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NITI Aayog

Enhancing Circular Economy of Waste Tyres in India

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Enhancing Circular Economy of Waste Tyres in India

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NITI AAYOG

National Institute for Transforming India

Government of India

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FOREWORD

India's journey towards a circular economy is gathering pace, as we seek more innovative ways to use resources and generate sustainable growth. The rapid pace of urban growth and evolving consumption patterns requires us to urgently rethink traditional methods and develop systems that effectively serve the needs of communities, industries, and the environment.

Within this context, the issue of End-of-Life tyres (ELTs) is both a test and an opportunity. As materials reach the end of their use, our approach must shift: from seeing waste to recognising the potential for renewal. Responsible recycling, clear standards, and the inclusion of all stakeholders, especially the informal sector, are central to shaping a future where waste tyres become valuable assets.

The Government of India is fully dedicated to advancing these goals. The NITI Aayog report, *"Enhancing Circular Economy of Waste Tyres in India,"* offers timely insights and guidance on strengthening Extended Producer Responsibility, improving recycling practices, and supporting innovation across the value chain.

By working together and embracing new ideas, India can transform the end of tyre use into the start of new opportunities for green jobs, industrial competitiveness, and climate resilience.

I extend my sincere appreciation to Team Green Transition, Climate & Environment, GTC&E, NITI Aayog, and the knowledge partner, The Energy and Resources Institute (TERI), for their research, diligence, and insights in developing this report. It will support policymakers and stakeholders in advancing these efforts and help India build a robust, transparent, and accountable tyre recycling ecosystem.

(Suman Bery)

Place- New Delhi
Dated- 20th January 2026

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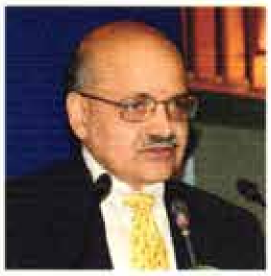

FOREWORD

India's expanding road network and rising mobility has led to a sharp increase in tyre demand. As of 2024, India's domestic tyre production is approximately 4.2 million metric tonnes (MMT), registering steady growth of around 10% per annum. This is driven by higher vehicle usage across passenger and commercial segments. However, this also creates a challenge to manage tyres at the end of their useful life.

Recycling of End-of-Life Tyres (ELTs) is not only an environmental priority but also a strategic opportunity. It helps reduce dependence on imports, recover valuable materials, support domestic manufacturing, and create employment in the green economy. In 2024, approximately 3 million metric tonnes (MMT) of waste tyres recycled. Although Extended Producer Responsibility (EPR) for waste tyres exists, the sector continues to face major gaps. A large share of recycling remains informal, many high-value applications remain underutilised, and inconsistencies in standards limit the full benefits that can be realised.

To overcome these challenges, the tyre recycling sector must scale responsibly through stronger frameworks, clear accountability, and broader stakeholder participation. Improved operational practices, and a focus on sustainability can position India as a global leader in safe and efficient tyre recycling.

The NITI Aayog report ***"Enhancing Circular Economy of Waste Tyres in India"*** lays down a clear pathway for sustainable tyre recycling. It highlights the need for stronger policy direction, strengthening of the EPR framework, robust standards, and greater formalisation of the sector. By aligning policy and industry practices, the report highlights ELT recycling as a driver of India's circular economy and a pathway to climate-resilient growth.

I appreciate the research work done by the working group on End-of-life Vehicles (ELVs) chaired by Maj Gen K Narayanan, PD (Security & Law) and the support provided by Green Transition Energy & Climate Change division under Dr. Anshu Bharadwaj, Programme Director. I hope this report leads the way in creating a stronger circular economy in tyres.

Dated: 15th January, 2026 **[B.V.R. Subrahmanyam]**

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Message

The Lord says in verse 22 of Chapter 2 in Bhagavad Gita
वासांसि जीर्णानि यथा विहाय
नवानि गृह्णाति नरोऽपराणि।
तथा शरीराणि विहाय जीर्णान्य्
अन्यानि संयाति नवानि देही॥

Purport: *As a person sheds worn-out clothes and wears new ones, likewise, at the time of death, the soul casts off its worn-out body and enters a new one.*

India stands at a critical stage in its development journey, with the transportation sector playing a crucial role in driving economic growth, industrial progress, and social connectivity. As the nation's automobile industry continues to expand rapidly, tyre consumption has increased, shaping the landscape of resource use and waste management. This calls for a strong strategy to manage End-of-Life Tyres (ELTs), as their volume is expected to double in the next decade.

Recycled products from waste tyres include pyrolysis oil, carbon black, crumb rubber, reclaimed rubber, and recovered steel, which are used in tyre manufacturing, road construction, and various applications. This shows how ELTs can support industries, reduce environmental impact, and boost economic growth. Across the lifecycle, from manufacturing to disposal, tyres affect both industry and environment.

NITI Aayog recognises the urgent need for stronger policy and frameworks, particularly to address gaps in the recycling ecosystem—such as traceability, standardisation, value recovery, and formalisation of the informal sector in tyre recycling. Addressing these issues will not only reduce the harmful impacts of waste but also unlock significant economic potential for industry growth and job creation. Moreover, it will position India as a global leader in sustainable tyre management, reinforcing the country's commitment to resource efficiency and climate resilience. This report *"Enhancing Circular Economy of Waste Tyres in India"* highlights the vital role of sustainable ELT management in strengthening domestic industries, advancing circular practices in transport and mobility, and meeting our environmental commitments.

I thank Team NITI and our knowledge partner TERI for their hard work and research.

(Maj Gen K Narayanan)

Acknowledgements

We thank Shri BVR Subrahmanyam, CEO, NITI Aayog, for his guidance and valuable suggestions in the preparation of this report. We also thank the members of the Working Group on Circular Economy of Tyres for their active participation and constructive inputs. We thank our knowledge partner, The Energy and Resources Institute (TERI), the concerned ministries and all stakeholders for their support in finalising the report.

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List of Abbreviations

ABAP	Advanced Batch Automated Pyrolysis
ATMA	Automotive Tyre Manufacturers' Association
BIS	Bureau of Indian Standards
CPCB	Central Pollution Control Board
CRMB	Crumb Rubber Modified Bitumen
DGFT	Directorate General of Foreign Trade
DPIIT	Department of Promotion of Industry and Internal Trade
ELT	End-of-Life Tyres
EPR	Extended Producer Responsibility
MoEFCC	Ministry of Environment, Forests and Climate Change
MoMSME	Ministry of Micro, Small and Medium Enterprises
MoPNG	Ministry of Petroleum and Natural Gas
MMT	Million Metric Tonnes
MRAI	Material Recycling Association of India
MRP	Micronised Rubber Powder
OCEMS	Online Continuous Effluent and Emission Monitoring System
OEM	Original Equipment Manufacturer
rCB	Recovered Carbon Black
SOP	Standard Operating Procedure
SPCB	State Pollution Control Board
TDP	Tyre Derived Polymer
TPO	Tyre Pyrolysis Oil

Executive Summary

India stands at a pivotal juncture in managing its growing volume of End-of-Life Tyres (ELTs)[1], driven by a fast-expanding automobile sector and increasing tyre consumption. With tyre production projected to double in the coming decade, the challenge of sustainably managing ELTs has assumed critical importance. At the same time, the recycling of tyres presents a unique opportunity to advance circular economy objectives, reduce import dependence on key raw materials, and create new avenues for green employment.

The current recycling ecosystem is fragmented, with critical gaps in traceability, standardisation, and value recovery. Despite the presence of an Extended Producer Responsibility (EPR) framework, inconsistencies in the weightage methodology, ambiguity in assigning values to different recycled products, and an established informal sector limit the effectiveness of waste tyre recycling.

High-value recycled products face limited uptake due to the lack of standards and market mandates. This results in downcycling and missed opportunities for import substitution. Additionally, tyre retreading—a well-established circular pathway—remains under-incentivised, with the majority of retreaders operating informally and the practice excluded mainly from EPR credits.

The report recommends a cohesive approach to unlock the circular potential of ELTs. The EPR certificate generation may be revised to include a precise, auditable mechanism, supported by a common conversion factor, to ensure adequate transparency into certificate availability, environmental integrity, and market efficiency. Verification of materials produced from waste tyre processing may be standardised through mass-flow mapping, and mandatory installation of Online Continuous Emission Monitoring Systems (OCEMS) may be enforced for tyre pyrolysis units. Tyre Pyrolysis Oil (TPO) may be restricted to refineries or select industrial applications, and carbon char may be refined exclusively into recovered Carbon Black (rCB) to prevent sub-optimal end uses and strengthen downstream material accountability. National standards for TPO and rCB may be notified and guidelines for their use in value-added applications may be issued to promote the uptake of recycled tyre materials and integration of recycled tyre products into domestic procurement and supply chains.

Formalisation of the ELT recycling ecosystem is essential for effective implementation of the EPR regime. All stakeholders across the ELT value chain to be integrated into the EPR framework. Digital platforms such as the Udyam Assist Platform may be leveraged to onboard unauthorised recyclers. Targeted financial support and a one-time waiver of outstanding environmental liabilities may be extended to facilitate infrastructure upgrades in non-compliant units, subject to formalisation and future compliance. GST rationalisation for ELTs and recycled tyre products, along with separate HSN codes for crumb rubber and micronised rubber powder, is recommended to improve market clarity and competitiveness.

These measures will help create a robust, transparent, and formalised ecosystem with proper accounting of ELT material flows. Strengthening domestic markets for secondary raw materials will generate multiple co-benefits: enhancing material recovery, reducing import dependence, creating high-quality green jobs, and positioning India as a leader in sustainable tyre recycling and advanced circular practices. Moreover, such interventions will support the Government's Make in India initiative, improve industrial competitiveness, and contribute to broader national commitments on resource efficiency, and sustainable development.

1 Waste Tyres and End-of-Life Tyres (ELT) have been used interchangeably in this report.

1. Introduction

1.1 Overview

India's rapid growth in the automobile sector has led to a corresponding rise in the demand for tyres, and consequently, in the generation of waste tyres. Tyres, being a safety-critical component, are subject to significant wear and tear and typically last only about one-fifth the life of a vehicle. This accelerated turnover has resulted in a surge in End-of-Life Tyres (ELTs), which, if not managed through responsible recycling, can pose serious environmental hazards and economic inefficiencies.

Improper disposal or technologically inferior recycling of ELTs not only contributes to pollution but also leads to the loss of valuable materials such as rubber, steel, and carbon black—critical inputs for a range of downstream industries. As tyres are inherently material-rich (Figure 1), their mismanagement represents a missed opportunity for resource recovery and circularity. Unregulated recycling practices have led to poor compliance with emission standards, which poses environmental risk, and low-value recovery of materials, weakening the economic viability of the sector.

Figure 1: Components of a Tyre

This report examines the current landscape of waste tyre management in India, with a focus on the Extended Producer Responsibility (EPR) framework, the structure of the recycling ecosystem, and the challenges faced by waste tyre recyclers. It highlights the regulatory inconsistencies, informality in operations, and lack of product standardisation that currently limit the potential of India's waste tyre economy. Drawing from global best practices and domestic data, the report presents actionable recommendations to build a transparent, standardised, and circular tyre recycling ecosystem that supports environmental sustainability and industrial resilience.

