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Scoping Study on India's Tyre Industry: Potential, Challenges & Recommendations

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LIST OF ABBREVIATIONS

AFC	Average Fuel Consumption
AIS	Automotive Industry Standards
AM	Annual Mileage
ATMA	Automotive Tyre Manufacturers' Association
ATS	Automated Testing Stations
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BKT	Balakrishna Tyres
BS	Bharat Stage
BTKm	Billion Tonne Kilometre
BUR	Biennial Update Report
CETA	Comprehensive Economic and Trade Agreement
CMVR	Central Motor Vehicles Rules
CO_2	Carbon dioxide
FP	Fuel Price
FTA	Free Trade Agreements
GVW	Gross Vehicle Weight
HDV	Heavy-duty Vehicle
HSTT	High-speed Test Track
ICE	Internal Combustion Engine
INR	Indian Rupee
KMPH	Kilometre Per Hour
LCV	Light Commercial Vehicle
LRR	Low Rolling Resistance

LT	Life of tyre
MoRTH	Ministry of Road Transport and Highways
MoSPI	Ministry of Statistics and Programme Implementation
N_2O	Nitrous dioxide
NH_3	Ammonia
NRSP	National Road Safety Policy
OEM	Original Equipment Manufacturer
PM e-Drive	Prime Minister e-Drive
PM	Particulate Matter
QCO	Quality Control Orders
ROI	Return on Investment
RRC	Rolling Resistance Coefficient
TCFC	Total Annual Cost of Fuel Consumption
TCO	Total Cost of Ownership
TPMS	Tyre Pressure Monitoring Systems
TTC	Total Cost of Tyre
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
USD	United States Dollar
VECTO	Vehicle Energy Consumption Calculation Tool
VRDE	Vehicle Research & Development Establishment
ZET	Zero Emission Trucking

EXECUTIVE SUMMARY

India's road transport system is undergoing rapid expansion driven by economic growth, urbanization, development of new expressways and highways, increased consumer spending, rising freight movement, and increasing vehicle ownership. Heavy-duty vehicles (HDVs)—trucks and buses—consume nearly 70% of India's diesel and are a major contributor to transport sector emissions (TERI, 2022). As the country strives to balance economic growth with environmental sustainability, tyre technologies have emerged as a critical yet underutilized lever for improving fuel efficiency, enhancing road safety and reducing emissions.

India's transport sector contributes to approximately 15% of national CO_2 emissions, with road transport accounting for 92% of that share. Freight vehicles particularly heavy-duty trucks constitute only 3% of India's vehicle fleet but are responsible for over half of PM emissions. With freight demand expected to quadruple by 2050, India faces an urgent imperative to decarbonize this sector to meet its climate goals (NITI Aayog, 2022).

The global tyre industry is transforming through innovations in radial construction, tubeless formats, advanced rubber compounds, and low rolling resistance designs. India, now among the world's largest tyre producing nations, is experiencing similar market shifts, with radialization accelerating and multiple policies AIS-142, Bureau of Energy Efficiency (BEE) star labelling, HDV fuel-efficiency norms, PM e-Drive, etc., directly and indirectly supporting higher efficiency. With India entering into Free Trade Agreements (FTA) with multiple countries, there is a strong case for increasingly integrating with global supply chains.

A detailed cost benefit analysis conducted on a 42-tonne HDV confirms that low rolling resistance tyres can substantially reduce annual operating costs with the most optimized tyre delivering the highest fuel savings and best overall lifecycle economics. Stakeholder consultations further highlight an evolving market, where fleet operators increasingly prioritize fuel savings and tyre life over just upfront cost.

Given India's sustainability goals, expanding freight corridors, electrification initiatives and upcoming BS-VII emission norms, the strategic adoption of advanced tyre technologies can deliver significant economic and environmental benefits. Aligning labelling programmes, strengthening testing infrastructure, strengthening emission norms, improving awareness, incentivizing low rolling resistance (LRR) tyres and aligning India's regulations with global best practices while ensuring better road conditions can accelerate India's transition to cleaner, more efficient freight systems.

1 INTRODUCTION

1.1 Background of the Global Tyre Industry

The global tyre industry is one of the cornerstones of the automotive industry, producing over a billion tyres annually and generating an estimated market value of USD 143 billion in 2024 (GVR, 2024). It plays a pivotal role in the automotive ecosystem, directly influencing vehicle safety, fuel efficiency, and environmental impact. Over the past decade, the production of tyres has expanded along with the global vehicle fleet, with major players like Bridgestone, Continental, Goodyear and Michelin leading innovations in materials, design and sustainability. Asia, & especially countries such as China, India and those in Southeast Asia have emerged as dominant tyre manufacturing hubs.

India's transport sector is undergoing rapid transformation, driven by economic growth, urbanization, and rising demand for passenger and freight mobility. Road transport dominates the landscape, accounting for 90% of passenger movement and 50% of the freight movement (MoRTH, 2022). Road transport alone accounts for 14% of India's total energy consumption representing 92% of all transport-related energy demand (MOSPI, 2024) and 94% of CO_2 emissions from transport (BUR, 2024). Freight vehicles particularly heavy-duty trucks constitute only 3% of India's vehicle fleet but are responsible for over half of particulate matter (PM) emissions (TERI, 2026). The rising energy footprint is closely linked to the rapid expansion of the nation's freight-carrying vehicle stock which doubled in the last decade. Supporting this expansion, the National Highway network has grown by 60% from 91,287 km in 2014 to 146,195 km in 2024 (MoRTH, 2025). With the freight demand expected to quadruple by 2050 (TERI, 2026), India faces an urgent imperative to decarbonize this sector to meet its climate goals.

1.2 Objective of the Study

The objective of the study is to examine the status of the Indian tyre market – particularly in the freight and heavy-duty vehicle segment (HDV) and its contribution to transport-related carbon emission, while evaluating how advanced tyre technologies such as radial tubeless tyres and low rolling resistance (LRR) tyres in particular can enhance fuel efficiency, sustainability, and safety.

The study also critically reviews relevant government policies, including PM-eDrive, Zero-Emission Trucking (ZET), AIS-142 tyre regulations, and heavy-duty fuel-efficiency norms, to identify synergies that can accelerate India's transition towards a cleaner freight ecosystem. Additionally, it draws lessons from international best practices—especially from Europe—to inform India's strategy for reducing emissions and improving logistics performance.

1.3 Methodology

The study employs a structured, evidence driven methodology integrating technical research, analyzing market data and stakeholder insights to assess the role of tyre technologies in improving fuel efficiency and reducing emissions in India's heavy-duty vehicle sector.

The study undertook an extensive review of national and international literature, including technical studies, regulatory documents, tyre testing standards, and industry reports. This provided insight into the performance characteristics and energy efficiency implications of different types of tyres. The secondary data was sourced from tyre manufacturers, industry associations and other sources to understand production trends, radialization rate, and the technology landscape.

To capture the ground realities, the study incorporated qualitative inputs through consultations with tyre manufacturers, fleet operators, researchers, and policy experts. This facilitated incorporation of first-hand insights into technology adoption barriers, operational challenges, safety considerations, and cost sensitivities.

In addition, the study included a structured assessment using available test results and realistic operating assumptions for Indian HDVs. This provided an evaluation of rolling resistance impacts on fuel savings and potential and lifecycle economics of advanced tyres. Finally, the findings were examined alongside India's policy and regulatory frameworks to ensure that the analysis is aligned with current standards, market conditions, and future regulatory trajectories.

1.4 Scope

This study evaluates the technological, regulatory and market factors that influence tyre performance, fuel efficiency and emissions within India's freight and HDV segment. It examines the current landscape of the Indian tyre market—including production—and examines trends in adoption of radial and low rolling resistance tyres. While the study does not look at fuel use or emissions related to the manufacture of tyres, it focuses on the potential for fuel savings and emission reductions related to the operational performance of tyres.

The study also includes a detailed cost benefit analysis comparing different tyre types using standardized test data under typical Indian operating conditions, along with a sensitivity analysis to understand how variations in tyre life, procurement cost and fuel price affect annual savings and return on investment. In addition, the report reviews India's existing policy landscape and compares the trends in international standards with a view to identify opportunities for aligning and accelerating the market adoption of more efficient and advanced tyre technologies across India's freight ecosystem.

2

OVERVIEW OF THE TYRE INDUSTRY IN INDIA

2.1 Market Size and Growth Trends

India is the third largest automotive market globally marked by a strong presence of local manufacturers and leading international brands. MRF, Apollo tyres, CEAT, JK Tyres and Balakrishna Tyres (BKT) are the major Indian manufacturers while Michelin, Bridgestone, Goodyear, Continental and Yokohama are the key multinational companies. These companies bring advanced technologies, global standards, and premium products to the Indian market contributing to its modernization and competitiveness. Overall, 28 companies operate across 62 manufacturing plants, underscoring the sector's scale.

India's transport sector is undergoing rapid transformation driven by economic growth, urbanization, and rising passenger and freight demand. Road transport dominates, accounting for 90% of passenger movement and 50% of the freight movement (MoRTH, 2022). Supporting this expansion, the National Highway network has grown by 60% from 91,287 km in 2014 to 146,195 km in 2024 (MoRTH, 2025). Despite rapid increase in EV penetration, currently diesel remains the primary transport fuel particularly for heavy-duty vehicles (HDVs), such as trucks and buses. These consume around 70% of the total diesel consumption in India (MoPNG, 2023). This reliance poses challenges for air quality, energy security, and climate goals. While engine and transmission upgrades are commonly discussed, tyre technologies offer a substantial and often underutilized opportunity for efficient fuel consumption.

India is also the world's second largest manufacturer of two-wheelers and a significant hub for tractors, commercial vehicles, and passenger cars (MoRTH, 2022). This large and highly utilized vehicle base translates into replacement tyre demand that is approximately five times higher than OEM tyre demand over the vehicle lifecycle (ATMA, 2025). Over the past two decades, the Indian tyre industry has witnessed sustained expansion, with market size increasing from ₹8,000 crore in 2004 to ₹49,000 crore in 2014 and further to ₹109,000 crore in 2024 (ATMA-pwc, 2025). Exports have also exceeded ₹25,000 crore (USD 3.2 billion) in FY25 (ATMA, 2025). Growth is expected to be further supported by infrastructure expansion and rising incomes.

Figure 1 shows the overall production trend of tyres across categories from 1995–96 to 2022–23. This trend reflects an optimistic outlook, with India manufacturing over 200 million units annually across categories.

