different market segments.

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 compares potential environmental impacts associated with the life cycle of two sector representative EU truck tyres, HP and MLP truck tyres, with the same function and the same size 315/70x22.5 li 154, with different performances that are produced, used, and disposed of in the European region.

Scope

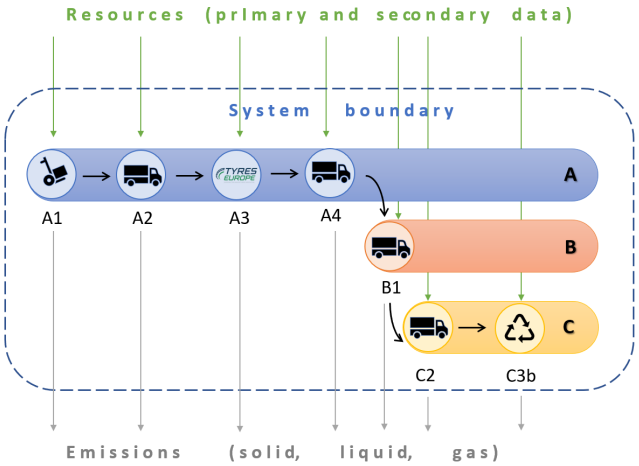
The study is based on the following assumptions and conditions:

- **What:** This study evaluates the potential environmental impacts of truck tyres, across both HP and MLP performance levels.
- **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.

Technical Specifications of Tyres Europe's Industry Average Truck Tyre (Size 315/70x22.5 li 154)

Performance Information	Use	Average Weight [kg]	Average Mileage [km]	Average Rolling Resistance coefficient [kg/t]
HP	Truck	64,1	253.410	5,27
MLP	Truck	58,75	163.240	5,81



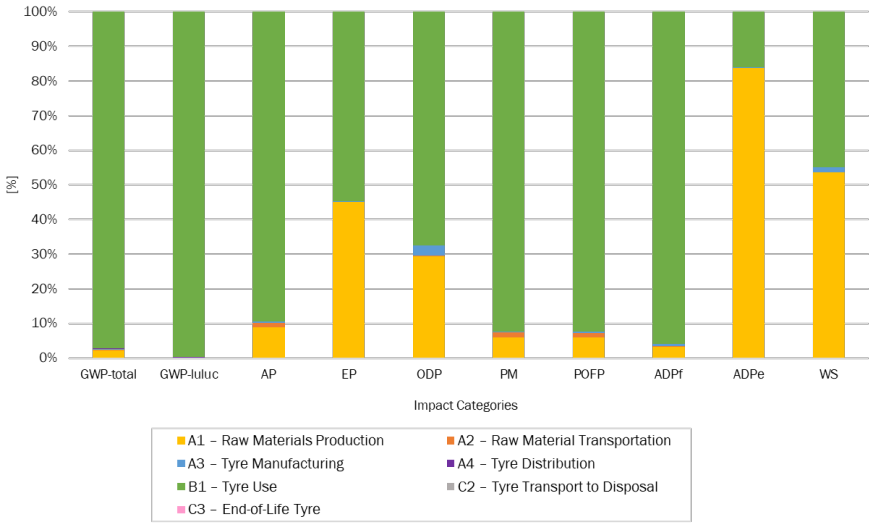
Schematic representation of the tyre life cycle system boundaries