1.2 Tyre Production in India

India's tyre industry plays a crucial role in the global market, ranking 7th in global tyre production with a 3% share. The industry has been witnessing steady growth at an annual rate of 10%, driven by increasing demand from various vehicle segments and a focus on expanding production capacity. For the financial year 2024-25 (FY 24), India's total domestic tyre production stands at 4.2 million metric tonnes (MMT). Of this, 2.5 MMT is absorbed for the domestic market along with 0.2 MMT of inner tubes and flaps, while 1.5 MMT is exported, showcasing India's strong presence in the global tyre market. Import of new tyres remains relatively low at just 0.07 MMT, indicating a self-sufficient industry with minimal reliance on foreign supply. (Figure 2)

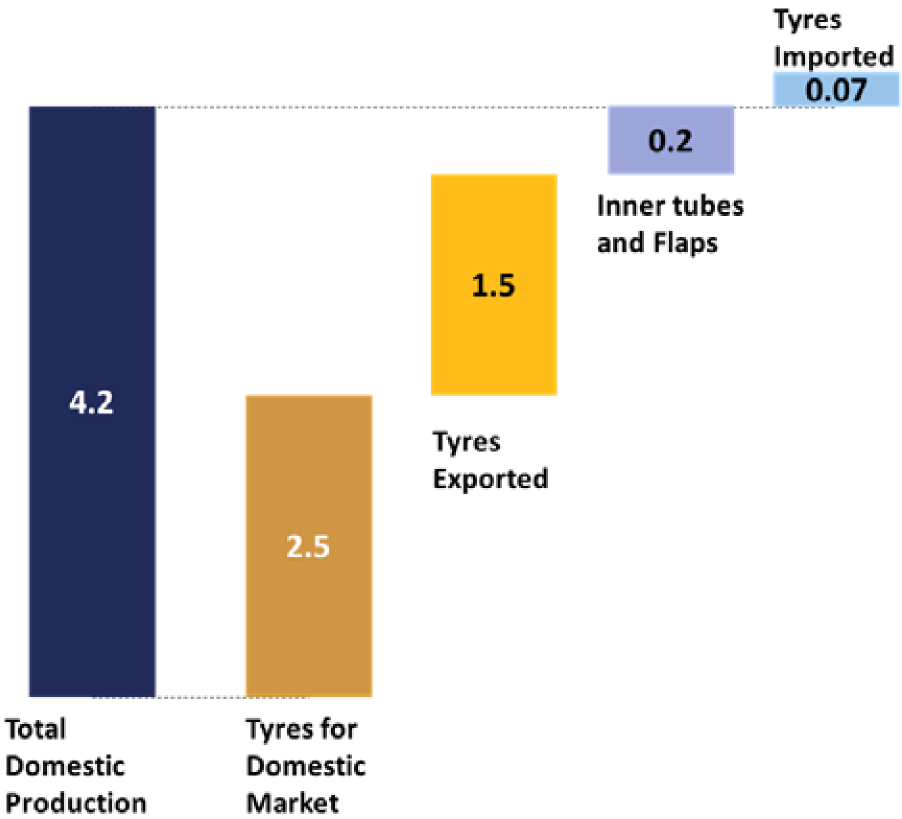


Figure 2: Tyre Production for FY 2024, in MMT (Values provided by ATMA)

The two and three-wheeler segment contributes the most to tyre production, accounting for 53% of total output. This dominance is driven by the high demand for two-wheelers in India, particularly in urban and rural mobility. Other major contributors include passenger cars (26%), followed by truck and bus tyres (11%), light commercial vehicles (5%), and agricultural and farm tyres (4%). The remaining 1% of production serves miscellaneous vehicle categories. (Figure 3)

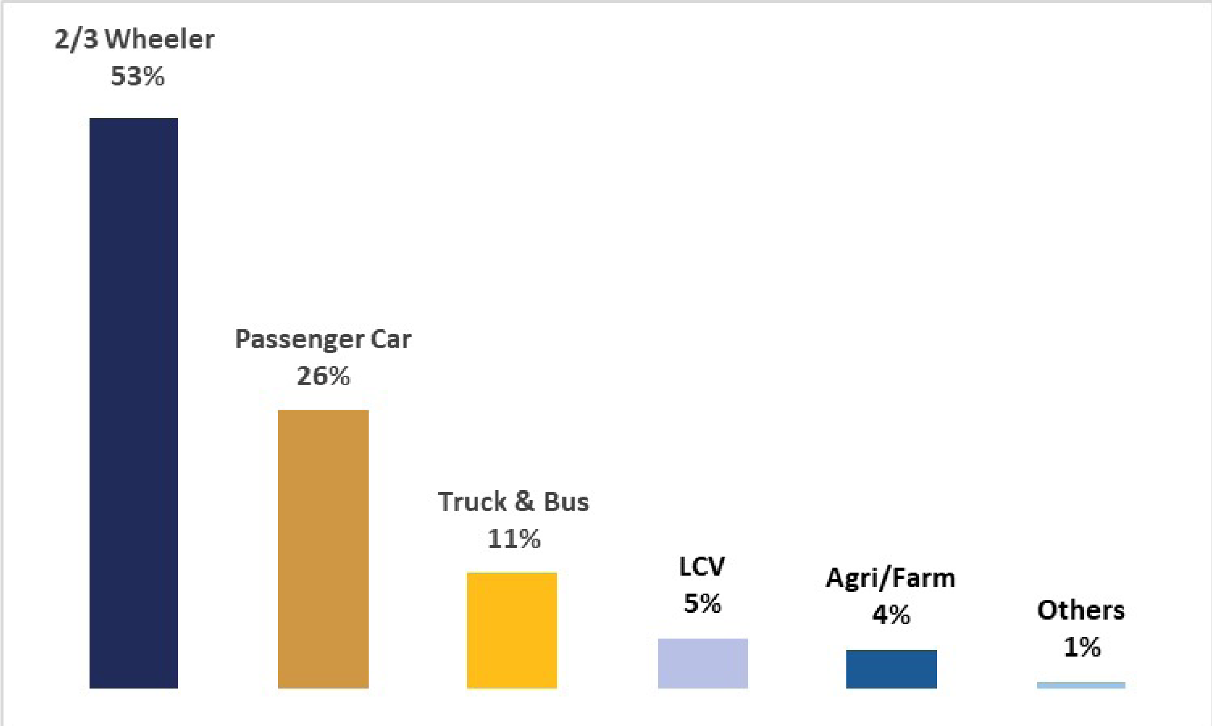


Figure 3: Segment-wise tyre production by volume for FY 2024 (Source: ATMA)

Given this production landscape, India's tyre industry continues to expand its export footprint while meeting growing domestic demand. With sustained growth, increasing investment, and advancements in technology, the sector is poised for further development within the next ten years. A report on the Indian tyre industry[2] predicts that it has the potential to more than double its revenue by FY 2032 compared to its revenue in FY 2022. The growth would be driven by rising vehicle demand, sustained government investment in infrastructure, and a robust replacement market supported by a large in-use vehicle base. Its share in India's manufacturing GDP is expected to rise from 2.2% to 3.4% over the same period, alongside higher GST contributions, employment generation, and global trade share. However, volatility in natural rubber and other raw material prices poses a risk to industry profitability. Strengthening domestic recycling and advancing tyre circularity can help mitigate these risks by reducing import dependence, stabilising input costs, and enhancing resource efficiency, thereby supporting the sector's long-term competitiveness.

2 "Tyre industry on a roll, driving towards doubling in size", Crisil

2. Waste Tyre Generation and Recycling

2.1 Waste Tyre Generation

Waste tyre generation and recycling are critical aspects of sustainable waste management and resource efficiency in the country. In FY 2024, the total waste tyres recycled in India amounted to 3 MMT. Out of this, 1.6 MMT were generated domestically, while 1.4 MMT were imported, highlighting the substantial level of imported waste tyres feeding into the domestic tyre recycling feedstock. (Figure 4)

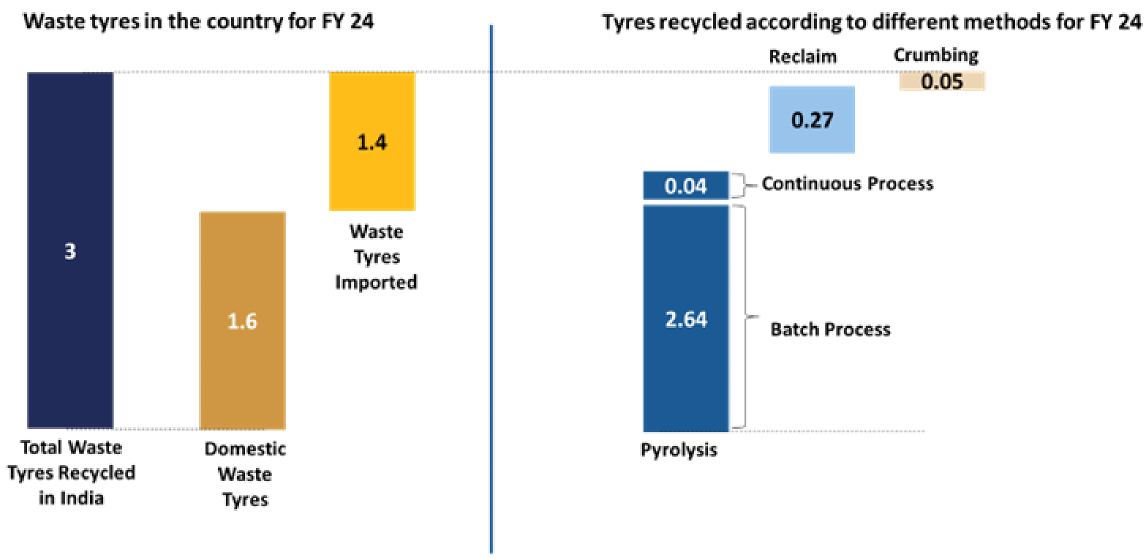


Figure 4: Waste Tyres Generation and Recycling in FY 2024
(all values in MMT) (Values provided by Industry)

Broadly, pyrolysis emerges as the dominant method of tyre recycling, accounting for 2.68 MMT. Out of which, 2.64 MMT goes to batch process and 0.04 MMT is recycled through the continuous process. Concurrently, 0.27 MMT of reclaim/devulcanised rubber was generated from waste tyres. While a lot of waste tyres are mechanically processed into crumb rubber, it is largely used as an intermediate product in continuous pyrolysis and in the production of reclaim rubber. This leaves about 0.05 MMT of crumb rubber which is used as raw material in the rubber goods industry.

The different tyre recycling processes as mentioned above are discussed in Box 2.1.

Box 2.1 Different Tyre Recycling Processes

i) Batch Pyrolysis

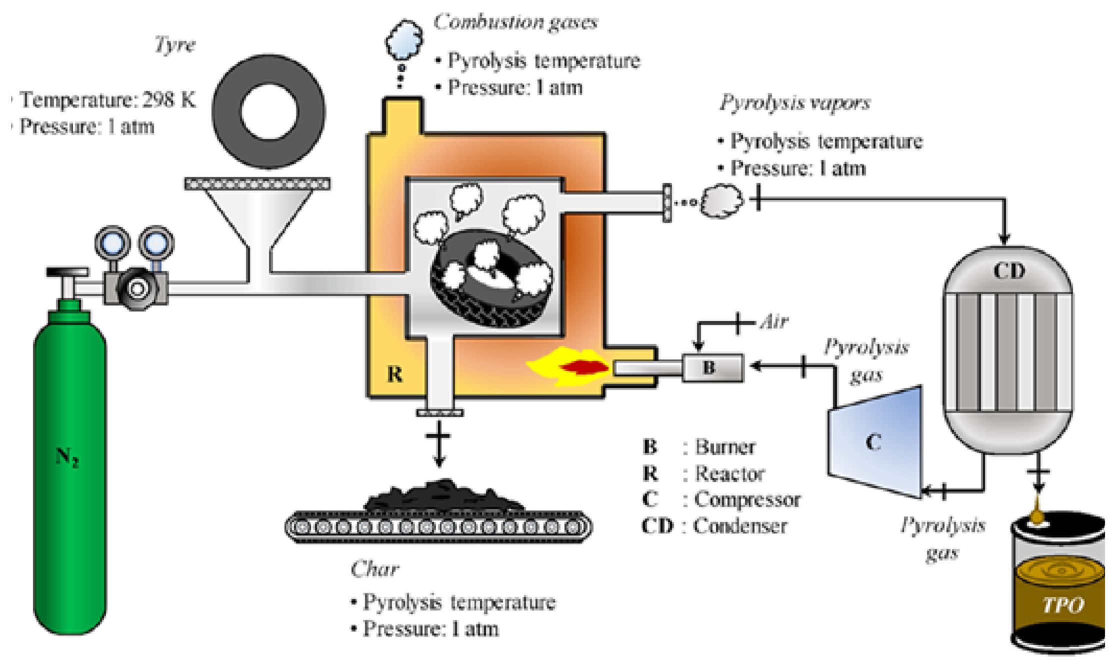


Figure 5: Batch Pyrolysis

(Source: Gamboa, A. A., dos Santos, L. R., Martins, C. A., Rocha, A. M., Alvarado-Silva, C. A., & de Carvalho Jr, J. A. (2023). Thermodynamic Evaluation of the Energy Self-Sufficiency of the Tyre Pyrolysis Process. Energies, 16(24), 7932.)