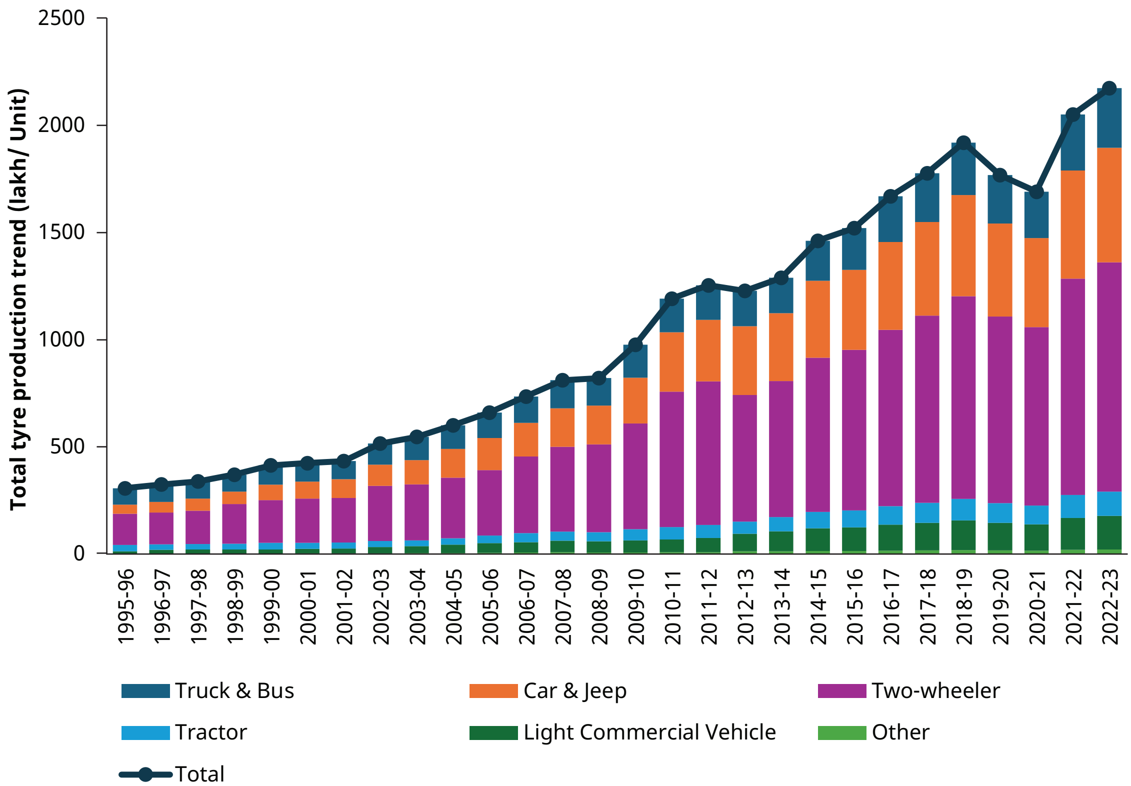

Figure 1: Tyre production trend (lakh/unit)

2.2 Segmentation: HDV, LCV, Buses

Indian tyre market is segmented by vehicle type with distinct dynamics across HDVs, light commercial vehicles (LCVs), and buses. Buses, used in public transport and intercity travel, require tyres that offer safety, comfort, and long life. LCVs are used for intra-city logistics and last-mile delivery.

HDVs represent a critical segment due to their role in freight transport. These vehicles require durable high load bearing tyres to optimize fuel efficiency. Overall, the segmentation reflects the diverse needs of India's transport ecosystem, and tyre manufacturers are tailoring their products accordingly.

2.3 Role of Tyres in Emission Reduction

Tyres are a critical vehicle component, directly influencing road safety, fuel efficiency, handling, and environmental impact. As the only contact point between a vehicle and the road, tyre performance affects braking distance, cornering stability, ride comfort, and energy consumption. In India's rapidly expanding road transport sector, advancements in tyre technology can play an important role in achieving energy security, emissions reduction, and road safety goals.

Modern tyres employ advanced tread designs and reinforced structures to enhance grip and stability which is particularly important given India's varied road conditions. The adoption of Tyre Pressure Monitoring Systems (TPMS)—notified under the Central Motor Vehicle Rules by MoRTH (PIB, 2020)—improves safety and fuel efficiency by preventing underinflation.

In India, tyre manufacturers are increasingly developing eco-friendly tyres using sustainably sourced natural rubber, bio-based oils and recycled materials such as rubber and plastics. These materials reduce the carbon footprint of tyre production while also improving performance by enhancing flexibility, durability, and rolling resistance characteristics (ATMA, 2025; JK Tyres, 2023; BS, 2024).

2.4 Export - Import Linkages

With the Government's vision of "Make in India," India aspires to become a manufacturing hub, exporting to countries across the world. Figure 2 shows the potential of Indian market for exporting tyres. Indian tyre industry has emerged as a global player, with exports crossing ₹25,000 crore in 2025, around 9% higher than the previous year (IBEF, 2025). The industry exports to over 170 countries, with the United States of America (USA) being the largest market, accounting for 17% of export value, followed by Germany, Brazil, the United Arab Emirates (UAE), and France (ATMA, 2025).

The Government has recently on January 27, 2026 concluded a Free Trade Agreement with the European Union with the objective of increasing trade volumes between India and the EU while also facilitating ease of doing business for the industry. This looks promising even though the draft will undergo legal scrubbing before it is ratified by the EU Parliament and EU Council. Similarly, both India and the USA are engaged in discussions for a Comprehensive Trade Agreement between the two countries.

The India-UK Comprehensive Economic and Trade Agreement (CETA) eliminates import duties on tyres and rubber products exported from India, enhancing competitiveness and opportunity for expanding market access in the United Kingdom (UK). This duty-free regime has already strengthened export performance, with shipments reaching ₹732 crore in FY 2024–25 and expected to grow further (ATMA, 2025). Meanwhile, tariffs on tyre imports from the UK are expected to be reduced gradually over ten years, ensuring a balanced and sustainable trade framework (ET, 2025).

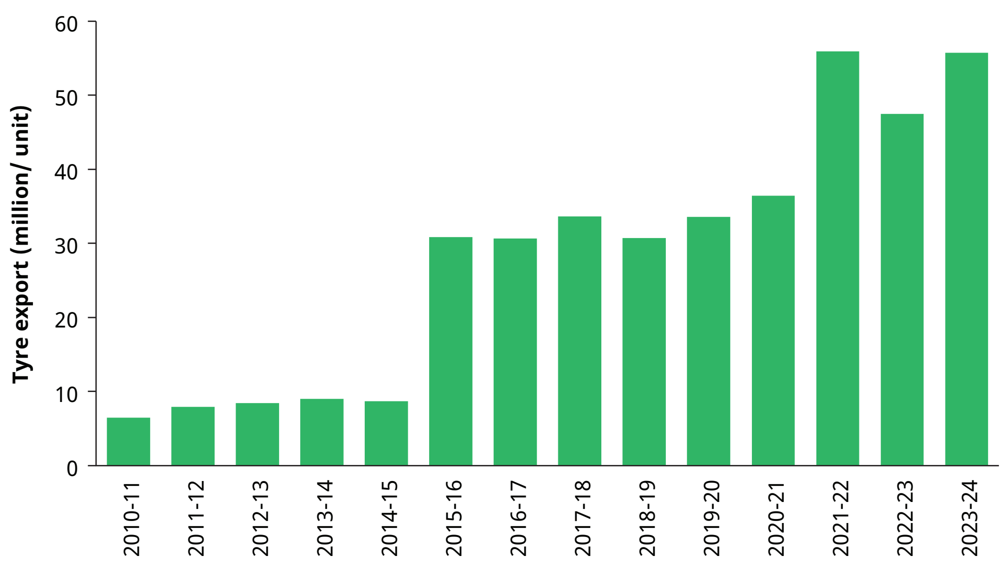

Figure 2: Export of tyres (million/unit)

Import restrictions

In June 2020, the Government had imposed restrictions on import of tyres for commercial usage (DGFT, 2020). Hence, no tyres could be imported for commercial purposes. Subsequently, in August 2023, the Government came up with an investment linked policy wherein license authorizations could be issued to companies who are willing to invest in manufacturing (PIB, 2023). The industry continues to engage with the Government on permitting limited imports for niche tyres not manufactured domestically.

Similarly, the Government has been focusing on local procurement of raw materials. This has been mainly through the release of Quality Control Orders (QCO) mandating BIS certification for imported raw materials, components, and machinery. While the industry is looking at enhancing local procurement, at present it is difficult to have the entire supply chain operating out of India. Further issuance of QCOs also makes the environment unpredictable, especially for companies which have a manufacturing presence and cannot risk loss of business continuity. Accordingly, recognizing the industry's point of view, recently the Government announced withdrawal of QCOs across sectors which has provided relief to manufacturers. This helps industry to reduce compliance requirements and make imports easier.

2.5 Tyre Technology Landscape in India

The modern tyre found in today's global market falls into one of the two types, viz., a bias-ply or a radial construction.

Bias-ply tyres: These are tyres manufactured traditionally. This design creates a rigid carcass that offers high resistance to sidewall damage, making bias tyre suitable for rough terrains and heavy-load conditions.

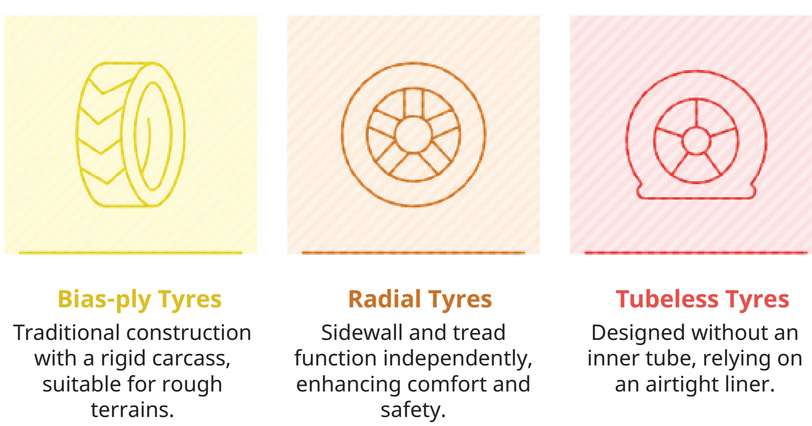

Figure 3: Tyre types

Retreading tyres: It is a process that extends the life of a worn tyre by replacing its old tread with a new layer while retaining the original casing.

Radial tyres: The design of radial tyres allows sidewall and tread to function independently, reducing deformation and heat build-up during operation. Additionally, radial tyres enhance ride comfort, stability and safety due to their flexible sidewalls and strong tread area.

Tubeless tyres: These are designed without an inner tube, relying instead on an airtight liner inside the tyre and a secure seal between the tyre bead and the wheel rim to maintain air pressure.

Tubeless tyre technology has some inherent advantages over tube-type tyre technology as reflected in Table 1.

Table 1: Comparison between tube tyres and tubeless tyres

Advantage Parameters	Tube-type tyres	Tubeless
Vehicle Weight Management	Heavy weight	Light weight
Safety	Greater chance of accidents	Less chance of accidents
Air leakage	High	Low
Inventory cost	High	Low

Tubeless tyres reduce inventory costs because they use fewer components. While tube-type tyres require five elements (tube, flap, rim, valve, tyre), tubeless tyres need only three (rim, tyre, valve). This lower component count reduces inventory holding costs. In addition, tubeless tyres improve safety and reliability, making them better suited especially for time-critical transportation.