Impact category list

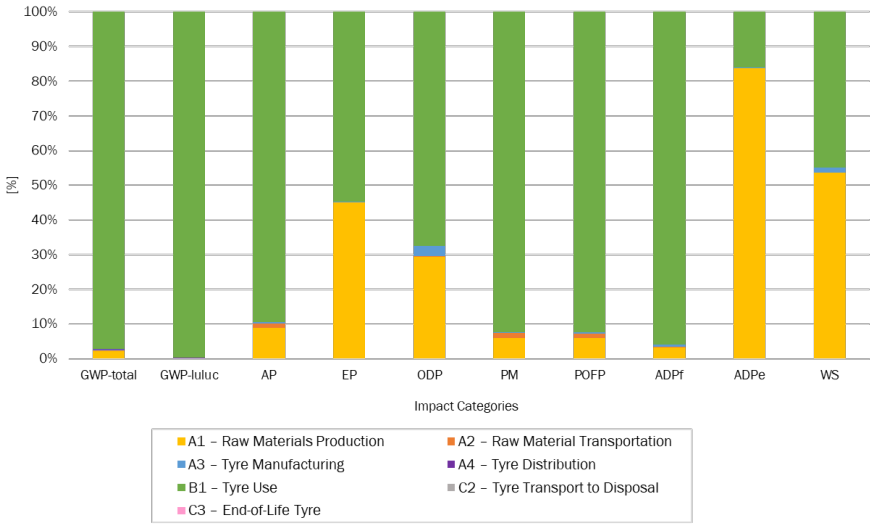
Impact Category	Unit	Reference
Climate change (GWP)	kg CO_2 eq.	(IPCC, 2013)
Climate change, land use and land use change (GWP-luluc)	kg CO_2 eq.	(IPCC, 2013)
Acidification Potential, terrestrial (AP)	moles H^+ eq.	(Seppälä J., 2006; Posch, 2008)
Eutrophication (freshwater) (EP)	kg P eq.	(Seppälä J., 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 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 carbon black and steel belt production mainly, followed by natural rubber and synthetic rubber. 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.

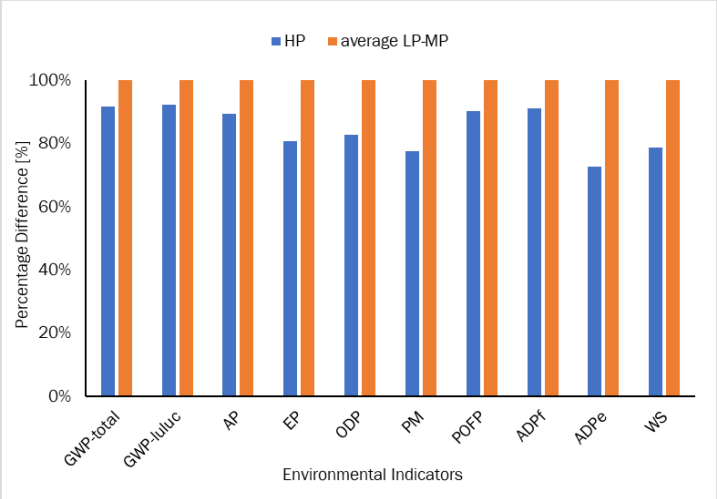


Relative Contributions LCIA Results for Average HP Truck Tyre



Relative Contributions LCIA Results for Average MLP Truck Tyre

HP truck tyres showed consistently lower impacts than MLP tyres in every LCA category. HP tyres had 8% lower GWP, 8% lower acidification, 18% lower freshwater eutrophication, and 10% lower photochemical ozone formation. These advantages are mainly driven by HP tyres' lower rolling resistance and longer lifetime, which reduce fuel-related emissions during use and raw-material impacts during production.



Normalized Cradle to Grave Results for HP and MLP Truck Tyres

Conclusions

LCA results calculated show the potential impacts of two representative European average truck tyres, according with the most recent and accurate guidelines and rules and involving an important number of different tyre European producers. This characteristic allowed to develop sector average LCA results with a high level of precision and accuracy. HP truck tyre exhibits lower environmental impacts compared to the MP truck tyre. HP tyre demonstrates lower impacts across all considered environmental categories in the present study, ranging from 8% to 27%.

The main takeaways from this study are as follows:

- **Both tyre types show the same overall trends** in results and sensitivity analysis.
- **The use phase is the biggest contributor** to almost all impact categories. Rolling resistance and vehicle weight strongly influence fuel consumption, and most impacts come from fuel-related emissions.
- **Mileage has a major influence on raw material impacts .** Lower mileage means more tyre mass is needed to cover 1,000 km, increasing raw material and manufacturing impacts. Mileage does *not* affect emissions during the use phase.
- **Raw material production strongly affects several indicators**, particularly EP, ADPe, and WS.
- **Different materials drive different impacts:**
    - Natural rubber affects GWP-luluc, EP, and WS.
    - Synthetic rubber, carbon black, and steel belt drive most of the GWP.
    - Phenolic resin mainly affects AP and POFP
    - Overall, rubber (natural and synthetic), carbon black, and steel belt are consistently high-impact materials.
- **Sensitivity analysis shows that Rolling Resistance, mileage, and tyre weight** significantly influence the results. Since these data were collected consistently across companies, the model is considered robust and the results reliable.