Batch pyrolysis is a cyclic thermochemical process that decomposes waste tyres in an oxygen-deficient reactor, one batch at a time. It uses manual or hydraulic feeders that can directly accept whole tyres or small-sized materials. The process yields tyre pyrolysis oil (TPO), carbon char, and steel.

Box 2.1 Different Tyre Recycling Processes (contd.)

ii) Continuous Pyrolysis

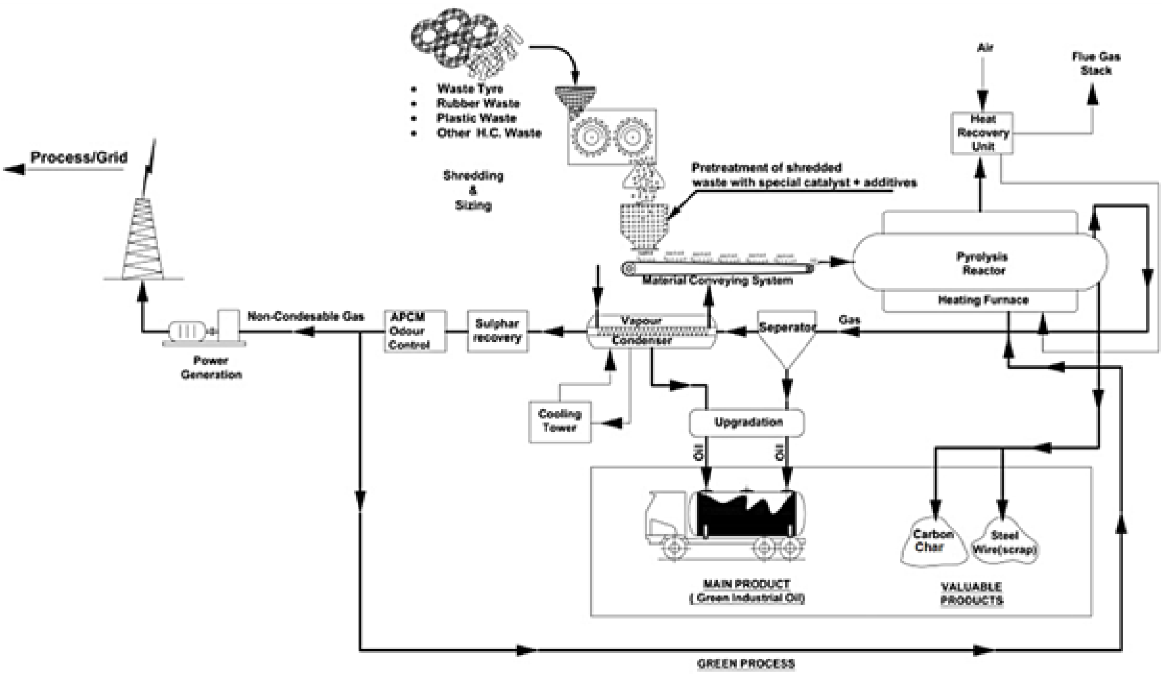


Figure 6: Continuous Pyrolysis

(Source: Radhe Group of Energy - Waste Tyre / Waste Plastic Recycling Pyrolysis Process)

Continuous pyrolysis is an automated process where rubber powder or blocks are fed into a closed reactor through a fully automatic system. It allows for efficient heat transfer, higher processing capacity, and improved energy efficiency compared to batch systems.

Box 2.1 Different Tyre Recycling Processes (contd.)

iii) Mechanical Crumbing

Figure 7: Mechanical Crumbing

(Source: Bilema, M., Yuen, C. W., Alharthai, M., Al-Saffar, Z. H., Al-Sabaeei, A., & Yusoff, N. I. M. (2023). A review of rubberised asphalt for flexible pavement applications: production, content, performance, motivations and future directions. Sustainability, 15(19), 14481.)

Mechanical crumbing is a process in which waste tyres are physically ground into fine rubber particles known as crumb rubber. The two primary technologies are (i) ambient grinding, conducted at or above room temperature and widely used in practice, and (ii) cryogenic grinding, which involves cooling tyres with liquid nitrogen before processing. In India, ambient grinding is the prevalent practice due to relatively lower capital investment as opposed to cryogenic grinding, which is markedly costlier. This method enables material recovery for use in roads, sports surfaces, and rubber products.

Box 2.1 Different Tyre Recycling Processes (contd.)

iv) Devulcanisation/ Reclaim Rubber

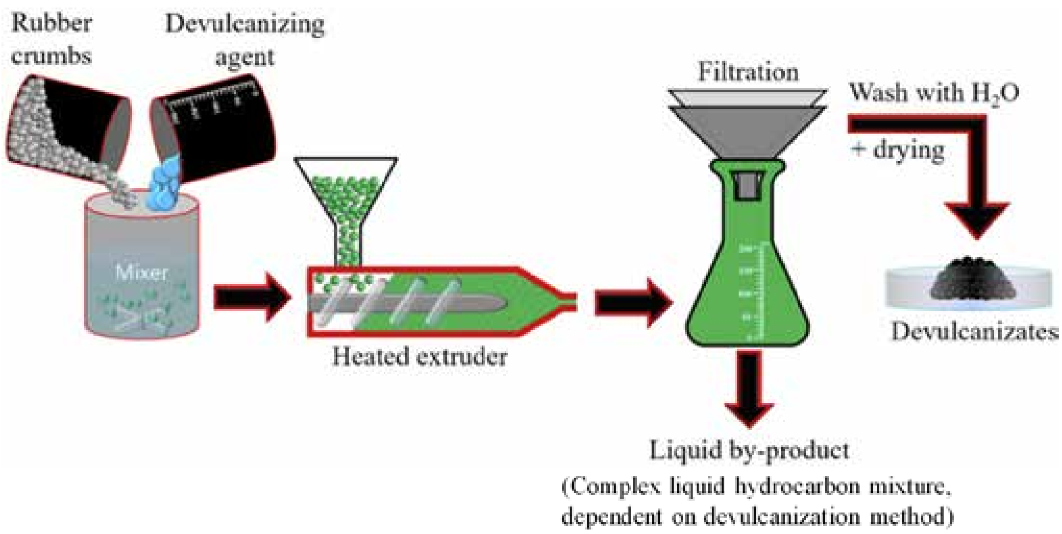


Figure 8: Devulcanisation (Chemical)

(Source: Saputra, R., Walvekar, R., Khalid, M., Mubarak, N. M., & Sillanpää, M. (2021). Current progress in waste tire rubber devulcanisation. Chemosphere, 265, 129033.https://www.sciencedirect.com/science/article/abs/pii/S0045653520332306)

Reclaim rubber is produced by selectively breaking sulfur-sulfur (S–S) and carbon-sulfur (C–S) bonds in vulcanized rubber, with minimal degradation of the main polymer chains, a process known as devulcanisation. This allows the rubber to regain plasticity and be reused in various rubber products. Reclamation of rubber has multiple methods, broadly divided into physical, chemical and biological methods. Further divisions which find industry applications in physical reclaim include thermal and thermo-mechanical devulcanisation. This material is used by the tyre industry (upto 5%) for production of new tyres.

2.2 Material Flow of Waste Tyre Recycling in India

The recycling process is dominated by pyrolysis processes (Figure 9) accounting for 2.68 MMT of ELT recycling. Of this, batch pyrolysis accounts for recycling 2.64 MMT of ELT, and only about 0.04 MMT ELT is processed through continuous pyrolysis systems. A sizeable share of pyrolysis feedstock is likely to come from imported waste tyres which has first been converted into crumb rubber.

The pyrolysis route results in the generation of 1.10 MMT of tyre pyrolysis oil (TPO), 0.80 MMT of carbon char, and 0.3 MMT of steel wire, of which 0.05 MMT of carbon char is processed into recovered carbon black (rCB), while a larger share (0.75 MMT) of carbon char is diverted directly to industrial applications.

Crumbing and devulcanisation account for a smaller share of the recycling landscape. While these processes primarily account for imported waste tyres recycling, a smaller share of domestic tyres are also crumbed, chiefly to be used in other processes. Approximately 1.53 MMT of ELT are directed towards crumb rubber production, while 0.27 MMT undergo reclaiming or devulcanisation. However, only 0.05 MMT of crumb rubber currently goes towards direct applications and therefore it is largely considered to be an intermediary product. Micronised Rubber Powder (MRP), a very fine crumb grade of 170 mesh is used directly in new tyres demonstrating circularity in tyre sector. A major proportion of crumb rubber finds its way to the pyrolysis industry – either as feedstock for continuous pyrolysis or as feedstock in batch pyrolysis plants to meet processing capacity. Devulcanisation processes yield high-quality substitutes for virgin rubber. Reclaim rubber finds application across both tyre and non-tyre sectors. Within the tyre industry, it is used in approximately 0.06 MMT of production, contributing to circularity, while in the non-tyre segment, its utilisation is split between the automotive sector at around 0.02 MMT and non-automotive uses at nearly 0.10 MMT. Overall demand is supported by both domestic and export markets, with exports accounting for about 0.09 MMT.

The data underscores the heavy reliance on pyrolysis in India's tyre recycling landscape. While it provides an efficient way to recover valuable materials, a considerable portion (20-25%, as per research and stakeholder interactions) of the current batch process plants operate outside regulatory oversight. They do not comply with the standard operating procedure (SOP) for Advanced Batch Automated Pyrolysis (ABAP) and continuous pyrolysis as laid down by the Central Pollution Control Board (CPCB), creating material loss, environmental degradation and environmental and health hazards.