3

NATIONAL & INTERNATIONAL POLICY AND REGULATION LANDSCAPE

3.1 India's Policy and Regulatory Frameworks

India's policy architecture governing tyres and freight transport has evolved significantly over the past decade from fragmented standards and pilot initiatives to a more cohesive and integrated framework that aligns vehicle regulation, energy efficiency labelling, and zero-emission freight strategies. At the core of this framework is the Central Motor Vehicles Rules (CMVR), 1989, which provides a statutory basis for prescribing construction, performance, and safety standards for critical automotive components. This regulatory authority was further strengthened through the amendment to Rule 95 notified on June 28, 2022, which mandates compliance with AIS-142 for tyres across passenger vehicles, light trucks, and heavy commercial vehicle segments.

In parallel, India's climate commitments have reinforced the policy emphasis on energy-efficient mobility. At COP26, the Hon'ble Prime Minister announced India's target of achieving net-zero carbon emissions by 2070, alongside a commitment to reduce projected emissions by 1 billion tonnes by 2030. Achieving these targets necessitates concerted action across sectors. Including the tyre industry, through the accelerated adoption of energy-efficient technologies such as LRR tyres can help play a further role.

Additionally, enhancing energy security remains a critical policy priority. India currently imports over 80% of its crude oil requirements, thus making energy efficiency strategically important. In this context, LRR tyres play a pivotal role in improving vehicular fuel efficiency, thereby contributing to lower hydrocarbon consumption and reduced import dependency. The current crisis in the Middle East is putting strain on the supply chain for oil & gas and highlights the need to increase demand side management strategies.

Collectively, these regulatory and policy measures underscore the direct and indirect impact of tyre performance, particularly rolling resistance on national fuel consumption and greenhouse gas emissions. They firmly position tyre standards as an integral component of India's broader transport decarbonization and energy transition strategy. *Figure 3* illustrates the current policy and regulatory framework influencing tyre performance, with a specific focus on heavy-duty vehicles in India.

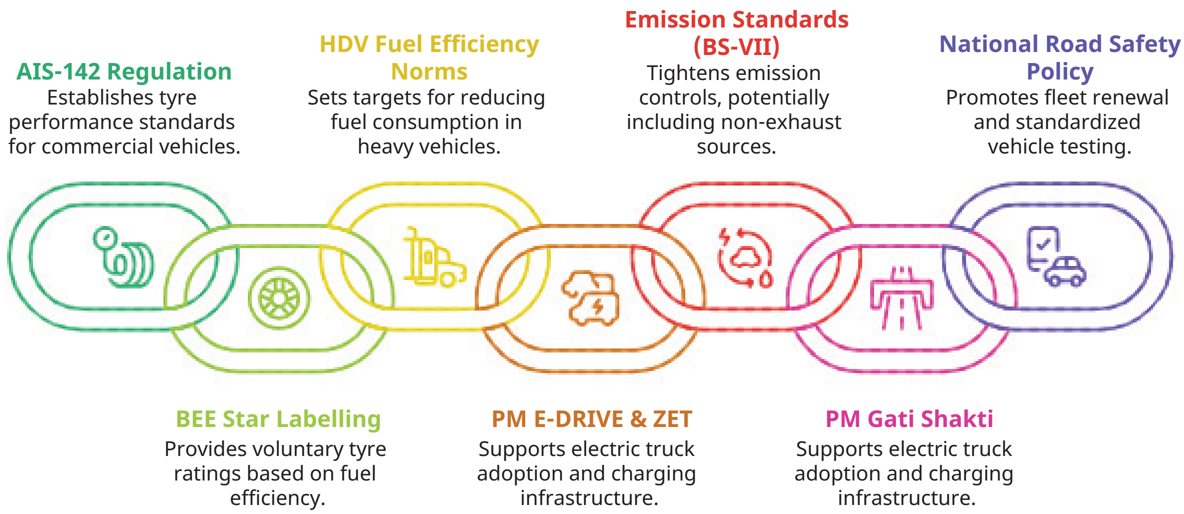

Figure 4: Framework for policy and regulation in India

The following sections discuss some of the main policy and regulatory measures related to tyres.

3.1.1 AIS-142 Regulation

Automotive Industry Standards (AIS) are technical specifications issued by the Ministry of Road Transport and Highways (MoRTH) under the framework of CMVR. Among these, AIS-142 establishes India's regulatory framework for tyre performance, including provisions applicable to commercial vehicles.

For heavy-duty applications (specifically Class C3) radial tyres used in trucks and buses the standard prescribes defined limits on rolling resistance, including a Rolling Resistance Coefficient (RRC) threshold of ≤ 7 N/kN (for radial tyres), along with standardized procedures for assessing wet grip and external rolling noise. By mandating test methods aligned with ISO standards, AIS-142 ensures measurement consistency, regulatory enforceability, and technical credibility.

While Conformity of Production (CoP) provisions are defined within the standard, their full-scale implementation and enforcement are still evolving. Nonetheless, AIS-142 plays a critical role in incentivizing the adoption of fuel-efficient tyres by integrating safety and energy performance parameters.

Furthermore, AIS-142 is broadly harmonized with international benchmarks, particularly UN ECE Regulation 117, including reference to the latest R117-04 series. This alignment reflects India's intent to converge with global best practices while facilitating a phased transition towards advanced, energy-efficient tyre technologies in the domestic market.

3.1.2 BEE Star Labelling Programme

A voluntary tyre labelling initiative, in addition to AIS-142 standards, has been introduced by the Bureau of Energy Efficiency (BEE) in 2022 under Schedule–30, and subsequently upgraded to Version 2.0 in March 2025. For HDVs, the scheme specifically covers C3 tyres and assigns performance ratings based on the RRC and Wet Grip Index, using test methodologies aligned with AIS-142.

The star-rating system ranges from 1-Star to 5-Star, with progressively stringent RRC thresholds—higher star ratings indicating lower rolling resistance and superior fuel efficiency. By standardizing and disclosing performance metrics, the scheme enhances market transparency and reduces information asymmetry for fleet operators and buyers.

The tightening of star bands under Version 2.0 further strengthens the commercial proposition of energy-efficient tyres, supporting a faster transition towards LRR technologies. Importantly, the BEE star labelling framework extends to the replacement market, ensuring that in-use vehicles continue to benefit from efficiency gains through informed tyre replacement choices.

This alignment is particularly significant in the context of India's HDV fuel efficiency regulations, notified from 2017 onwards and progressively expanded to cover lower gross vehicle weight (GVW) categories. By linking tyre-level performance with vehicle-level efficiency standards, the labelling programme reinforces a systems-level approach to reducing fuel consumption and emissions in the freight transport sector.

3.1.3 **Heavy-Duty Fuel Efficiency Norms**

India's HDV fuel efficiency norms, notified by the BEE, aim to reduce diesel consumption and GHGs from trucks and buses. Introduced in 2017 and strengthened under Phase II, the upcoming regulatory cycle (2027–2032) is expected to set more stringent targets, with an ambition of achieving ~30% improvement in fuel efficiency over FY2023 baselines. The norms currently cover vehicles above 3.5 tonnes GVW.

The evolving framework will function as a supply-side instrument, requiring OEMs to meet vehicle-level fuel consumption targets through technologies such as powertrain optimization, aerodynamics, and tyre improvements. Compliance will be supported by Bharat VECTO, which standardizes fuel consumption assessment under defined conditions.

Within this system, tyre rolling resistance is a key input parameter, creating an indirect but clear linkage between tyre performance and vehicle efficiency.

3.1.4 **PM E-DRIVE & Zero Emission Trucks (ZET)**

Electrification has emerged as a key pillar of India's clean transport strategy and is complementary to the adoption of energy-efficient tyres. In this context, the PM E-DRIVE Scheme supports electric trucks and buses under the Zero-Emission Trucks (ZET) framework. Launched in October 2024 and extended in August 2025, the scheme provides demand incentives for e-trucks, e-buses, and charging infrastructure through March 2028, thereby lowering upfront costs and enabling early market adoption.

For the freight segment, incentives of up to ₹9.6 lakh per N2 and N3 electric truck (GVW > 3.5 tonnes) are provided, directly contributing to reduced diesel consumption, CO_2 emissions, and air pollutants. As ZET adoption scales, tyre performance becomes increasingly critical for vehicle range, lifecycle energy efficiency, and operating costs particularly under Indian conditions characterized by high loads and mixed duty cycles. The scheme also emphasizes strengthening testing and certification capacity, including alignment with AIS-142, which supports faster homologation and wider availability of efficient tyres across both electric and ICE fleets.

While India does not yet have a formal zero-emission vehicle (ZEV) mandate, PM E-DRIVE and complementary state-level initiatives act as demand-side accelerators. These efforts align with long-term pathways outlined by NITI Aayog, which envision substantial adoption of zero-emission freight vehicles by mid-century, supported by advancements in tyre efficiency and enabling infrastructure.

3.1.5 **Emission Standards (BS-VII)**

India is expected to further tighten vehicular emission standards beyond Bharat Stage VI; however, the formal notification and timeline for Bharat Stage VII remain under development, and alignment with Euro 7 is indicative rather than fully codified at this stage. Nevertheless, the direction of policy suggests a transition towards broader emissions control potentially extending beyond tailpipe pollutants to include non-exhaust sources such as tyre and brake wear.

In HDVs, tyres contribute an estimated ~30% of total energy losses, making rolling resistance a significant factor influencing fuel consumption and real-world emissions. As emission norms become more stringent, inefficient tyres can increase both compliance burden for manufacturers and operating costs for fleet operators.

Globally, Euro 7 formally adopted in 2024 marks a notable shift by introducing limits on non-tailpipe emissions, including particulate matter from tyre abrasion and brake wear, along with expanded coverage of pollutants such as N_2O and NH_3.

Taking together, these developments indicate a structural shift in vehicle regulation, where tyre performance across both rolling efficiency and abrasion will increasingly influence emissions compliance. This is expected to drive adoption of advanced, low-loss tyre technologies in the HDV segment over time.

3.1.6 **PM Gati Shakti & Urbanization Policies**

PM Gati Shakti, launched in 2021, is India's integrated infrastructure planning platform aimed at improving multimodal connectivity across road, rail, ports, aviation, and industrial corridors. Its core objective is to reduce logistics costs, enhance freight efficiency, and address infrastructure bottlenecks through coordinated planning across ministries and states.

While the programme does not directly regulate tyre performance or rolling resistance, it creates enabling conditions for the adoption of fuel-efficient technologies, including LRR- and radial tubeless tyres. The development of high-quality expressways and dedicated freight corridors supports longer-haul, higher-speed, and higher-load HDV operations conditions under which the efficiency benefits of advanced tyres are maximized.