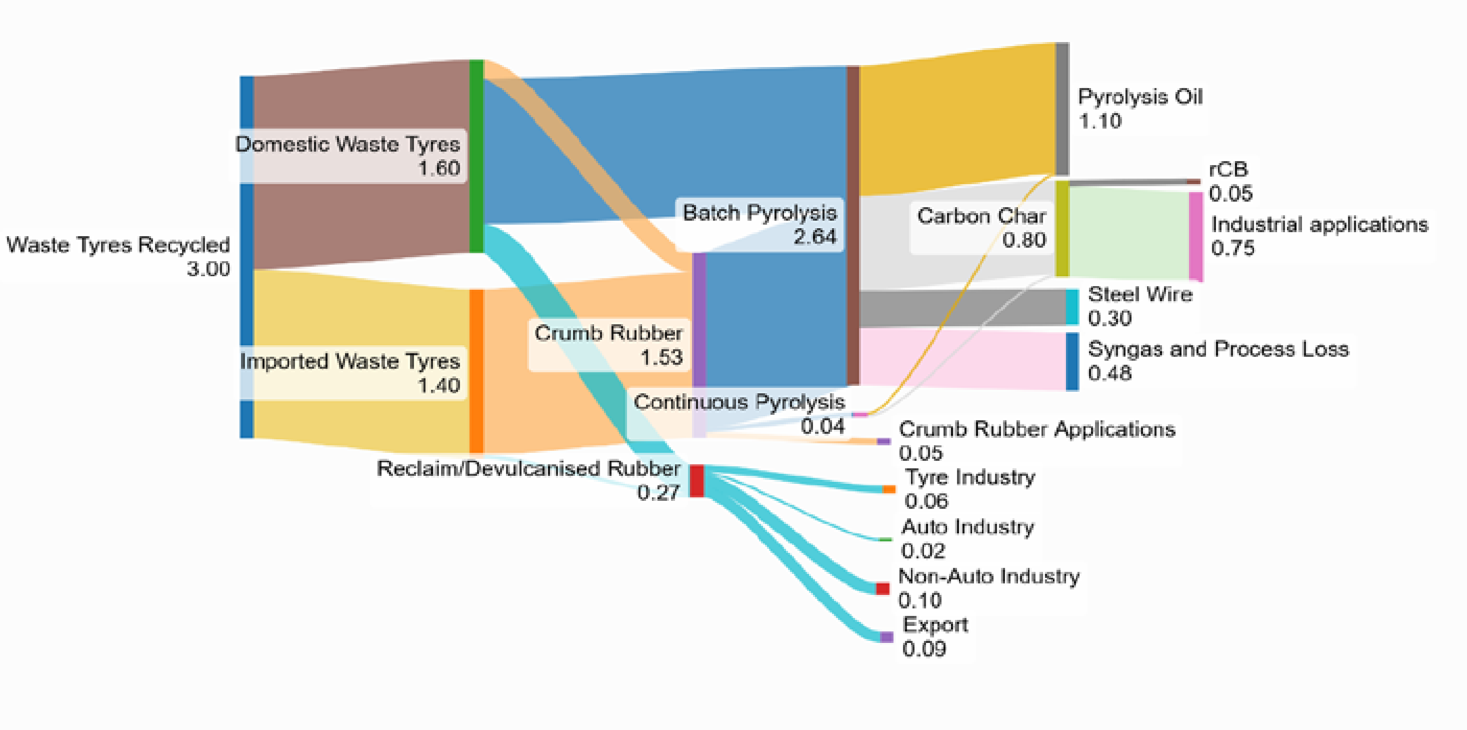


Figure 9: Estimated Material Flow of ELT Recycling in India (Values in MMT) (Based on industry data and in-house calculations)

2.3 Different Tyre Recycling Processes and Their Products

While different tyre recycling processes vary in their material recovery potential and corresponding product applications, their adoption in India is often determined less by recovery efficiency alone and more by operational parameters such as infrastructure and capital cost, access to energy required for the respective processes, as well as the availability of feedstock. These factors largely shape investment decisions and have influenced the predominance of pyrolysis over other recycling methods. The different parameters for different tyre recycling processes are summarised in Table 1.

Table 1: Comparison of Tyre Recycling Processes

Parameters	Pyrolysis	Devulcanisation	Crumbing
Cost	Batch - Low-cost Continuous - High-cost	Moderate to High	Moderate
Feedstock	Whole/Shredded tyres	Shredded tyres	Whole tyres
End product	Tyre pyrolysis oil (TPO) Carbon Black Steel wire	Reclaimed rubber	Crumb rubber
Energy requirement	Low	High	Moderate

The different end products of the different recycling processes and their respective uses are explained in detail in Box 2.2.

Different tyre recycling processes vary considerably in terms of capital and energy requirements, and the range of products they generate. Within pyrolysis, both batch and continuous processes are practiced, with batch process forming most of the pyrolysis practiced in the country. Each process is characterised by distinct operational efficiencies, investment needs, and environmental performance. Table 2 provides a comparative overview of these two pyrolysis pathways, underscoring their implications for scalability, compliance, and circular economy outcomes.

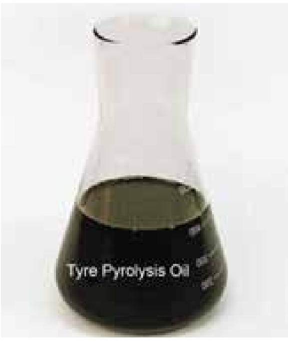
Table 2: Differences between Batch and Continuous Pyrolysis

Parameters	Batch	Continuous
Feeding method	Manual or simple hydraulic feeders.	Fully automatic closed feeding system.
Material fed	Directly process whole tires and small-sized materials.	Process small-sized materials such as rubber powder and blocks.
Automation level	Semi-automatic and requires 3-4 people to operate. High labour intensity and low automation.	Can operate continuously and requires 1-2 people. High degree of automation and low labour intensity.
Final Product quality	Uses cyclic heating and cooling. Difficult to ensure consistent product quality.	Uses a continuous and stable environment. Stable final product quality.
Plant Cost	Low investment and operating cost.	High investment and operating cost.
Energy utilisation	Each operation requires reheating and cooling. Efficiency is low with high energy consumption.	Fuel consumption low and saves operating costs. Higher efficiency with continuous feeding and discharging system.

Box 2.2 Recycled Products from Different Processes and Their Applications

i) Pyrolysis

Results in two primary outputs: carbon char and Tyre Pyrolysis Oil (TPO); along with the recovery of a small amount of steel wire. Carbon char, by itself is often used as a substitute for pet coke by industries. When processed, it yields rCB—a fine black powder used as a reinforcing filler in rubber products. While lower grade rCB is commonly used in products like floor mats, moulded goods, and low-end footwear, high-quality rCB can replace a portion of virgin carbon black in tyre manufacturing, particularly in sidewalls and non-critical areas. This reduces dependence on imports. TPO is a waste-derived fuel that can be used as an industrial heating oil in boilers, furnaces, or kilns, offering a substitute for Light Diesel Oil (LDO) and Furnace Oil. When refined, TPO has potential applications in blending with commercial fuels or as a feedstock for petrochemical industries. Pyrolysis also generates syngas (non-condensable gases), which can be used to power the pyrolysis plant itself, improving energy efficiency. The recovered steel is usually sold as scrap and further processed and can go on to be used in concrete reinforcement and manufacturing.



Tyre Pyrolysis Oil (TPO)[1]

Carbon Char[2]

Steel Wire Scrap[3]

1 IndiaMart. indiamart.com/proddetail/tyre-pyrolysis-oil-20179300848.

2 Beston. bestonpyrolysisplant.com/carbon-black-tyre-pyrolysis/

3 IndiaMart. indiamart.com/proddetail/tyre-pyrolysis-steel-wire-scrap-23169282788.

Box 2.2 Recycled Products from Different Processes and Their Applications (Contd.)

ii) Mechanical Crumbing

Crumb rubber is extensively used in sports and recreational infrastructure, such as running tracks, synthetic turf infill, and children's playground surfaces, where it provides cushioning, shock absorption, and slip resistance. In civil construction, it is incorporated into CRMB (Crumb Rubber Modified Bitumen) for building more durable and weather-resistant roads with improved elasticity and reduced cracking. Crumb rubber is also molded into rubber pipes, seals, and gaskets for non-critical industrial uses. It finds applications in flooring tiles, speed bumps, noise barriers, and even as a component in composite building materials when blended with plastics. In manufacturing, fine-grade crumb rubber can be used to produce rubberized adhesives, coatings, and mats, while ultra-fine grades serve in rubber-plastic composites or as additives in paints and sealants. Crumb rubber can also serve as an intermediate feedstock for reclaiming or further pyrolysis, supporting closed-loop recycling.

Crumb rubber[4]

Crumb Rubber Modified Bitumen (CRMB)[5]

Micronized Rubber Powder (MRP)[6]

Tiles from crumb rubber[7]

4 EcoMENA. ecomena.org/crumb-rubber-uses

5 PetroNaft. petronaftco.com/rubber-modified-bitumen

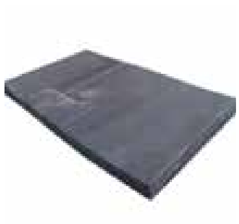
6 Tinna. tinna.in/rubber-products

7 Bullrock Fitness. bullrockfitness.com/crumb-rubber-tiles

Box 2.2 Recycled Products from Different Processes and Their Applications (contd.)

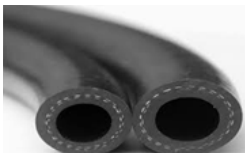
iii) Devulcanisation

Reclaim rubber is widely used in the manufacture of roofing sheets, reclaimed rubber mats, and tiles, which are durable and cost-effective options for building applications. Its use in tyre manufacturing has been prevalent for decades, with around 5% of the rubber being used by the tyre industry being reclaim rubber. In the automotive and mechanical sectors, reclaimed rubber is used to produce rubber gaskets, hoses, belts, and mud flaps, especially for aftermarket components. The material also supports the creation of outdoor furniture, garden accessories, and footwear soles, offering an alternative to virgin materials in consumer goods. Reclaimed rubber, due to its soft texture and good bonding properties, is also blended with natural and synthetic rubber to reduce production costs of rubber sheets, conveyor belts, and tubes. It plays a crucial role in non-tyre rubber goods, including insulation panels, vibration dampers, and soundproofing materials.



Reclaim rubber sheet[8]

Conveyor belt[9]



Rubber pipe[10]

Rubber shoe soles[11]

8 Tinna. tinna.in/rubber-products

9 IndiaMart. indiamart.com/rubber-conveyor-belt

10 Hongyun Recycled Rubber. en.hsxjw.com/dingjizsjbaike_1897.html

11 Hongyun Recycled Rubber en.hsxjw.com/rujiaozsjbaike_1983.html

2.4 Extent of Pollution in the Tyre Recycling Industry

CPCB classifies industrial sectors into Red, Orange, Green, and White categories based on a Pollution Index (PI) framework. The tyre recycling industry[3] is classified as a red/orange category by CPCB as shown in Table 3:

Table 3: Categorisation of Different Tyre Recycling Industries

S. No.	Recycling Processes	CPCB Pollution Categorisation
1	Advanced Batch Automated Process (ABAP)/ Continuous Pyrolysis	Orange
2	Mechanical Crumbing	Orange
3	Rubber reclaim/ Devulcanisation	Red

3 A detailed breakdown of pollutants emitted by different recycling processes is provided in Annexure B.

3. Regulatory Landscape for Waste Tyres

3.1 Broad Policies Governing Waste Tyres Recycling

The regulatory framework governing the recycling and management of waste tyres in India spans multiple ministries, with responsibilities distributed across environmental protection, pollution control and trade regulation. Key policy instruments are summarised below:

3.1.1 MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE (MOEFCC)

The MoEFCC is the nodal authority for waste management regulation, including waste tyres, under the broader umbrella of hazardous waste. The governing framework for ELT management is currently codified under the *Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules, 2022,* which was an amendment (Schedule IX) to the *Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016*, providing a dedicated framework within them. The Hazardous and Other Wastes Rules ban the import of waste tyres for direct reuse and permit import of waste tyres strictly for recycling, subject to compliance with operational guidelines. Further, they cover the general principles of environmentally sound management, authorisation for recyclers, proper handling, storage, and movement (including transboundary movement). The Amendment notified in 2022 specifically introduces Extended Producer Responsibility (EPR) for waste tyres, mandating producers to ensure environmentally sound recycling of ELTs and prohibit the import of waste tyres for pyrolysis.

Earlier, the MoEFCC had issued an Office Memorandum (OM) dated 24 Nov 2015, to lay down operational protocols for the import of waste tyres for recycling under special permits and for procedural guidance to establish and operate tyre pyrolysis units.

3.1.2 CENTRAL POLLUTION CONTROL BOARD (CPCB)

In 2024, CPCB issued the Standard Operating Procedure (SOP) for the Recycling of Waste Tyre Scrap for the Recovery of Tyre Pyrolysis Oil, Pyro Gas, and Char in Tyre Pyrolysis Oil (TPO) Units. The SOP prescribes environmental safeguards and infrastructure requirements for setting up and operating Advanced Batch Automated Pyrolysis (ABAP) and Continuous Pyrolysis facilities. It aims to standardise operational practices, improve environmental performance, and ensure regulatory compliance across the sector, in accordance with National Green Tribunal (NGT) directives and in consultation with NEERI (National Environment Engineering Research Institute) and IIT Delhi. The SOP establishes differentiated guidelines for ABAP and continuous pyrolysis units with the objective of minimizing environmental and safety risks associated with the recycling of waste tyre scrap. It outlines criteria for plant sites, plant capacity, pollution control infrastructure, and mandates stringent operational protocols.