By reducing congestion, idling, and stop-start driving, PM Gati Shakti contributes to lower fuel consumption and emissions per tonne-kilometre. In doing so, it indirectly incentivizes tyre upgradation and fleet radialization facilitating a shift towards more efficient and stable operating conditions in the HDV segment.

3.1.7 **National Road Safety Policy (NRSP)**

While safety is the primary focus of the National Road Safety Policy (NRSP), it has indirect linkages with fuel efficiency and emissions. By promoting fleet renewal and better vehicle maintenance, it supports the replacement of older, inefficient vehicles with newer, more efficient ones.

The phased rollout of Automated Testing Stations (ATS) for commercial vehicle fitness testing (from 2023 onwards) further strengthens standardized, technology-driven checks for safety and emissions.

Although NRSP does not directly regulate tyre performance, integrating tyre-efficiency parameters aligned with AIS-142 or the BEE star labelling could leverage this framework to deliver both safety and emissions co-benefits.

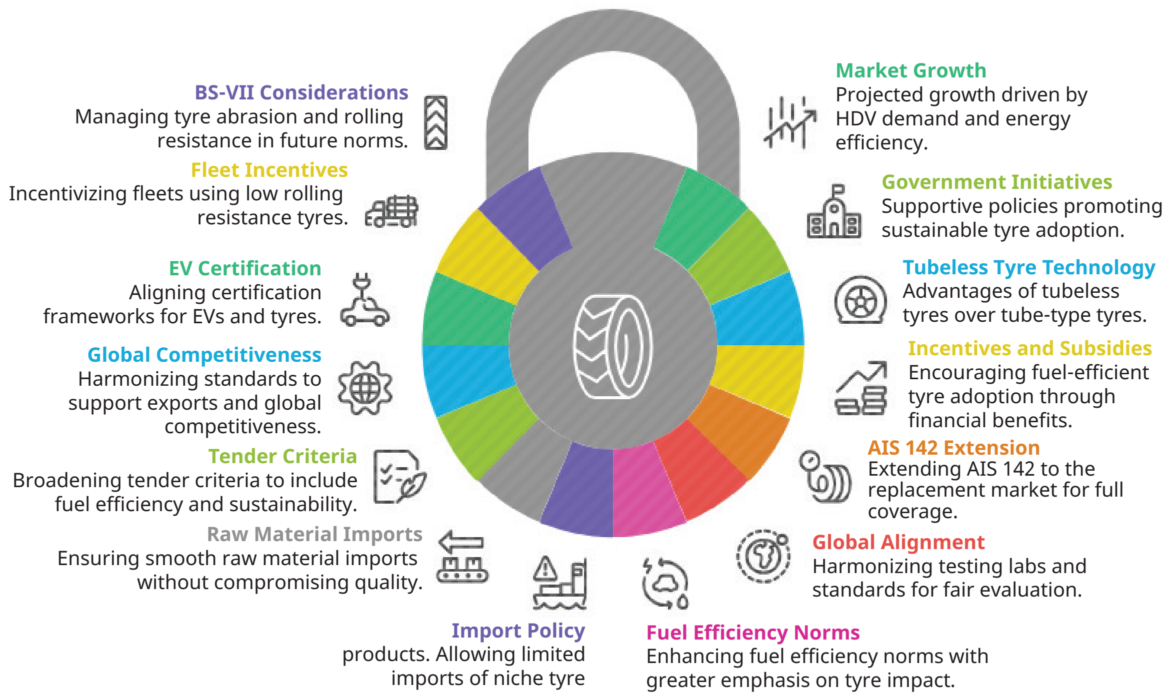

Figure 5: Strategic framework for Indian tyre market

3.2 Best Practices in EU and India

Table 2 presents a comparison of various standards and policy parameters across the EU and India.

Table 2: Quantitative comparison of tyre policy parameters

Parameter	EU	India
Policy Standards	UNECE R117	AIS142
Rolling Resistance	Mandatory	Mandatory
Wet Grip	Mandatory	Mandatory
Emission Norms	EURO 6*	BS-VI/ CFSC
Labelling	Mandatory	Voluntary
Retreading	R108/109	Unregulated

* *EURO 7 adopted and phase in from 2026 onwards*

The EU has taken several initiatives around tyre sustainability and integrating those with the broader policy framework on decarbonization. This includes making rolling resistance mandatory for the entire market, strengthening emission norms, mandatory labelling, enhancing methodology for tyre testing, and promotion of tubeless tyre technology. Given common country priorities on decarbonization, EU-India FTA, increasing tyre exports including from the tier 2 industry to Europe, there is a strong case for considering incorporation of the above-mentioned regulations to India. Not only will this bring uniformity, but it will also help the local industry which seeks to play a larger role in global market.

Key EU Regulation and Policy Best Practices

- **Euro 7 emission norms and tyre abrasion limits:** The Euro 7 regulation introduces enhanced emission requirements for both LDVs and HDVs, for all light-duty (passenger and commercial) vehicles begins November 2026, while for HDVs, begin from May 2028. Importantly, Euro 7 also establishes limits on emissions arising from tyre abrasion, making tyre wear a regulated environmental parameter.

  Implementation timelines include:

  - C1 tyres (passenger cars): new tyres from July 2028, existing market tyres from July 2030
  - C2 tyres (vans): new tyres from April 2030, existing market tyres from April 2032
  - C3 tyres (trucks): new tyres from April 2032, existing market tyres from April 2034

- **Vehicle Energy Consumption Calculation Tool (VECTO):** The EU has developed VECTO, a simulation-based tool used to estimate CO_2 emissions and fuel consumption of HDVs. This enables standardized reporting, benchmarking, and regulatory enforcement for decarbonization of freight transport.

- **Regulation on worn tyres (UN/ECE R117-04):** The updated European regulation R117-04, effective July 7, 2024, introduces requirements for worn tyres to ensure durability and long-lasting performance, supporting sustainability through longer tyre life and reduced waste generation.

- **Promotion of tubeless tyre technology:** The EU places strong regulatory and market emphasis on adoption of tubeless tyres, recognizing their benefits in terms of safety, fuel efficiency, and reduced failure risks, along with improved compatibility with modern vehicle infrastructure.

- **Inter-laboratory alignment for rolling resistance measurement:** To strengthen market surveillance and ensure consistency in testing, the EU has established an Inter-laboratory Alignment Procedure for Rolling Resistance Measurement, as per Annex V of Regulation (EU) 2020/740 on tyre labelling. This framework supports harmonized test results across laboratories, enabling stronger compliance monitoring and enforcement.

4

ANALYSIS OF CHALLENGES AND OPPORTUNITIES IN THE INDIAN MARKET

This chapter provides an analysis of the challenges and opportunities for fuel efficient tyres in the India market. The analysis is based on the stakeholders consultation, cost benefit analysis and study of the evolving policies and technologies environment for tyres.

4.1 Stakeholder's Consultations

India's transition from bias-ply to radial tubeless and more fuel-efficient tyres for HDVs is both necessary and time-relevant. While global evidence suggests comparative fuel-saving advantage from LRR tyres, mass adoption of these tyres is still limited in India.

To understand the current environment and barriers to widespread adoption, TERI conducted a stakeholder consultation and surveyed a number of tyre manufacturers in India.

4.1.1 Methodology

TERI organized a workshop on November 6, 2025, to discuss stakeholder perceptions and feedback on experiences related to adoption of low RR tyres, global best practices, safety, behavioural issues, barriers and opportunities to adoption of low RR tyres, fuel efficiency in freight movement, etc. It involved discussions with the participants from the tyre industry, OEMs, fleet operators, testing agencies and the Government regarding their viewpoints.

Table 3 reflects the participation at the workshop.

Table 3: Participants for stakeholder consultation at TERI

Stakeholder	Key Players
Tyre industry company	Bridgestone, Yokohama, Michelin
Government agency	Department for Promotion of Industry and Internal Trade, Bureau of Energy Efficiency, Indian Rubber Materials Research Institute, Central Institute of Road Transport
OEMs	Mahindra, Daimler, Volvo, Green Cell Mobility, Tata Motors, Volvo Trucks, Daimler India Pvt. Ltd, Mahindra & Mahindra
Fleet operators	Blue, Energy Motors, VE Commercial Vehicles, Ahmedabad Roadlines Pvt. Ltd., Sure Cargo, Synchronized Supply Logistics

The consultation included obtaining feedback on questions to rank responses followed by roundtable discussions focusing on the fuel efficiency of HDV and understanding the importance of tyre technology in fuel savings and other co-benefits.

4.1.2 **Key Takeaways from the Discussion**

In the consultation workshop, stakeholders ranked fuel efficiency (rolling resistance as the first priority, followed by life of tyres, safety & reliability, upfront cost and brand network & reputation as the most important factors considered during the purchase of tyres in the HDV segment. This is a notable inversion from 2016, where upfront cost dominated decisions among small fleet owners (details given in section 4.3). The expectation of <12 month or 12–15 months payback for low rolling resistance tyres shows a growing awareness of total cost of ownership (TCO) and operating margin sensitivities among fleet managers.

The discussion outcome can broadly be categorized under three headings and sub-headings, as below:

(a) Consumer behaviour and market dynamics

Indian HDV fleet market is majorly characterized by high annual utilization rate and fuel cost as the major operating expense. With the presence of competitive freight market, the adoption of innovative fuel-saving technology is deemed as an automatic byproduct of market transition. However, there are certain structural and financial barriers that may impact the internal dynamics of the consumer market:

- **Lack of recognition of total cost of ownership (TCO)**: Upfront cost is one of the key factors to procure the tyre for HDV in India. Radial tyres cost more than bias-ply tyres in India. Since fleet operators are cost-sensitive, higher upfront costs dis-incentivize the adoption and replacement decisions. The lack of recognition of the concept of Total Cost of Ownership (TCO) framework in state and private fleet procurement acts as a barrier to adoption of fuel-efficient tyres. Therefore, clear assessment of life-cycle savings (fuel cost in addition to reduced replacements), is helpful for the adoption of radial and more fuel-efficient tyres (having low rolling resistance).
- **Road Infrastructure**: Indian HDVs operate on heterogeneous road surfaces, starting from high-speed expressways to rural unpaved patches. Therefore, tyre performance and consequent fuel-savings get affected by change in topography, rough surfacing and resulting change in vehicle velocity and braking.

  TERI's interaction with stakeholders also suggests that road infrastructure is a major factor affecting the tyre life for HDV segment. With better highway-corridor expansion and penetration of Gati-Shakti in India, the prospect of more fuel-efficient tyres and their usability in HDVs may become more feasible and viable in near future, owing to larger and more predictable pattern of journey.
- **Lack of Awareness**: As mentioned above, the fleet operators are cost sensitive, and certain manufactures believe that bias tyres are suited for Indian terrain condition. In addition to this, there is a lack of awareness among consumers about how radial tubeless tyres raw materials used in manufacture, load distribution, heat management, energy efficiency and durability compared to bias-ply tyres. Some fleets, especially smaller ones, have not yet institutionalized pressure check routines, torque procedures for wheel nuts or tyre rotation schedules, attenuating the practical benefits of radial adoption.