The SOP prioritises compliance with emission, effluent, and hazardous waste standards under the Hazardous Waste Rules, 2016, and promotes co-processing of char or its upgrade to recovered carbon black (rCB). It prohibits the import of waste tyres for pyrolysis, requiring the exclusive use of domestically generated ELTs. Furthermore, it mandates units to register on the CPCB EPR portal, maintain detailed records of input and output, submit annual reports, and adopt occupational health and safety practices.

3.1.3 DIRECTORATE GENERAL OF FOREIGN TRADE (DGFT)

The DGFT governs the import of waste tyres through the Notification on Restricted Items for Imports (2019). Under this regulation, waste tyres are classified as 'Import Restricted' items and may be imported only against a valid permit. However, import of used rubber tyres with one cut in the bead wire and used rubber tubes cut in two pieces are permitted.

3.2 Extended Producer Responsibility (EPR) for Waste Tyres

The primary policy governing recycling of waste tyres in the country is the Extended Producer Responsibility (EPR) framework, notified as the *Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules, 2022.* It is designed to ensure sustainable recycling and environmental responsibility. Under this framework, tyre manufacturers and importers are mandated to manage the recycling of end-of-life tyres in proportion to their production or imports from previous years. Waste tyres, as covered by the EPR, *"means any tyre, including tubes and flaps that is no longer mounted on a vehicle and is no longer used for its intended purpose"*. The norms for EPR obligations, for tyre producers, new tyre importers, waste tyre importers and for the retreading of tyres are given in Table 4 and the relative performance of the EPR over three years is given in Box 3.1.

Table 4: Details of EPR Obligation for Different Stakeholders

Compliance Period	EPR Obligation
Producers and Tyre Importers	
2024 – 2025 (Year Y) onwards (for established units)	EPR obligation shall be 100% of new tyres manufactured or imported in year (Y-2).
Production Units established after 01 Apr 2022	EPR obligation shall start after 2 years (Y) and shall be 100% of new tyres manufactured or imported in year (Y-2)
A wear and tear discount factor (currently, 20%) is applicable on total EPR obligation	
Waste Tyre Importer	
Since enforcement of EPR	EPR obligation in year (Y) shall be 100% of the tyre imported in year (Y-1)
Note: Import of waste tyre for purpose of producing pyrolysis oil or char is prohibited (mentioned in EPR)	
Tyre Retreading	
Since enforcement of EPR	Retreading certificates defer EPR obligation by one year for corresponding quantity of waste tyres generated

(Source: MoEFCC)

In the Waste Tyres EPR, the amount of EPR certificates generated is calculated according to a formula which considers the end product from processing Waste Tyres. Different recycling methods and products have been assigned weightage factors (determined by MoEFCC), along with a conversion factor[4] (determined by CPCB). The weightages are assigned based on the properties and reusability of the material recovered, and the conversion factor is assigned based on the number of units of waste tyre required to produce one unit of recycled product. The respective weights and factors for different products are listed in Table 7, and the EPR formula is discussed in Box 3.2 along with an illustrative example.

Box 3.1 A Snapshot of Current EPR Scenario

The implementation of Waste Tyres EPR has been supported by the establishment of a centralised digital registration system on the CPCB portal. Table 5 presents the status of registration of different stakeholders in the country so far.

Table 5: Stakeholder Registration Data on CPCB Portal (As on 1 Sep 2025)

Category	Applications Received	EPR Registration Granted
Manufacturer and Importer of New Tyre	117	84
Importer of Waste Tyre	194	164
Recycler	711	552
Retreader	11	1

To assess progress under the EPR regime, data on certificate generation and trading is monitored through the CPCB portal. Table 6 provides a snapshot of cumulative waste tyre processing outcomes under EPR from its inception in 2022 till date (data taken from the CPCB portal as on 1 Sep 2025).

Table 6: Waste Tyre Processing Data on CPCB Portal (As on 1 Sep 2025)

Parameter	Category	Quantum (MMT)
EPR Obligation (Cumulative [2022-2025])	Total (across all producer classifications)	6.20
EPR Certificates Generated (Cumulative [2022-2025])	For Domestic Tyre	6.64
	For Imported Tyre	2.56
EPR Certificates Traded/ Transferred (Cumulative [2022-2025])	For Domestic Tyre	4.67
	For Imported Tyre	1.64

4 A discussion on the derivation of the conversion factors by CPCB is given in Annexure C

Table 7: EPR Weightage and Conversion Factors

Recycled Product	EPR Weightage (W_P)	Conversion Factor (C_F)
Reclaimed Rubber	1.3	1.298
Recovered Carbon Black usable as raw material for manufacture of new tyre	1.25	3.676
Crumb rubber Modified Bitumen (CRMB)	1.1	0.2
Crumb rubber	1	1.333
Pyrolysis oil and char (usable as fuel only and not as raw material for manufacture of new tyre)		
Extracted from continuous pyrolysis method	0.8	1.49
Extracted from batch pyrolysis method	0.5	1.49

(Source: CPCB)

Box 3.2 EPR Formula for Waste Tyres

The quantity of EPR certificates generated is calculated using the formula:

$$Q_{EPR} = Q_P x\ C_F\ x\ W_P$$

Q_P = Quantity of recycled product

C_F = Conversion factor - units of waste tyre to produce 1 unit of recycled product

W_P = EPR Weightage - weightage allotted to recycled product

C_F is determined by CPCB, whereas W_P determined by MoEFCC

For example,

If 10 tons of reclaimed rubber is produced, then the quantum of EPR certificates generated for the same is calculated as follows:

Quantity of recycled product Q_P = 10 metric tonnes (mt)

The EPR weightage (W_P) of reclaimed rubber = 1.30

The Conversion Factor (C_F) of reclaimed rubber = 1.298

Corresponding quantity of EPR certificates generated:

$$Q_{EPR} = Q_P\ x\ C_F\ x\ W_P$$

$$Q_{EPR} = 10\ x\ 1.298\ x\ 1.30$$

$$Q_{EPR} = 16.874\ mt$$

Enhancing Waste Tyres Recycling

1. **Improving Waste Tyres EPR Framework**
2. **Integrating Informal Sector in ELT Recycling**
3. **Strengthening Standards for Valorisation of Recycled Products**

4. An Analysis of EPR

4.1 Understanding the EPR Multiplier Factors

As outlined in Section 3.1 and illustrated in Box 3.2, the EPR framework for waste tyres uses weightage factors to reflect circularity potential and conversion factors to account for variations between tyres processed and recycled output, together determining the total EPR multiplier factor as shown in the Table 8.

Table 8: EPR Multiplier calculated based on Weightage and Conversion Factor

Recycled Product	EPR Weightage (WP)	Conversion Factor (CF)	EPR multiplier (WP* CF)
Reclaimed Rubber	1.3	1.298	1.69
Recovered Carbon Black usable as raw material for manufacture of new tyre	1.25	3.676	4.59
Crumb rubber Modified Bitumen (CRMB)	1.1	0.2	0.22
Crumb rubber	1	1.333	1.33
Pyrolysis oil and char (usable as fuel only and not as raw material for manufacture of new tyre)			
Extracted from continuous pyrolysis method	0.8	1.49	1.19
Extracted from batch pyrolysis method	0.5	1.49	0.74

(Source: CPCB)

For example, products such as CRMB have a reasonably high weightage (1.1), but given its conversion factor[5] (0.2), is assigned the lowest multiplier value (0.22). Similarly, while it may be the intention of the EPR weights to penalise the low circularity of products obtained from pyrolysis (0.8/0.5), the conversion factor (1.49) ensures a more favourable outcome (1.19/0.74) according to the overall EPR multiplier. This may lead to suboptimal compliance incentives and may not fully capture the true environmental and resource recovery potential of each pathway. The current mismatch between recycled product weight and the EPR credits assigned can obscure the actual progress towards meeting mandated obligations, thereby constraining the overall efficiency and transparency of the EPR framework.

Finally, the EPR weightage is assigned as a characteristic of recycled product (as in the case of rCB, reclaim, crumb), a process (separate weight for pyrolysis products) as well as a specific application (CRMB). This approach to use product, processes and application as a basis of assigning conversion factor brings in an inconsistency in generation of EPR, where the initial objective was to ensure a certain obligated weight of tyres are available for recycling.

5 The calculation of the conversion factor is discussed in further detail in Annexure C.

4.2 The EPR's Position on Tyre Pyrolysis

The foregoing analysis underscores a key observation—that waste tyre pyrolysis has been subjected to comparatively more stringent treatment under the EPR framework than other recycling processes. An international comparison of pyrolysis regulations (Table 9) shows that while India's standards for tyre pyrolysis are broadly aligned with global benchmarks, the industry's enhancement is constrained by restrictive provisions—notably the prohibition on processing imported ELTs. This ban also is counterintuitive to the push given to rCB with its high weightage in the EPR as explained in Box 4.1 as rCB cannot be produced without pyrolysis as an intermediate process.

Table 9: Tyre Pyrolysis Regulation - Global Comparison

Region	Predominant Technology	Legality of Pyrolysis	Key Regulatory Features
Europe	Continuous Pyrolysis	Permitted under stringent conditions	EPR, free market, government – models across members Stringent emission regulations and product testing
USA	Mixed (Batch & Continuous)	Permitted with strict EPA oversight	Stringent emission standards; Dynamic regulatory environment
China	Batch Pyrolysis	Domestic processing permitted; Import of ELT banned	Strict domestic waste management laws Comprehensive waste import ban
India	Batch Pyrolysis	Advanced Batch permitted with strict norms; Processing of imports banned	SOP for Tyre Pyrolysis; EPR obligations; Import restrictions

Furthermore, India has instituted an SOP for ensuring environmental compliance in tyre pyrolysis units—a framework not yet adopted by several leading nations adopting pyrolysis as a mode of tyre waste management. This approach enables batch pyrolysis units to achieve environmental compliance through technological upgradation to the Advanced Batch Automated Pyrolysis (ABAP). The expansion of batch pyrolysis in India emphasises the need for enhancing regulatory checks and promoting safe and environmentally friendly operations. Globally comparable regulations already exist and would serve to effectively curtail enviromentally harmful practices when applied to tyre pyrolysis units in the country.

Box 4.1 Implication of Import Ban on ELT for Pyrolysis

India's regulatory framework currently prohibits the import of waste tyres for pyrolysis, while permitting imports for other recycling processes such as devulcanisation and crumbing. This stems primarily due to concerns about illegal on-road use of the imported waste tyres. This policy however, alongside addressing this concern, also creates a regulatory complexity pertaining to promoting rCB as a priority circular product under the EPR. rCB is derived from the carbon char produced during the pyrolysis of waste tyres—and the quality of rCB is dependent on the pyrolysis feedstock. High-quality rCB is mostly derived from imported feedstock. Restricting access to imported tyres for pyrolysis undermines the upstream value chain required for producing high-quality rCB.

This poses challenges to optimising EPR policy outcomes and constrains the growth potential of domestic rCB manufacturing, which depends on a reliable and scalable supply of carbon char. Aligning policy provisions to ensure a consistent, high-quality feedstock supply would strengthen the rCB value chain, reduce reliance on virgin carbon black, and further the objectives of circularity in tyre manufacturing.

Table 10: Import Permissible based on Recycling Process

S.No.	Recycling Process/ Product	Whether Import of Waste Tyres Permitted
1	Reclaim rubber (Devulcanisation)	Yes
2	Recovered Carbon Black [rCB]	Ambiguous
3	Crumb Rubber (Mechanical Breakdown)	Yes
4	Pyrolysis (Batch and Pyrolysis)	No

India does not have specific emission standards for pyrolysis plants. However, a comparative analysis has been carried out using European Union's Industrial Emissions Directive (IED) stack emission standards for waste incineration plants (which is the category European tyre pyrolysis plants are evaluated under). A comparable Indian standard would be the waste incineration stack emission standards for Online Continuous Effluent and Emission Monitoring System (OCEMS) for waste incineration industries (pyrolysis has not been classified as an OCEMS-mandated industry by CPCB as of now) (Table 11). The analysis shows that India's guidelines for pollutants such as total dust, SO_2, NO_x, and CO are broadly aligned with EU norms.

Table 11: Emission Standards Comparison

Pollutant	EU IED (mg/Nm³)	Indian Guidelines for CEMS
Total dust	30	50
Gaseous and vaporous organic substances, expressed as Total Organic Carbon (TOC)	20	20
Hydrogen chloride (HCl)	60	50
Hydrogen fluoride (HF)	4	4
Sulphur dioxide (SO_2)	200	200
Nitrogen monoxide (NO) + nitrogen dioxide (NO_2), expressed as NO_2	400	400
Carbon monoxide (CO)	100	100

(Source: EU IED and OCEMS Guidelines, CPCB)

Globally, pyrolysis is classified as a form of waste incineration, and policy formulation is usually with this understanding. Developing emission norms tailored specifically to tyre pyrolysis—accounting for the products recovered from the process and its distinct thermal characteristics—will be important to ensure that environmental safeguards are upheld while enabling tyre pyrolysis to contribute effectively to circular economy objectives.

Box 4.2 Plasma Pyrolysis

Plasma pyrolysis* is an advanced thermal treatment process that uses plasma—a highly ionized gas with extremely high temperatures—to break down waste materials into their basic components. This process is particularly effective for tyre recycling. It is currently the Best Available Technology (BAT) for waste tyre pyrolysis globally.

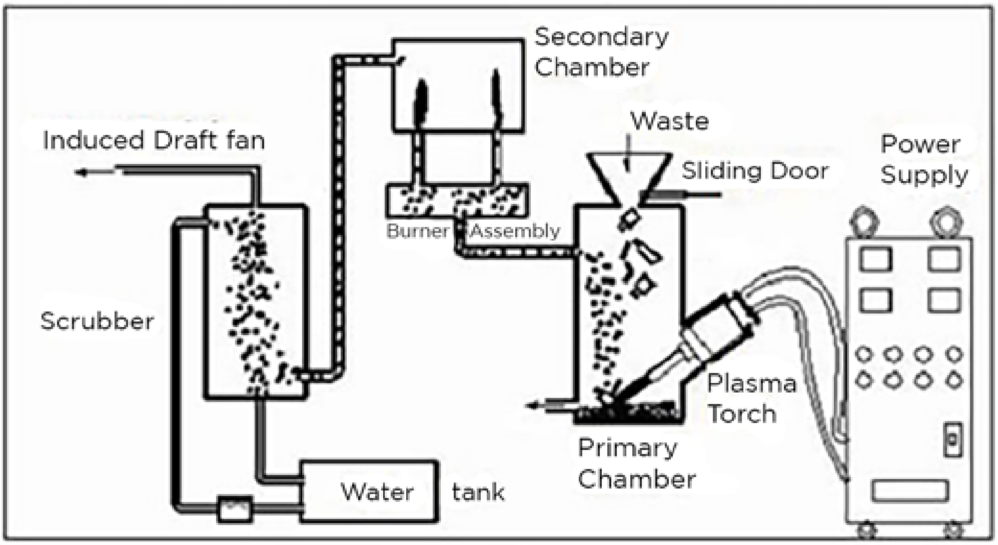


Figure 10: Plasma Pyrolysis Schematic Diagram
(Source: Institute for Plasma Research, India)

While Plasma Pyrolysis is currently operational mainly in Singapore and Italy, it has a high capital cost, energy intensity, and advanced machinery requirement, which has rendered it commercially unviable at scale in countries as large as India. In addition to the high initial investment, the process demands a consistent supply of high-grade electricity and specialised technical expertise for operation and maintenance, further increasing operational costs. The absence of established domestic manufacturing capabilities for plasma pyrolysis equipment also contributes to dependence on imported machinery, raising procurement lead times and costs. Consequently, despite its potential for near-complete conversion of waste into energy with minimal emissions, its uptake remains limited, with conventional pyrolysis or crumbing methods being favoured due to their lower entry barriers and established market linkages.

* Source: Plasma Pyrolysis Technology Explained: Revolutionizing Tyre Recycling, Global Enviro

4.3 Key Challenges and Proposed Solutions

4.3.1 EPR WEIGHTAGE SYSTEM RATIONALISATION

The current EPR framework for waste tyres relies on a product-based weightage system to determine how certificates are generated, as outlined in Section 4.1. Under this approach, different recycled outputs—such as crumb rubber, reclaim rubber, pyrolysis oil, or recovered carbon black—are assigned varying weights, which reflect their presumed contribution to material recovery and circularity. However, the system does not incorporate uniform conversion factors to link the quantity of tyres processed with the volume of recycled product generated. It also does not adopt input-based mass balance accounting, which would provide a clearer picture of how much waste is actually being processed, or environmental performance criteria that distinguish cleaner, more circular processes from less sustainable ones.

In the absence of such mechanisms, there is a risk of inconsistency in the issuance of certificates, which in turn undermines transparency and investor confidence, particularly in advanced recycling technologies such as devulcanisation and continuous pyrolysis. To address these challenges, it is suggested that the framework should have a more comprehensive, input based system—where the actual amount of waste tyres fed into recycling is the primary basis for generating certificates. Standardised conversion factors would then be applied to ensure adequacy and consistency of certificates, while transparent mass-flow verification would strengthen accountability and resource efficiency. The mix of recycled products chosen to be generated by the recyclers would be based on the market, as long as the recyclers follow strictly the guidelines issued by CPCB for environmental norms. Such a system would also better align incentives with environmental performance, thereby encouraging industry participation and supporting the transition towards a circular economy.

Key Action Points:

1. Refining the EPR Generation Formula

A new formula for EPR certificate generation with a transparent mechanism, based not on the weightage of specific recycled products but on the total quantum of waste tyres processed is proposed as follows :-

$EPR_Q = Q_p \times C_f$; where

EPR_Q is the quantity of EPR certificate generated
Q_p is the weight of ELT processed
C_f is the common conversion factor

The purpose of the conversion factor is to ensure sufficient availability of EPR certificates.

The above formula ensures that the quantum of EPR certificates will not depend on process (Batch/continuous pyrolysis), intermediates (crumb rubber, rCB) or product (CRMB).

2. Mass Flow Verification by CPCB

CPCB may standardise verification of materials produced from waste tyre processing through standardised mass-flow mapping across collection, processing, and output streams. This will enable uniform tracking, reduce inconsistencies in reporting, and strengthen overall regulatory oversight.

3. Market-Based Product Mix Determination

Product mix should be a function of the market, while following CPCB emission norms. A capacity and investment-based approval framework for projects may be adopted, ensuring that only projects with adequate scale, financial commitment, and land availability are permitted. A suitable model can be drawn from the recently established framework in the state of Gujarat, which mandates a minimum continuous pyrolysis plant capacity of 60 tonnes per day.

4. Re-evaluating Emission Regulations for the Tyre Recycling Industry

CPCB may re-evaluate and categorise the reclaim rubber industry as an "orange" industry instead of its current "Red" industry status, considering its circularity potential.

4.3.2 REFINING REGULATION FOR TYRE PYROLYSIS

Key Action Points:

1. Emission Monitoring for Pyrolysis Units

CPCB may propose that the tyre pyrolysis industry be mandated to install Online Continuous Emission Monitoring Systems (OCEMS).

2. Review of Import Restrictions

MoEFCC may reconsider the prohibition on importing ELTs for pyrolysis and review the current ban, as the EPR framework emphasises rCB as a priority circular product.

3. Use of Imported Feedstock Products

CPCB may notify that TPO from imported ELT feedstock be used only in refineries or select industries, and carbon char be refined into rCB, depending on infrastructure or in a few select industries.

5. Informality and Traceability in ELT Processing

5.1 Production-Recycling Gap Due to Leakage to Informal Sector

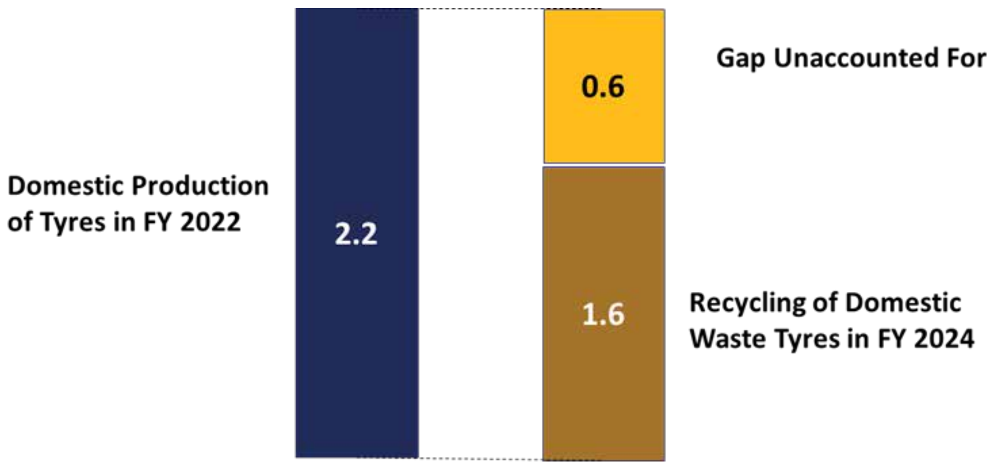


Figure 11: Gap between Production and Recycling (all values in MMT)

A persistent structural challenge in India's tyre recycling ecosystem is the pronounced mismatch between domestic tyre production volumes and the quantities processed through formal recycling channels, a gap attributable largely to leakages to the informal sector. Under the provisions of the EPR framework, annual recycling obligations are calculated based on tyre production from two years prior. For example, the recycling target for 2024 is derived from the 2.4 million metric tonnes (MMT) of tyres manufactured domestically in 2022 (including inner tubes and flaps). Yet, in 2024, only 1.6 MMT of domestic waste tyres had been processed in facilities operating under formal authorisation, leaving an unaccounted volume of 0.8 MMT—equivalent to roughly 33% of total production. Even with the wear factor of 22%, it still leaves close to 0.27 MMT of tyres unaccounted for, a significant amount considering ELTs are a material-rich resource.

This discrepancy indicates that a considerable proportion of ELTs are being channelled into informal or unregistered units that operate outside the ambit of regulatory oversight. Such facilities often lack adequate environmental safeguards, emissions control technologies, and occupational safety measures, resulting in heightened environmental and health risks. Addressing this challenge will require enforcing mandatory registration of all processing units and incentivising the transition of informal operators into the regulated sector.