There is also information asymmetry regarding the understanding of rolling resistance, its relationship with fuel-use and the understanding of how tyre inflation changes with the change in load conditions. Thus, the gap in awareness among fleets, buyers, retailers and enforcement agencies often acts as a key behavioural barrier towards adoption of better-quality tyres in the HDV market.

- **Limited Dealership**: A large proportion of tyre distribution and servicing occurs through independent retailers and unconsolidated networks. Hence, dealers prioritize low-cost tyres that sell quickly and consider premium expensive tyres as special inventory.
- **Availability of Data**: Limited real-world data makes it difficult to link LRR tyres with actual fuel savings and emission reductions in trucking. While lab tests show efficiency gains, these results often differ in real use due to road quality, traffic, climate, and operating conditions. As a result, tyre life and payback periods remain uncertain. Although improved testing and labelling systems may narrow this gap over time, real-world validation remains limited.

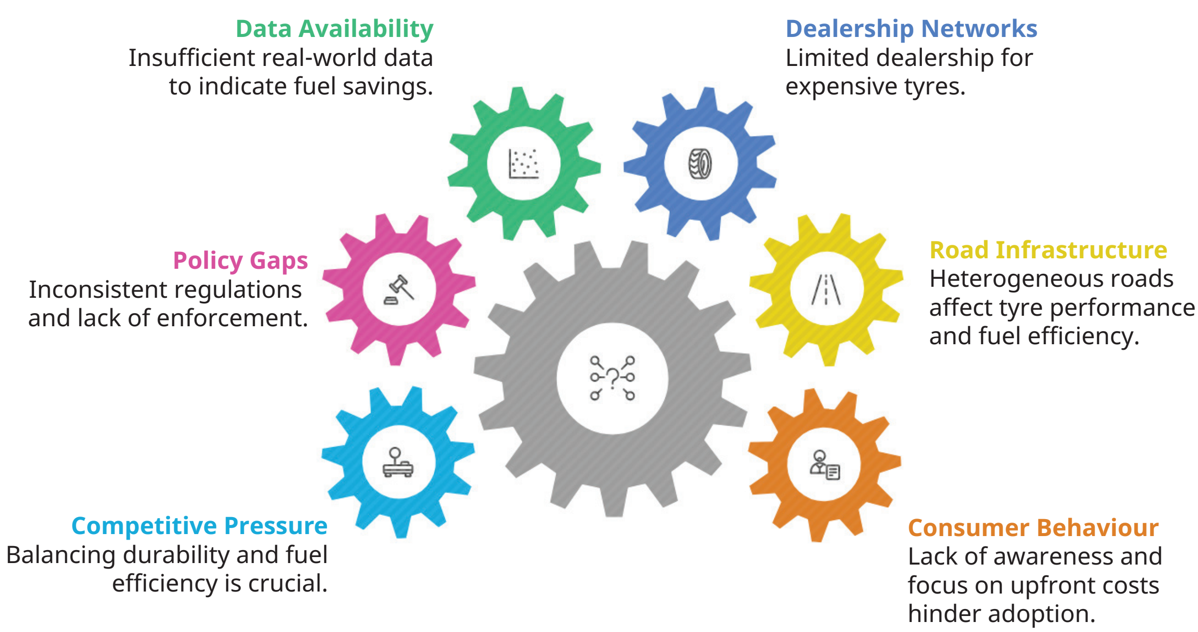

Figure 6: Challenges to fuel-efficient tyre adoption in India

(b) Competitive pressure and innovation needs

In the HDV tyre market, competitive pressure and innovation-needs influence fleet operators' decisions, tyre manufacturers' R&D strategies & promotion, policy development of efficiency standards.

- **Tyre Performance Spiral**: In comparison to Europe, there are combinations of good road infrastructure with bad patches in India. Tyres work best when their key features – such as durability, fuel efficiency, and safety – are balanced. Improving one feature can reduce another. Because Indian drivers and road conditions are unique, tyre design must find the right balance and clearly communicate the benefits to encourage wider adoption of fuel-efficient tyres. As road infrastructure improves we see the scope for fuel efficient tyre increase.

(c) Policy Gap

Based on discussions with experts and stakeholder consultations, our analysis indicates that adoption of fuel-efficient tyres is influenced not only by technology, but also by policy and regulatory frameworks that shape consumer behaviour and market dynamics. Some of the key policy gaps in India's tyre ecosystem include:

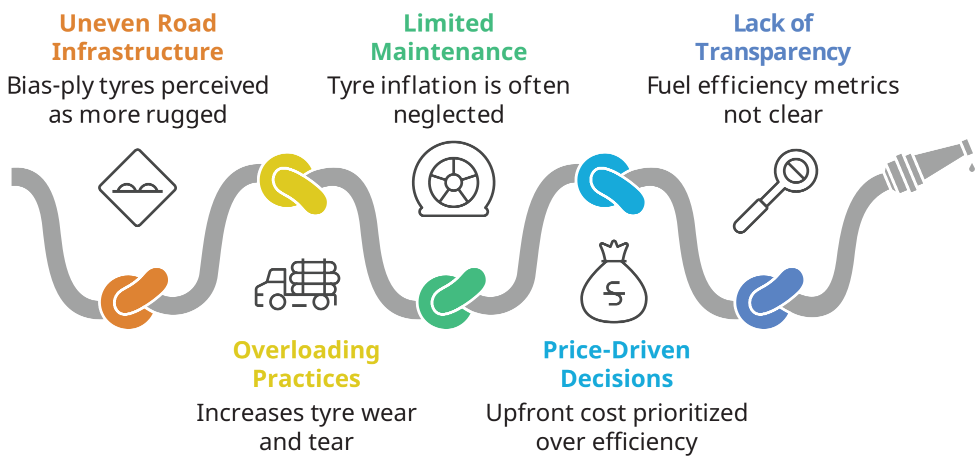

Figure 7: India's HDV tyre market: challenges to full radialization

1. **Limited enforceability of performance standards**: While CMVR and BIS prescribe safety requirements, energy-efficiency parameters for HDV tyres though defined under AIS-142 are still evolving in terms of full enforcement, particularly across segments.
2. **Weak alignment with national energy and climate goals**: Tyre-specific policies have not yet integrated with discussions on broader national objectives such as net-zero goals, fuel import reduction, and logistics efficiency, limiting the impact.
3. **Limited coverage of replacement market**: Current implementation of AIS-142 is more strongly linked to the OEM segment, with relatively weaker penetration and enforcement in the replacement market.
4. **Inconsistencies in testing and certification**: Variability across testing laboratories, along with the absence of strong lab alignment or a virtual/networked testing ecosystem, can lead to differences in measured performance outcomes, affecting standardization, and transparency.
5. **Voluntary labelling regime with limited scope**: Under the BEE framework, star labelling of tyres remains voluntary and is primarily focused on rolling resistance. Broader performance parameters such as wet grip (safety) and noise (comfort and environmental impact) are not yet fully integrated into the labelling framework, limiting its effectiveness as a holistic consumer information tool.
6. **Uniform GST structure**: The current GST regime does not differentiate between conventional, radial tubeless, and LRR tyres, offering no fiscal incentive for adoption of more efficient technologies.
7. **Absence of retread performance standards**: Despite the widespread use of retreaded tyres in the HDV segment, there are no comprehensive performance standards governing their energy efficiency or durability.

Collectively, these gaps constrain large-scale adoption of fuel-efficient tyre technologies and highlight the need for a more integrated and enforcement-driven policy approach.

4.2 Cost Benefit Analysis

4.2.1 Methodology

A detailed cost-benefit analysis of normal radial tyre (Tyre-1) was compared with a low rolling resistance tyre (Tyre-2).

The evaluation was conducted on a 10×2 configuration, 42-tonne TATA 4225 truck. The analysis integrates laboratory drive rolling resistance values, fuel-consumption measurements at controlled speeds and comprehensive operational cost modelling for one year enabling a quantitative comparison of economic and performance outcomes for fleet operators.

The RR characteristics of tyres were evaluated in accordance with ISO 28580, the international standard that defines controlled laboratory methods. The standard specifies a free-rolling steady-state test conducted perpendicular to the drum surface. It includes provisions for aligning inter-laboratory results to maintain global consistency. Rolling resistance (RR), measured for the three tyres in kg/tonne in laboratory, was found to be 6.2 for Tyre-1, and 5.1 for Tyre-2 (as shown in Table 4).

Table 4: Rolling resistance, fuel consumption and mileage of tyres in testing/fleets

Tyre	RR (kg/tonne)	AFC_t (l/100 km)	LT_t (km)
Tyre-1	6.2	26.4	120,000
Tyre-2	5.1	24.0	99,600

Fuel consumption testing was conducted in accordance with IS 11921:2020, India's official standard for evaluating constant-speed fuel consumption of heavy vehicles. The standard applies to M and N category vehicles with gross vehicle weight of 42 tonnes and outlines the complete test methodology, including vehicle preparation, test track requirements, and data-recording protocols.

Testing was performed at the Vehicle Research & Development Establishment (VRDE), utilizing the High-Speed Test Track (HSTT) for vehicle warm-up and the straight test track for fuel consumption trials. These facilities provide controlled and repeatable test conditions compliant with IS 11921:2020 requirements.

The test platform used for evaluating the fuel-consumption effects of rolling resistance was a TATA 4225 heavy-duty truck configured as 10×2, meaning the vehicle is equipped with five axles and wheel arrangements providing 14 wheels in total. The average annual mileage of these trucks running on diesel was 85,000 km (as shown in Table 5).

The average fuel-consumption (AFC) recorded at 40 kmph and 55 kmph, representing operating speeds typical of on-road commercial transport. AFC for Tyre-1 and Tyre-2 was recorded as 26.38 L/100 km and 24.04 L/100 km respectively.

Table 5: Truck parameters considered

Parameter	unit	Value
Truck	-	10×2
Weight	Tonne	42
Number of tyres (Nu)	-	14
Annual Mileage (AM)	km	85,000
Fuel type	-	Diesel
Fuel price (FP)	INR	98

The step-by-step formulation for savings and returns of investment is given in Equation 1 to 5 below.

$$TCFC_t = \frac{AM \times AFC_t \times FP}{100} \qquad \textit{Eq 1}$$

TCFC is the total annual cost of the fuel consumption in Indian National Rupee (INR) for tyre, AM is the annual mileage of truck in kilometre,

AFC is the average fuel consumption of the truck with tyre t installed measured in litres per 100 kilometres (l/100 km),

FP is the fuel price in INR per litre.

$$TTC_{t,} = \frac{C_t \times Nu}{LT_t} \times AM \qquad \textit{Eq 2}$$

Where TTC is the total cost of tyre t for one year in INR,

C is the cost of one tyre,

Nu is the number of tyres in a truck (14 in this case),

LT is the life of tyre measured in km for a tyre t. Table A.1 in the Appendix shows the average value of life of the tyres collected from seven fleets across India on a 10X2 vehicle configuration and the cost of the tyres are taken as the average value in the market from the tyre dealers.

$$TCO_{t,} = TTC_t + TCFC_t \qquad \textit{Eq 3}$$

Where TCO is the total cost of ownership for tyre t.

$$Savings = \frac{TCO_{t2} - TCO_{t1}}{TCO_{t1}} \qquad \textit{Eq 4}$$

$$ROI = \frac{(TCO_{t2} - TCO_{t1}) - [(C_{t2} \times Nu) - (C_{t1} \times Nu)]}{[(C_{t2} \times Nu) - (C_{t1} \times Nu)]} \qquad \textit{Eq 5}$$

Where, savings are the annual saving to the consumer with respect to normal radial tyre measured in percentage, ROI is the annual return of investment in percentage.