5.2 Estimate of Unauthorised Recyclers

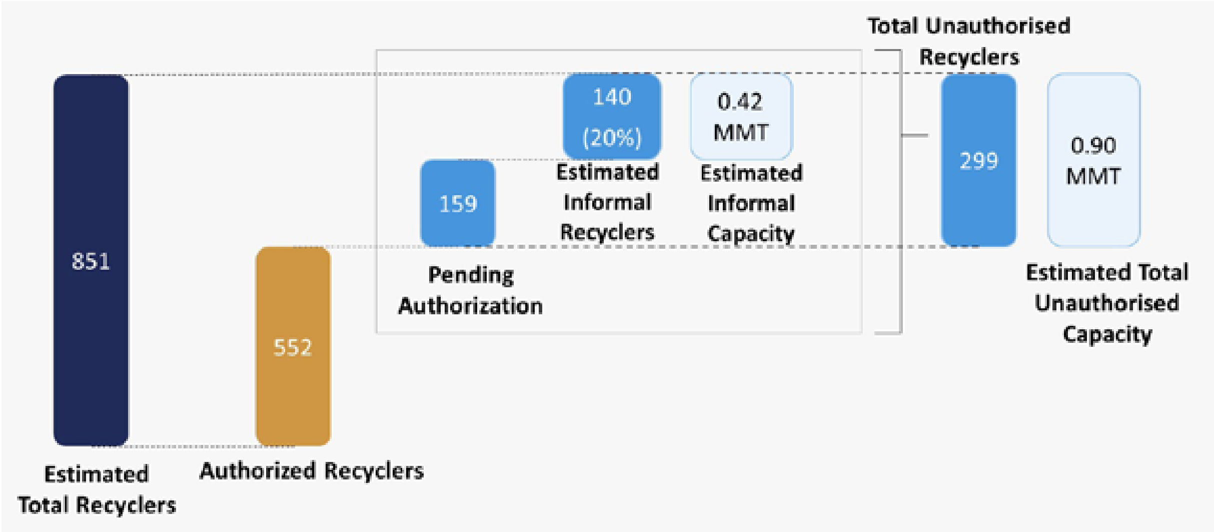


Figure 12: Authorised and Estimated Unauthorised Recyclers (per CPCB data as on 01.09.2025)

Figure 12 highlights a considerable degree of informality within India's tyre recycling sector. Out of an estimated 851 total recyclers, 552 are authorized, with 159 recyclers pending authorization, and around 140 identified as informal operators—constituting nearly 20% of the recyclers . These informal recyclers account for an estimated 0.42 MMT of recycling capacity. The two above categories combined give approximately 300 unauthorised recyclers, and the total unauthorized capacity rises to about 0.90 MMT, revealing a significant portion of the recycling landscape that operates outside regulatory oversight. Informal players often rely on low-cost, non-compliant batch pyrolysis units that lack proper environmental safeguards. To address this, there is a pressing need to identify, formalize, and integrate these recyclers into the regulated ecosystem. Doing so would not only enhance environmental compliance and safety but also minimize resource leakage and maximise the recovery of valuable materials, thereby reinforcing the tyre sector's transition towards a circular economy.

5.3 Key Challenges and Proposed Solutions

5.3.1 OPERATION OF UNAUTHORISED FACILITIES LEADING TO COMPLIANCE CONCERNS

Despite steady growth in domestic tyre production, formal recycling figures continue to reflect a sizeable shortfall. The unaccounted tyres are often disposed of in uncontrolled environments, repurposed in low-value applications, or diverted to informal recycling units.

Operational unauthorised tyre recycling facilities contribute to localised pollution, pose fire and accident hazards, and undermine the competitive viability of compliant facilities.

Key Action Points:

1) CPCB

i. May undertake an exercise to ensure informal recyclers in the ELT recycling value chain are integrated into the EPR ecosystem within one year to ensure that quantum of ELT processed is accurately recorded.

ii. All recyclers under EPR may be subject to checklist-specific audit for meeting compliance requirements.

2) SPCBs

i. May identify and integrate unauthorised recyclers into the EPR ecosystem given a fixed deadline.

ii. Udyam Assist Platform of Ministry of Micro, Small & Medium Enterprises (MoMSME) may be utilised to help in onboarding of unauthorised recyclers.

iii. MoMSME's MSE-SPICE[6] scheme may find application in providing financial support to upgrade infrastructure in non-compliant tyre pyrolysis units.

3) State Governments

i. An incentive scheme may be designed by MoEFCC in conjunction with State Governments to support the transition process. It may be done in conjunction with registered entities on the Waste Tyres EPR portal.

ii. May provide a one-time waiver of outstanding environmental liabilities, thereby enabling informal tyre recyclers to overcome initial financial and regulatory entry barriers.

5.3.2 GST COMPLEXITY UNDERMINING WASTE TYRE FORMALISATION

Recycled products derived from ELTs are presently subjected to an 18% GST rate. The high taxation structure places an undue burden on products that are vital to the ELT recycling value chain, inadvertently reinforcing the persistence of informal practices. Rationalising and revising these rates downwards would help streamline value chain operations, incentivise formal sector participation, and foster greater alignment with national priorities of ease of doing business and advancing circular economy objectives.

Key Action Points:

MoEFCC with representation from Ministry of Finance (MoF) may constitute a committee to review GST rationalisation for ELTs and recycled products. It has been highlighted by formal recyclers that reduction of GST from 18% to 5% on the waste streams will drastically increase the informal-to-formal transition process. A uniform rate across all such similar waste streams will reduce compliance burden and lower transaction costs.

6 Micro & Small Enterprises Scheme for Promotion and Investment in Circular Economy (2024) – One of the eligible circular economy actors being rubber waste recycling plants.

5.3.3 DEDICATED HSN CODE FOR TYRE RECYCLING SECTOR

To further enhance the circularity in tyres, the ambiguity in HSN codes for waste tyres and their recycled products may be removed to address issues of their classification and accounting. Currently, crumb rubber and waste tyres are grouped under a common HSN, which creates multiple challenges:

i. Import policy gaps, as differentiation between processed products and input material is not possible. As a result, processed materials may be treated on par with raw ELTs, which not only discourages transparency but also weakens monitoring of recycling flows.

ii. Lack of incentive for formalization since value-added products like Crumb Rubber are not distinctly recognized. It is often grouped together with other recycled products or even raw ELTs. This limits its competitiveness and discourages investment in formal recycling facilities. The absence of distinct classification of value-added products from ELT undermines their potential role in import substitution, industrial applications, and circular economy pathways.

Key Action Points:

MoF may introduce separate 6-digit HSN codes for crumb rubber and waste tyres to help distinguish between the two. Similarly, a separate HSN code for Micronized Rubber Powder (MRP) may also be created. Introducing distinct HSN codes will help address the above mentioned challenges. With separate codes, regulatory authorities will be able to track imports and domestic transactions with greater precision, ensuring that only legitimate recycled products enter industrial supply chains. This will also improve the traceability of recycled products, reduce the scope for informal practices, and provide a stronger basis for targeted fiscal and trade incentives.

6. Recycled Material Standardisation

6.1 Constraints for High-Value Export Products

The absence of a clearly defined standards framework for Tyre Pyrolysis Oil (TPO) and Recovered Carbon Black (rCB) continues to constrain the growth of India's high-value tyre recycling ecosystem. Currently, TPO lacks classification as a certified fuel under Bureau of Indian Standards (BIS) or Ministry of Petroleum and Natural Gas (MoPNG) guidelines[7], despite its increasing use as a biogenic alternative to furnace oil or light diesel oil (LDO) in several industrial applications. Notably, international interest in TPO is growing, with global firms such as BASF (USA) (largest buyers of TPO from India) and H&R Group (Germany) actively sourcing TPO as a low-emission feedstock. Without clear standards for fuel quality, composition, and permissible contaminants, India risks losing valuable export opportunities and forfeiting a leadership position in emerging green fuel markets.

Similarly, the lack of regulatory clarity regarding import permissions and performance-based standards for rCB has led to underinvestment in scalable infrastructure. In the absence of defined parameters for product quality, application grades, or acceptable contamination levels, private sector actors face difficulty in securing financing and ensuring market uptake. This regulatory vacuum also hinders the development of a domestic market for high-quality rCB, which holds pivotal substitution potential for virgin carbon black in tyre and non-tyre industrial applications. Establishing comprehensive standards for both TPO and rCB is therefore critical not only to unlock export potential but also to reduce import dependence, enhance investment viability, and strengthen India's position in global circular economy supply chains.

6.2 Substitution Savings of Different Tyre Recycled Products

Tyre recycling offers major potential for import substitution savings across various products derived from waste tyres. These substitutes not only reduce dependency on imported industrial inputs but also support domestic manufacturing competitiveness. However, the uptake of these materials remains limited, and their import substitution potential remains largely unrealised. As a result, despite the availability of functional substitutes, industries continue to rely heavily on imported inputs. Table 12 outlines the key substitution pathways and the corresponding economic savings potential arising from the use of rCB, TPO, and reclaim rubber. This data underscores the strategic importance of scaling up the use of recycled tyre products for economic and resource efficiency.

7 Recently, the Customs Authority for Advance Rulings (CAAR) in Mumbai classified TPO as industrial liquid fuel oil under HS heading 27101990, distinguishing it from standard petroleum oils or biodiesel. This indicates a recognition of TPO as a distinct fuel under the other petroleum oils (OPO) category

Table 12: Potential Savings from Import Substitution by Recycled Products

Product	Recovered Carbon Black	Tyre Pyrolysis Oil	Reclaim Rubber
Substituting	Virgin Carbon Black (largely imported)	Other Petroleum Oils; Residual Fuel Oil; Light Diesel Oil	Natural Rubber; Synthetic Rubber (largely imported)
Savings (Import Substitution)	~INR 425 Cr.	Other Petroleum Oils: ~INR 1,471 Cr. Residual Fuel Oil: ~INR 10 Cr. Light Diesel Oil: ~INR 39 Cr.	Natural Rubber: ~INR 2,565 Cr. Synthetic Rubber: ~INR 3,186 Cr.
Aggregate Potential Savings from Substitution: ~ approx. INR 7,700 Cr.			
Domestic substitution - similar savings as imports due to comparable prices and volumes			

(Source: Recycling Industry figures and EXIM Data Bank, DGFT)

6.3 Key Challenges and Proposed Solutions

6.3.1 PRODUCTION STANDARDS FOR TPO AND RCB

Without formal specifications under regulatory frameworks, producers face difficulties in achieving market acceptance, securing finance, and meeting compliance requirements for high-value industrial applications. This regulatory vacuum discourages investment in advanced processing technologies and prevents the sector from fully leveraging market opportunities.

Key Action Points:

BIS may notify standards for TPO and rCB. BIS has previously notified standards for reclaim rubber (IS 7490:2023) and standards for crumb rubber to be utilised in CRMB (IS 17079:2019).

6.3.2 OPPORTUNITY FOR EXPORT MARKET

Global demand for high-quality TPO is rising. In the absence of recognised national standards, Indian producers are unable to tap into these export opportunities, resulting in a loss of potential foreign exchange earnings and a missed opportunity to position India as a competitive supplier in the global circular economy.

Key Action Points:

MoPNG may ensure uptake of TPO for value-added products based on standards notified by BIS. The framework for this may be determined by the specifications[8] used in other countries for uptake of TPO. To operationalise this, a fiscal mechanism could be instituted to address the current tax disparity, wherein TPO falls within the ambit of GST while petroleum does not. Aligning the tax treatment of TPO with conventional petroleum products, or providing targeted GST offsets/credits for refineries procuring TPO, would create a level playing field and incentivise its uptake.

8 Detailed specification is outlined in Annexure D.

6.3.3 RECYCLED PRODUCTS UTILISATION IN HIGH-VALUE APPLICATIONS

In the domestic market, recycled outputs are frequently diverted to low-value applications rather than being used as substitutes for higher-value industrial products. This is largely due to the low usage in premium segments, limited awareness of technical equivalence, and absence of procurement in relevant industries. As a result, high-quality recycled materials are underutilised in applications where they could deliver greater economic and environmental benefits. India forgoes significant opportunities to reduce imports of virgin carbon black, petroleum-based fuels, and rubber, natural and synthetic.

Key Action Points:

DPIIT may prioritise the integration of recycled tyre products into automotive, rubber goods, plastics, paints, inks, and energy substitution markets, where rCB, reclaim rubber, and TPO can directly replace imported virgin inputs. To achieve this, DPIIT may develop procurement guidelines for domestic industries, and encourage inclusion of recycled content in select manufacturing value chains. Fiscal incentives or preferential treatment for industries adopting recycled inputs could catalyse large-scale uptake.