Table 6 shows the estimated total cost of ownership for Tyre-1 and Tyre-2 and Table 7 shows savings and ROI of Tyre-2 over Tyre-1.

Table 6: Cost analysis comparison

Tyre	$TCFC_t$ (INR)	C_t (INR)	TTC_t (INR)	TCO_t (INR)
Tyre-1	2,197,304	24,240	240,380	2,437,684
Tyre-2	2,002,139	27,820	332,388	2,334,527

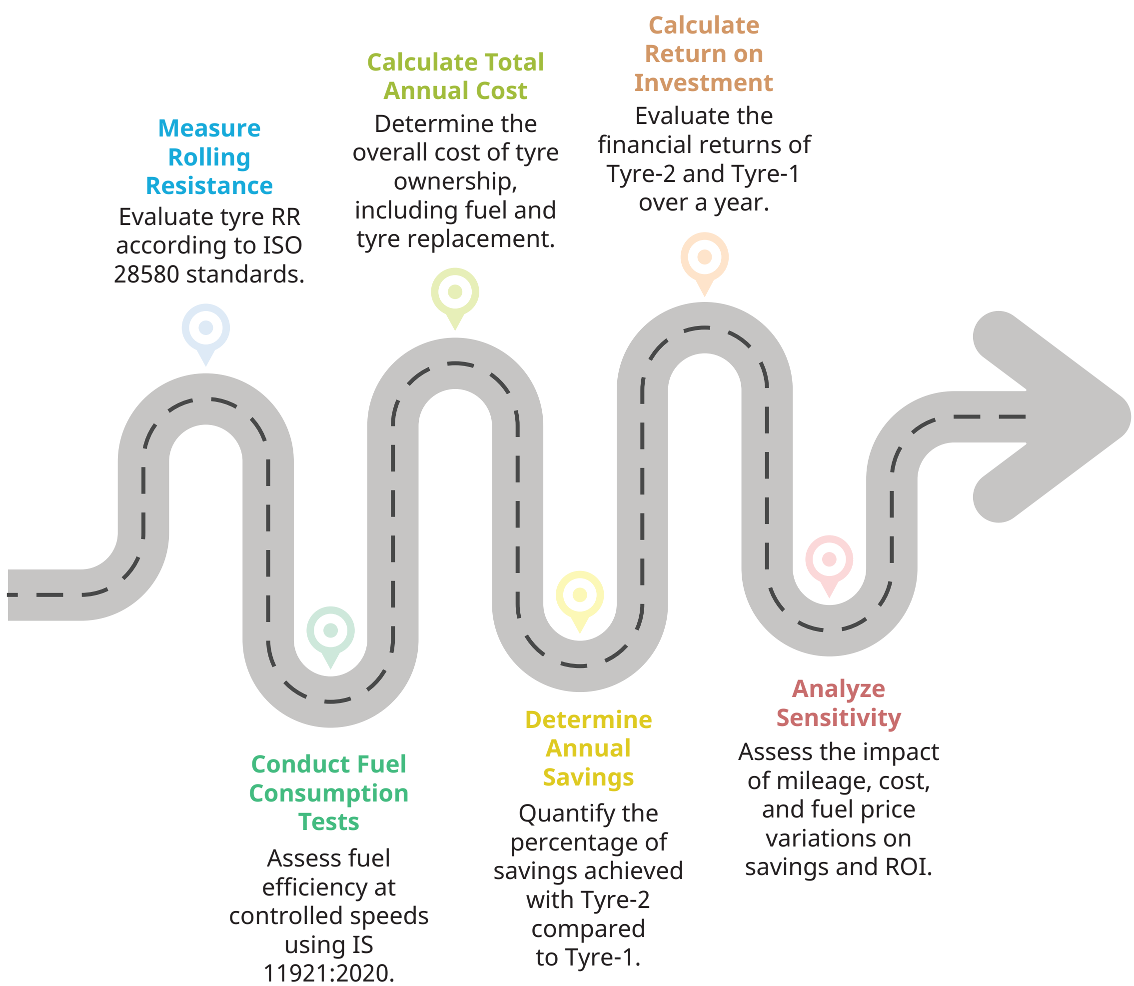

Figure 8: Methodology for evaluating optimal tyre performance

4.2.2 **Key Insights**

The cost benefit analysis demonstrated that tyre rolling resistance has a significant impact on annual operating cost. Normal radial tyre (Tyre-1) with high RR, results in higher fuel consumption and overall operating cost. Low rolling resistance (Tyre-2) provides improved fuel efficiency and excellent return of investment despite a shorter lifespan.

Figure 9 shows the detailed sensitivity analysis for Tyre-2 against the baseline Tyre-1 to understand how the key operating parameters impact annual savings and return of investment (ROI). In the current market state (base case), Tyre-2 shows 4.2% of savings and 106% of ROI with respect to Tyre-1.

In terms of sensitivity, if the tyre mileage decreases by 10% (MIL_10%), Tyre-2 and deliver positive savings, though the benefit reduces compared to the base case. Across fleets, average tyre mileage generally varies within 10% of the PAN India benchmark.

When tyre procurement costs increased by 10% and 20%, the cost burden disproportionately impacts Tyre-2, pushing its ROI into negative. Usually, a 10% rise in tyre cost is observed over a period of 4–6 years, depending on prevailing raw material prices and production costs. In contrast, increases in fuel prices by 10% and 20%, Tyre-2 experiences sharp rise in ROI and annual savings. In this analysis, Tyre-2 achieved the ROI due to its acquisition cost. And it offers attractive returns under normal fuel conditions.

Table 7: Savings and return on investment

Tyre	Savings (INR)	Cost (extra) to customer (INR)	ROI in a year
Tyre-1	-	-	
Tyre-2	103,157 (4%)	50,120	106%

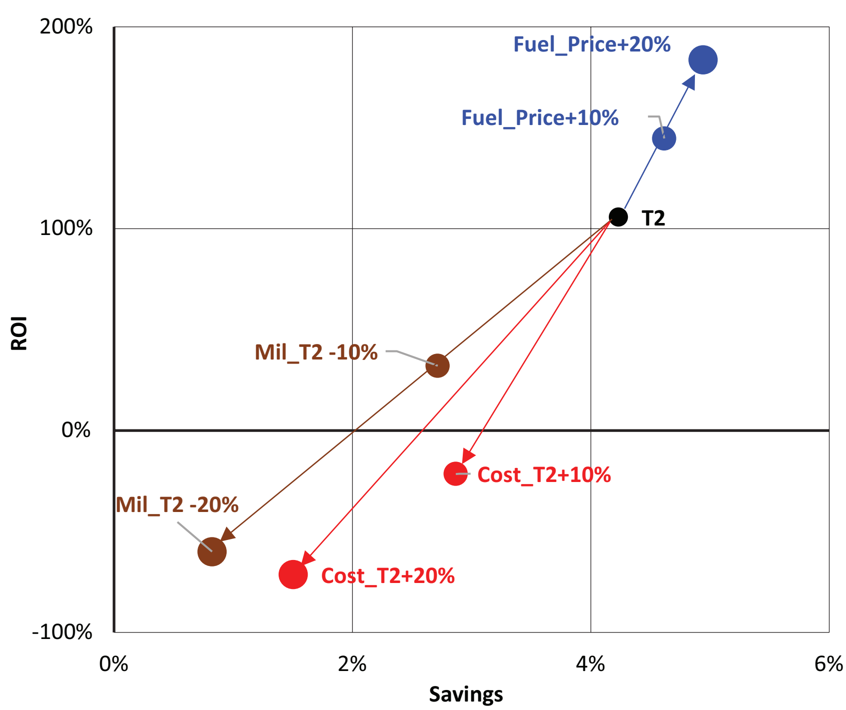

Figure 9: Sensitivity analysis

4.3 Analysis of Temporal Evolution in Tyre Technology

TERI had conducted a study in 2016 on tyre technologies (TERI, 2016) to examine their impact on HDV fuel efficiency in India. We draw on the insights of the earlier study to examine how the tyre use landscape has evolved.

In the mid-2010, India's HDV tyre landscape was shaped by three persistent realities: (i) uneven road infrastructure, (ii) widespread practices such as overloading, and (iii) limited routine maintenance – especially of tyre inflation. Together, these factors nourished a belief that bias-ply tyres were more rugged and thus better suited for Indian operating conditions than radial tyres. This perception was reflected in adoption: radial tyres held a minority share of HDV fitments with many small and fragmented fleets prioritizing low upfront prices and familiarity over lifecycle economics and efficiency gains. Without a clear regulatory anchor or transparent consumer information, most buyers compared tyres on price, durability in harsh conditions, and brand familiarity, rather than on fuel-efficiency metrics that directly affect operating costs.

However, from 2016 to 2025, the HDV tyre ecosystem has moved significantly. In 2022, India amended Rule 95 of the CMVR to mandate tyre performance requirements in line with AIS 142:2019 aligning India with UNECE regulations (PIB, 2022). In addition, India is operationalizing a BEE star-labelling framework for tyres that references AIS 142 measures like rolling resistance coefficient and wet grip index (BEE, 2021).

The emergence of HDV fuel-efficiency norms for ≥12 tonne vehicles and the ongoing policy work on vehicle efficiency creates cross pressure on OEMs and suppliers to optimize tyres, aerodynamics, and power train technologies (BEE, 2025).

Table 8 shows the evolution of tyre technology and market dynamics in India by comparing the current situation with the 2016 landscape.

Table 8: Evolution of tyre technology and market dynamics in India (2016–2025).

Aspect	2016	2025
Radial Adoption	< 20% in HDV segment	> 55%, tubeless gaining traction
Consumer Priority	Upfront cost > Fuel efficiency	Fuel efficiency & tyre life top priorities
Regulatory Framework	No mandatory norms	AIS 142 norms for rolling resistance & wet grip
Tyre Pressure Monitoring System (TPMS)	Optional	Optional
Sustainability Focus	Minimal	Strong push for eco-friendly tyres & recycling
Market Size	INR 50,000 crore approx.	INR 85,000–90,000 crore, global competitiveness

However, despite significant progress since 2016, India's HDV market has still not switched completely to radial tyres.

The changing market dynamics, steadily improving road infrastructure, and increasing focus towards fuel efficiency seem to steadily make a case for integrating tyre efficiency into sustainablility conversation and policy issues.

5

STRATEGIC RECOMMENDATIONS

The Indian truck radial tyre market is projected to grow from USD 1.75 billion (INR 159.2 billion) in 2024 to USD 2.76 billion (INR 251 billion) by 2030, at a CAGR of 8.2% (GVR, 2025) driven by rising HDV demand and a shift towards energy-efficient technologies.

Government initiatives such as AIS-142, BEE tyre star rating, and proposed CAFÉ norms are increasingly creating a supportive ecosystem for sustainable tyre adoption.

Given the country's larger ambition towards decarbonization, emission mitigation and reduction of the fuel import bill, the Government should encourage adoption of fuel-efficient tyre technologies through incentives and subsidies.

- AIS 142, though a positive step, applies only to OEMs. It should be extended to the replacement market for full coverage.
- Current HDV fuel-efficiency norms underweight tyre impact. Greater emphasis on tyre rolling resistance and tools like Bharat-VECTO, customized for Indian conditions, can improve accuracy and adoption of low rolling resistance tyres.
- Allow limited imports of niche or unavailable tyre products through a clear policy, especially for firms that have already invested in domestic manufacturing.
- Ensure smooth raw-material imports where local alternatives do not exist, without compromising quality, exports, or global supply-chain integration.
- Gradually broaden government tender criteria beyond price to include fuel efficiency, safety, and sustainability.
- Since AIS 142 already aligns with EU R117, maintaining harmonization will ease compliance and support exports.
- Harmonize Indian technical standards with global best practices to support exports and global competitiveness.
- Align EU and Indian certification framework for EVs, tyres and charging systems, and promote joint research for smoother regulatory convergence.
- Incentivize fleet using certified low rolling resistance tyres through GST benefits, accelerated depreciation or green freight vouchers.

If BS-VII explicitly considers tyre abrasion, tyre manufacturers will be required to manage compound and tread designs. This could produce co-benefits and increase relevance of rolling resistance (depending on compound choices) but also create trade-offs between wet grip and rolling resistance. When BS-VII designates tyre abrasion limits paired with RRC targets, the sweet trade-off point should be evaluated with proper testing and R&D activities. Combining tyre-efficiency awareness and benchmarking (integrating Star Labelling-BS VII) into logistics hub design and Gati Shakti freight corridor projects can act as positive externality over greater fuel saving for HDVs in India.

6

CONCLUSION

Improving tyre technology can serve as an important cost effective and scalable opportunity for reducing diesel consumption, improving HDV performance, and mitigating transport-related emissions.

According to the latest statistics published by the MoSPI, the road transport sector alone accounted for the consumption of 2.9 EJ (Exa Joule; 69.26 Mtoe) of diesel during 2023–24, which represents approximately 74% of India's total diesel consumption for that period. However, it is noteworthy that despite the HDV segment comprising only 3% of the total vehicular fleet in the country, this segment was responsible for consuming close to one-third of the transport sector's total diesel use, amounting to nearly 1.0 EJ (23.88 Mtoe). In this context, the adoption of LRR technology across the entire HDV segment had the potential to deliver significant energy savings, estimated at around 81.8 PJ (Peta Joule, i.e., 1.95 Mtoe), which would account for 2.1% of the total fuel consumed by the HDV sector.

The progression from bias ply to radial, tubeless and low rolling resistance tyres aligns with global best practices and India's national priorities for energy security, air quality improvement and climate action.

The cost benefit assessment clearly demonstrates that tyres with optimized rolling resistance consistently deliver fuel savings, lower total cost of ownership and strong return on investment for fleet operators. The same feedback was also shared by the participants at the stakeholder consultation. Policy developments – such as AIS-142, BEE star labelling programme, HDV fuel efficiency norms and incentives for electric trucks – are already shaping a more efficient tyre ecosystem. Yet, barriers relating to awareness, upfront cost, uneven road quality, lack of standardization with global best practices, absence of application of norms to the entire market, retreading norms, and limited consumer information still impede widespread adoption.

Looking forward, India's rapid expansion of Gati Shakti freight corridors, growth in electric trucks

and tightening emission norms (including potential BS-VII requirements on non-exhaust emissions) create a favourable environment for faster uptake of high-performance tyres. Strategic government support, improved testing capabilities, mandatory labelling of tyres, strengthening of emission norms, harmonization of standards with global best practices, differentiated taxation incentives, and stronger market awareness can accelerate full radialization and wider LRR tyre adoption.

With coordinated action between industry, policymakers and fleet operators, advanced tyre technologies can play an essential role in enabling India’s transition to a cleaner, safer and more fuel-efficient freight transport system.

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APPENDIX

(A) Policy Details

a. AIS-142 Regulation

AIS-142 follows UNECE R117. These regulations specify performance standards and their methodology for different classes of tyres (C1, C2, C3), tyre rolling resistance, wet grip, and rolling sound. It also includes the use of skid trailers for wet grips, drum tests for rolling resistance, and specific track conditions for noise measurement. For vehicle using Class C3 tyres – including trucks and buses – AIS-142 specifies strict limits on the rolling resistance coefficient (RRC). These tyres must achieve an RRC value below 7 N/kN. By defining the measurement method and stage-wise limits, AIS-142 directly constraints rolling resistance. This ensures that tyres approved under the standard deliver lower on-road fuel consumption, reducing operating costs and emissions for fleets.

In addition, it also defines test procedures and conformity of production rules. The standard uses ISO 28580 single point rolling resistance method. It depends on inter-laboratory alignment. This ensures one lab's measurements match another's. Such alignment is essential for enforcement and consumer trust. However, AIS-142 does not mandate the usage of LRR tyres, but it creates conditions where higher quality tyres become more conducive:

- Raising safety and performance baselines (ABS, ESC, TPMS)
- Increasing scrutiny on energy efficiency and emissions, and
- Standardizing tyre performance measurement and certification.

Hence, AIS-142 indirectly incentivizes LRR adoption and enables tyre-approval and procurement. Since fleet owners can correlate tyre choice with vehicle uptime and energy consumption, LRR tyres can help reduce energy loss and heat build-up.

Tyres sold in India must meet fixed energy-efficient and safety baseline. These baselines have shown real fuel saving benefits in fleet studies. They also support consumer protection goals seen in other regions.

- UNECE R117-04 is the latest European benchmark for tyre approval covering rolling sound, wet grip and rolling resistance across C1, C2 and C3 tyres. The 04 series, in force since January

2025, consolidates prior amendments and adds worn-tyre wet-grip concepts to keep safety high throughout the tyre's life. India's AIS-142 and Rule 95 already with UNECE methods and stage-2 limits; citing R117-04 signals the global reference point for future updates to testing, COP and homologation, and helps Indian manufactures remain export ready.

b. BEE Star Labelling Programme

Regulation alone cannot change behaviour in the replacement tyre market. To address this, the Bureau of Energy Efficiency (BEE) introduced a voluntary Star-Labelling Programme for tyre under Schedule-30. The programme was first launched in 2022. It was later updated to version 2.0 in March 2025. The scheme grades tyres using the rolling resistance coefficient (RRC). It also uses the Wet Grip Index (G). Both values are taken from AIS-142 test methods. The programme requires testing in National Accreditation Board for Testing and Calibration Laboratory (NABL) or International Laboratory Accreditation Cooperation – Mutual Recognition Arrangement (ILAC-MRA) accredited laboratory. It also requires BIS or ISO-9000 quality certification. The label must be clearly displayed at the point of sale.

BEE/Schedule documents specify star bands, testing methods referencing AIS-142, and labelling requirements for replacement tyres. Table A.1 shows the tyre star labelling specifically for the HDV segment (i.e. C-3 tyres).

Table A.1: Tyre labelling requirements

Star	Rolling Resistance Coefficient RRC (N/kN)	
	Lower Limit	Upper Limit
One Star	7.6	10.0
Two Star	6.6	7.5
Three Star	5.6	6.5
Four Star	4.6	5.5
Five Star	0.0	4.5

There is no tolerance for the upper limit for RRC value of the corresponding Star Rating Band. All tested products must meet the minimum threshold for each Star Rating Band. Higher star ratings indicate lower fuel consumption, helping consumers identify energy-efficient options, thereby influencing the tyre market in various prospective channels:

- Consumer Market transparency: Labelling informs fleet purchasers and operators about tyre rolling resistance and fuel-efficiency potential, reducing information asymmetry and enabling energy-aware procurement.
- Production Competition & Upgrade: BEE-Labels incentivize tyre manufacturers to move products into higher star bands (lower RRC), stimulating provisioning of more fuel-efficient tyres and integrating them into the HDV supply-chain.
- Enforceability: A narrow, strict star banding (i.e., making high-rating bands harder to reach) increases the commercial value of low-RRC tyres, thereby accelerating market shift.

- Labelling Expansion: Ensure labels appear in replacement market outlets (dealers, online retail) and on commercial tyre procurement platforms. Add a verified retest mechanism and expiry/ recertification windows to prevent stale claims.

OEMs often use LRR tyres to meet fuel economy rules, but these gains disappear when replacement tyres have higher rolling resistance. The proposed Indian Star Labelling Scheme for tyres aims to preserve these fuel-saving benefits throughout the vehicle lifecycle by encouraging the use of tyres with lower rolling resistance in the replacement market as well..

In parallel, India has reshaped freight sector policy through heavy duty fuel efficiency norms. These norms were first notified in 2017 for vehicles of 12 tonnes gross vehicles weight (GVW) and above. They were later expanded to cover vehicles of 3.5 tonnes GVW and above.

In practice, these fuel efficiency norms influence tyre choice. OEMs and fleets must meet fuel-consumption equations across many duty cycles. Rolling resistance becomes a key lever that needs no powertrain redesign. As a result, alignment between tyre standards and heavy-duty vehicles (HDV) fuel norms becomes important.

c. PM E-DRIVE & Zero-Emission Trucks (ZET)

Electrification programmes have created a second pillar in India's clean transport strategy. The PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) scheme, is a programme launched by the Government of India in October 2024 to accelerate the adoption of electric vehicles (EVs) including a specific incentive for electric trucks/e-MHDTs under the Zero Emission Trucks (ZET) programme. It is especially important for freight because E-DRIVE includes support for e-trucks and e-buses. In August 2025, the Government extended subsidies for e-trucks, e-ambulance, e-buses and public charging until March 2028. The scheme provides financial support (per kWh and capped share of vehicle price) to reduce upfront costs and push early ZET deployment. The scheme has been extended and remains active as a major push for demonstration and scale.

- Direct decarbonization of freight: The scheme provides financial incentives for N2 and N3 category electric trucks (gross vehicle weight above 3.5 tonnes) with incentives up to ₹9.6 lakh per vehicle. Subsidizing e-trucks reduces diesel consumption and associated CO_2 and local pollutants in the freight segment.
- Proof-of-concept & learning: Pilots and subsidies create real-world learning that can inform grid planning, depot charging, and total cost of ownership (TCO) calculations for long-haul operations.
- Complementary technology stack: Electric trucks still benefit from LRR tyres — reduced rolling resistance increases range and lowers battery sizing needs and costs. Conversely, tyre star-labelling and AIS requirements that improve tyre efficiency multiply the benefits of electrification. (efastindia.org)
- Demand creation for zero-emission powertrains with better quality tyres: Sales mandates/ incentives accelerate fleet electrification and thus cut diesel consumption. Along with battery-weight, Indian HDVs also operate on rough roads and carry high axle loads. Thus, efficient tyres must combine low hysteresis compounds to provide a proper trade-off between rolling resistance and traction. Achieving low rolling resistance while retaining wet/low-friction traction requires compound and tread innovations. For every percentage reduction in tyre rolling resistance, there is a fall in energy demand per km which either increases distance-range or reduces battery capacity needed for the same journey.

- Tyre Durability: With high ZEV uptake, tyre performance matters more for vehicle range and energy consumption. LRR tyres improve range-per-kWh and reduce lifecycle energy use and total cost of ownership and operating cost for e-trucks. However, their abrasion features also need to be aligned with Indian road conditions since reduction in rolling resistance may lead to fall in tyre durability.
- Testing: Vehicular tests need to be conducted to understand the scope of integration of ZEV with energy-efficient tyres, with proper focus on the feasibility of such tyres on long-hauls and short-hauls and hence pairing ZEV support with tyre-efficiency measures (labelling, procurement requirements).

The scheme highlights test-agency upgrades that matter directly for tyre compliance, laboratory alignment and vehicle homologation under AIS-142. A stronger testing ecosystem reduces delays in certifying wet-grip and rolling resistance. It also speeds model approvals and can lower compliance costs for domestic manufacturers. This helps make low-rolling resistance tyres more accessible for both electric and ICE fleets.

In parallel, global best practices show how simulation tools can support heavy-duty compliance. The EU's Vehicle Energy Consumption Calculation Tool (VECTO) is a simulation model used to determine CO_2 emissions and fuel consumption from heavy-duty vehicles. It models how different truck and bus configurations use fuel and produce emissions. It also underpins fleet-wide emission reduction targets such as 15% by 2025 and 30% by 2030 compared to 2019 levels. Under VECTO-based rules, all new city buses must be zero-emission by 2035, with 90% zero-emission sales required by 2030. This drives a major transition in urban transport using simulation tools like VECTO for CO_2 certification. These approaches align with India's move to tighten tyre standards and HDV efficiency norms. They show how better measurement, clearer mandates and market signals can keep rolling resistance low and reduce fleet emissions.

The ZET Policy Advisory proposes thirty measures covering incentives, regulation, infrastructure, business models, financing and stakeholder support to move ZET sales towards 100% by 2050 in line with national net-zero goals. Earlier roadmaps and priority-corridor studies by NITI Aayog and its partners also identify battery-electric and fuel-cell trucks as core to India's freight decarbonization pathways. They highlight the benefits of energy security, lower logistics cost and large cumulative CO_2 reductions across the sector.

India does not yet have a single nationwide zero emission vehicle sales mandate such as the UK, Canada, EU, and California. However, it has target/mandate-like instruments embedded within PM E-DRIVE, state initiatives, and centrally coordinated EV targets. Recent central funding and incentive announcements (e.g., allocations for e-trucks, buses) act like a demand-side sales accelerator.

d. Heavy-Duty Fuel Efficiency Norms

India's Heavy-Duty Fuel Efficiency Norms are set by the Bureau of Energy Efficiency (BEE) and enforced by the Ministry of Road Transport and Highways (MoRTH). The regulatory process formally begun in 2014 and was developed through collaboration of MoRTH, the Petroleum Conservation and Research Association (PCRA), which is part of the Ministry of Petroleum and Natural Gas (MoPNG), BEE, and various other stakeholders. The BEE published fuel-efficiency standards for HDVs with a gross vehicle weight (GVW) over 12 tonnes in August 2017 and amended the regulation in 2019 to include standards for vehicles of GVW 3.5 tonnes to 12 tonnes. These norms aim to reduce diesel

consumption and emissions from trucks and buses, which consume a large share of transport fuel.

The standards in Phase-I in April 2018, have adoption for vehicles greater than 12 tonnes, and in Planned Phase-II (initially 2021, later postponed and re-notified), with new, stricter norms proposed for 2027–2032, extending coverage to more vehicle categories (like LMCVs and HDVs, M2, M3, N1, N2, and N3 categories) and aiming for significant reductions by 30% over FY2023 baselines.

These regulations are designed towards reducing fuel consumption and greenhouse gas (GHG) emissions from diesel-powered trucks and buses.

- **Supply-side regulation**: By requiring manufacturers to meet fuel-consumption performance, the standards nudge the vehicle OEMs to adopt technologies (powertrain optimization, aerodynamic improvements, tyre selection) to meet regulatory targets — this creates market demand for low-drag and low-rolling-resistance tyres.
- **Market signaling and incentivization**: Standards create predictable demand for efficient technologies, making suppliers (tyre manufacturers) more likely to innovate and produce LRR tyres for HDVs. Vehicle-level constant speed fuel consumption (CFSC) norms can incentivize compliance linkage for tyre companies to contribute to more efficient tyre manufacturing.

e. National Road Safety Policy

The National Road Safety Policy (NRSP, approved in 2010 and periodically updated) outlines the policy initiatives to be framed / taken by the Government at all levels to improve the road safety activities in the country. It aims at creating the institutional and regulatory foundation for safer, newer and better-maintained vehicle fleets in India with a high-level framework for road safety interventions across ministries and states. It emphasizes vehicle safety standards, adoption of safer technologies and institutional mechanisms to reduce crashes. The policy has been a basis for many technology-led interventions (intelligent transport systems, vehicle fitness, enforcement) over the years. (MoRTH, 2022)

Although the NRSP is focused on safety provision, it has both direct and indirect linkages with fuel use and emissions:

- NRSP's emphasis on vehicle fitness/maintenance and push for newer & safer vehicles encourages replacement of old, inefficient trucks that emit and consume more. This creates a demand environment receptive to efficiency and emerging technologies and thus generating emissions co-benefits.
- A major operational step following the principles of NRSP was the mandatory use of Automated Testing Stations (ATS) for commercial vehicle fitness testing from 2024, improving standardization of fitness checks and emissions/idle smoke testing regimes.

Specifically, the NRSP is not a direct vehicle-efficiency policy and does not mandate tyre efficiency. However, aligning procurement/fleet renewal under NRSP with tyre-efficiency requirements (procurement checklists / vehicle fitness certificates referencing AIS-142 / star labelling) could accelerate adoption of LRR tyres.

f. Emission standards (BS-VII) including tyre abrasion

Bharat Stage (BS) emission norms are India's vehicle pollutant standards. To align India's automobile sector with global benchmarks, the government is planning to introduce the BS VII emission norms in 2026–27, equivalent to the Euro 7 emission standards aimed at reducing vehicular pollution.

BS-VII marks a significant step forward in India's vehicle emissions regulation by expanding its scope to include non-exhaust particulates, such as those from tyre wear. This is a first for BS norms, which have traditionally targeted pollutants like NO_X, CO and PM. These new standards introduce On Board Monitoring (OBM) for real world emission tracking, and they align emission limits more tightly across petrol, diesel, hybrid, and electric vehicles.

While BS-VII does not directly address tyre rolling resistance or fuel efficiency, its emphasis on tyre particulate matter reduction could spur industry attention. For HDVs, tailpipe emissions depend on engine efficiency, vehicle performance and energy demand. As part of energy demand, tyres are deemed as the second-largest component for energy loss (~ 18.8% - 20%) in HDVs after engine losses. Thus, there is a linkage between BS-VII and tyre technology as they influence the fuel-use per km and hence the real-world cost of inefficiency.

EURO 7: These are the European Union's latest vehicle emission regulations, adopted in 2024, that refer to a single set of rules, applicable to all motor vehicles including heavy duty vehicles. Euro 7 for all light-duty (passenger and commercial) vehicles begins November, 2026, while for heavy-duty vehicles, begin from May 2028. Euro 7 has, for the first time, limited the PM_{10} emissions from non-tailpipe factors like brake wear and tyre abrasion. Stringent limits have also been imposed on various pollutants, some of which were previously not there for HDVs like N_2O, NH_3.

Euro 7 will also limit the emissions stemming from tyre abrasion. For different vehicle-tyre categories, the following Table A.2 has specified different timelines for compliance with new and existing tyres.

Table A.2: Compliance timeline with Euro 7

Tyre categories		New tyres	Existing tyres
C1	Passenger Car	July 2028	July 2030
C2	Light Commercial Vehicles (like vans)	April 2030	April 2032
C3	Heavy Trucks & Buses	April 2032	April 2034

g. PM Gati Shakti & Urbanization Policies (infrastructure decentralization)

PM Gati Shakti, launched in 2021, India's National Master Plan for Multi-modal Connectivity is a digital platform and policy framework to integrate infrastructure planning across Ministries, states and major logistics corridors. Its core mandate is to reduce logistics costs, streamline freight movement, and bridge infrastructure gaps by creating a unified digital platform connecting rail, road, port, aviation, and industrial networks. The initiative brings together more than forty central ministries and dozens of states on a single GIS-enabled data system, enabling faster project execution, improved last-mile connectivity, and more efficient freight operations. Although PM Gati Shakti does not explicitly refer to tyre fuel efficiency or rolling-resistance standards, its goal of lowering logistics costs aligns naturally with technologies such as low-rolling-resistance tyres, which improve truck fuel efficiency and reduce per-tonne-kilometre energy use. As freight flows become more coordinated and corridor performance improves under Gati Shakti, the benefits of high-efficiency tyres become more pronounced, offering fleets an operational advantage within this upgraded national logistics ecosystem.

- With the shift from fragmented to corridor-based freight, Gati Shakti facilitates more long-haul, high-speed and heavy-load movement for HDVs, hence moving towards greater feasibility of fuel-efficient tyres in Indian conditions
- Better multimodal freight corridors reduce truck km travelled, with fewer stop-start cycles and idling, thereby lowering aggregate diesel consumption and emissions.
- Due to point-to-point connectivity, there will be lesser congestion losses, suspension losses and lesser scope of tyre deformation. Thus, HDVs tend to operate towards steady-state driving and better conditions for fuel-efficient radial tubeless tyres.

Although Gati Shakti does not put any mandate on tyres, creating smoother, high-speed expressways (like the Delhi-Mumbai Expressway) can qualitatively incentivize better radialization of Indian HDV market and enable better fuel-efficient tyre technologies.