7. Tyre Retreading

7.1 What is Retreading?

Tyre retreading is the process of refurbishing used tyres by replacing worn-out tread with new rubber layers, thereby extending the functional lifespan of the original tyre casing. This process reduces raw material consumption and environmental footprint compared to manufacturing a new tyre, with each retreaded tyre resulting in consumption reduction of approximately 57 litres of oil, 44 kilograms of natural rubber, and 136 kilograms of CO_2 emissions when compared to the production of a new tyre. Retreaded tyres can retain up to 50–70% of the original tyre's performance and durability, making them a cost-effective and resource-efficient alternative in commercial and industrial transport applications. India currently retreads an estimated 10 million tyres annually, underscoring the critical role the sector plays in promoting resource efficiency within the mobility ecosystem. The replacement-to-retreaded tyre demand ratio stands at 62%, in commercial segments such as trucks and buses, highlighting considerable dependence on retreaded tyres.

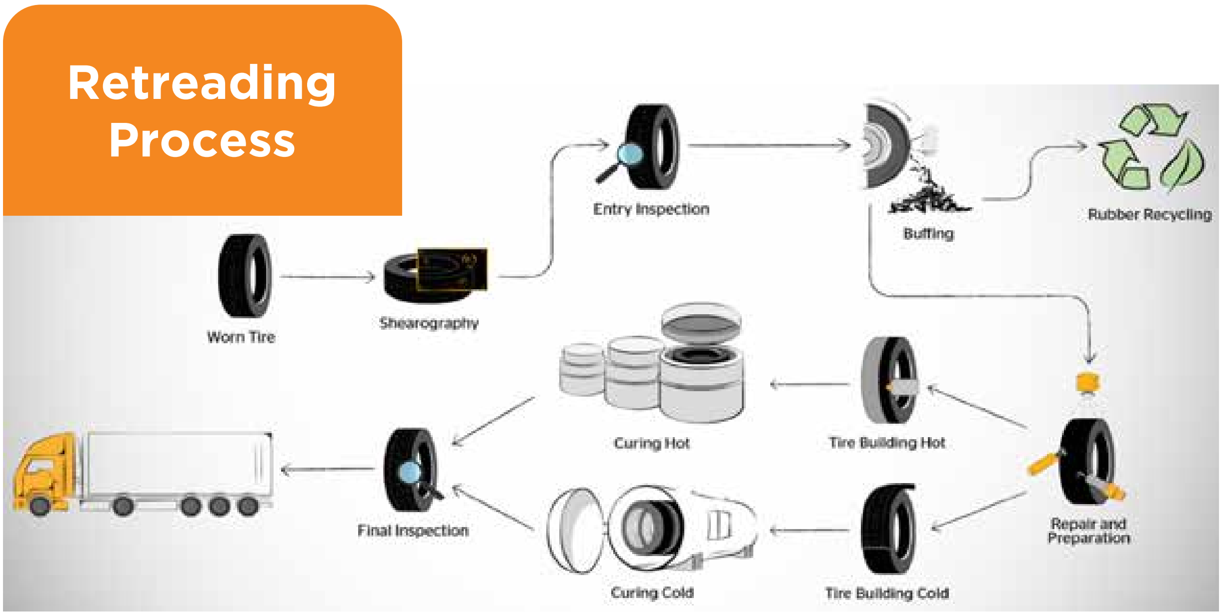


Figure 13: Tyre Retreading

(Source: Focus on the Circular Economy: Continental Celebrates more than 120 Years of Retreading for Truck and Bus Tires: Continental AG)

7.2 Market Share in Retreading across Vehicle Segments

Table 13 presents an overview of the market share and potential cost savings for retreaded tyres across key vehicle segments.

Table 13: Share of Tyre Retreading Market by Segment

Segment	Share of total retreading market	Potential Savings on Retreaded Tyre (in INR)
Trucks	65%	25,000
Bus	20%	15,000
Off-the-road (OTR)	12%	2,450
Passenger	3%	2,250

(Source: Review of relevant literature)

Retreading is widespread and offers substantial savings in the truck and bus segments, it is much less impactful for the passenger and OTR segments. Thus, despite retreading guidelines being notified by Ministry of Road Transport and Highways (MoRTH) in Automotive Industry Standard (AIS) – 064 (Part 1 & 2) (2005), the combination of low awareness, safety concerns and low savings means that it does not have the same acceptability and uptake in the passenger vehicle segment.

7.3 Issues Pertaining to Retreading

Current regulations concerning retreading are limited to the standards for retreaded tyres and a nominal provision enclosed in the EPR. According to data as of 01 Sep 2025 from the CPCB Waste Tyres EPR portal; there have been only eleven applications received for registering retreaders of which only one has been granted, and no record of retreading EPR certificates being generated. The current EPR framework includes a provision for a one-year deferment of EPR obligations as an incentive to promote tyre retreading. However, this deferment does not offer adequate economic or operational benefits to industry stakeholders to make retreading a financially attractive option. The EPR rules do not account for the substantial environmental and economic benefits of retreading, nor do they promote investment or formalisation of the sector. The sector remains largely unorganised, with only around one-third of over 10,000 retreaders operating formally, further limiting quality assurance despite the scale of operations. Moreover, there is a widespread lack of awareness about the environmental and economic benefits of retreading, particularly in the passenger vehicle segment where it is often overlooked. Strengthening policy support for retreading is essential to unlock its full potential as a resource-efficient and low-emission solution within the circular economy for tyres.

Key Action Points:

Retreading has been found to be practical exclusively in the truck and bus segment. The following interventions are a few policy interventions that may be considered for retreading by relevant government departments (MoRTH, MoEFCC, CPCB, SPCBs) going forward:

1. Revisiting the EPR and doing away with the provision for retreading completely to eliminate a layer of procedural complexity.
2. Work with stakeholders to establish retreader auditing and integrate retreaders into a SPCB-regulated ecosystem.
3. Collaborative efforts by tyre OEMs and automotive workshops to enhance retreading services.
4. Upgrade retreaded tyre marking system based on digital infrastructure for quality assurance.
5. Increase awareness regarding retreading in the mainstream through public awareness campaigns.

8. Conclusion – Summary of Recommendations

India's waste tyre recycling ecosystem presents a unique opportunity to advance circular economy objectives while addressing pressing environmental and industrial challenges. This report has examined the sectoral landscape, mapped current material flows, and identified key regulatory, infrastructural, and market gaps that hinder the full realisation of value from End-of-Life Tyres (ELTs). Drawing on these insights, the following table outlines a comprehensive set of policy recommendations designed to enhance resource efficiency, formalise operations, and stimulate demand for high-quality recycled products across the value chain.

Table 14: Summary of Key Recommendations and Implementation Agency

Recommendations	Implementation Agency
Improving Waste Tyres EPR system	
1. Revise formula for EPR certificate generation with a transparent mechanism. 2. Review ban on pyrolysis of imported ELT. ***Timeline: Six months***	MoEFCC
1. Determine common conversion factor to ensure availability of sufficient EPR certificates in the market. 2. Standardise verification of materials produced from waste tyre processing through standardised mass-flow mapping. 3. Consider changing pollution category of reclaim rubber industry from red to orange. 4. Recommend a capacity- and investment-based approval framework for pyrolysis units, ensuring that only projects with adequate scale, financial commitment, and land availability are permitted. 5. Propose tyre pyrolysis industry for online continuous emission monitoring (OCEMS) mandate. 6. Notify that TPO made from imported ELT feedstock be used in refineries or a few select industries. 7. Carbon char obtained from imported ELT feedstock may be refined to only rCB, dependent on available infrastructure or a few select industries. ***Timeline: One year***	CPCB

<table>
<tr><th>Recommendations</th><th>Implementation Agency</th></tr>
<tr><td colspan="2">Formalizing ELT Recycling</td></tr>
<tr><td>1. Undertake exercise to ensure all stakeholders pertinent to ELT recycling value chain are integrated into EPR ecosystem within a defined timeline.
2. Identify and integrate unauthorised recyclers into the EPR ecosystem given a fixed deadline.
3. All recyclers under EPR may be subject to checklist-specific audit for meeting compliance requirements.
Timeline: One year</td><td>SPCBs, CPCB</td></tr>
<tr><td>1. Udyam Assist Platform may be utilised to help in onboarding of unauthorised recyclers.
2. MSE-SPICE scheme may find application in providing financial support to upgrade infrastructure in non-compliant tyre pyrolysis units.
Timeline: One year</td><td>MoMSME</td></tr>
<tr><td>1. A one-time waiver of outstanding environmental liabilities may be provided to informal tyre recyclers to overcome initial financial and regulatory entry barriers.
Timeline: One year</td><td>State governments</td></tr>
<tr><td>1. Constitute a committee to review GST rationalisation for waste ELTs and recycled products to 5%.
Timeline: One year</td><td>MoEFCC, MoF</td></tr>
<tr><td>1. Introduce separate 6-digit HSN codes for crumb rubber and waste tyres to help distinguish between the two. Similarly, a separate HSN code for Micronized Rubber Powder (MRP) may also be created.
Timeline: One year</td><td>MoF, DPIIT</td></tr>
<tr><td colspan="2">Recycled Material Standardisation</td></tr>
<tr><td>1. Notify standards for TPO and rCB, similar to previously notified standards for reclaim rubber (IS 7490:2023) and CRMB (IS 17079:2019).
Timeline: Eighteen months</td><td>BIS</td></tr>
<tr><td>1. Issue guidelines for uptake of TPO for value-added products based on standards notified.
2. Framework to be determined by specifications by looking at global best practices for uptake of TPO.
3. Align tax treatment of TPO with conventional petroleum products, or provide targeted GST offsets/credits for refineries procuring TPO to incentivise uptake.
Timeline: Two years</td><td>MoPNG, BIS</td></tr>
</table>

Recommendations	Implementation Agency
1. Prioritise the integration of recycled tyre products into automotive, rubber goods, plastics, paints, inks, and energy substitution markets, where rCB, reclaim rubber, and TPO can directly replace imported virgin inputs. 2. Develop procurement guidelines for domestic industries, and encourage inclusion of recycled content in select manufacturing value chains. 3. Devise fiscal incentives or preferential treatment for industries adopting recycled inputs to catalyse large-scale uptake. ***Timeline: Two years***	DPIIT
Retreading	
1. Revisit EPR and do away with the provision for retreading completely. ***Timeline: Six months***	MoEFCC
1. Work with stakeholders to establish retreader auditing and integrate retreaders into a SPCB-regulated ecosystem. ***Timeline: Two years***	CPCB, SPCBs
1. Take collaborative efforts with automotive workshops to enhance retreading services. ***Timeline: Two years***	MoRTH, Retreaders
1. Upgrade retreaded tyre marking system based on digital infrastructure for quality assurance. 2. Increase awareness regarding retreading in the mainstream through public awareness campaigns. ***Timeline: Two years***	MoRTH, OEMs, Retreaders

9. Annexure

A. Pollutants from Recycling Processes

The pollutants emitted by the different processes are listed subsequently:[9]

Table A1: Pollutants Emitted by Different Tyre Recycling Processes

Pollutants	Batch Pyrolysis (BP)	Advanced Batch / Continuous Pyrolysis	Mechanical Recycling / Crumbing	Reclaim/ Devulcanisation
Gaseous Pollutants	PM SOx NOx CO H_2S Dioxins	PM (lesser than BP) SOx; NOx; CO	PM (during process)	SOx; NOx; VOCs (Major component)
Liquid Pollutants	Tyre pyrolysis water (pyro-water). A mixture of water, oil and carbon particles.	Pyro-water	Key leachate pollutants include heavy metals (Zn, Ni, Cr), and organic compounds (PAHs)	Sulfur compounds, organic contaminants, heavy metals, chemical additives, rubber industrial wastewater
Notes	Pyro-water can be highly polluting if not treated properly.	This is less polluting due to fully enclosed structural design, which prevents leakage of waste residues, and advanced exhaust gas treatment systems designed to purify emissions.	Risk of leachate contamination from the application of crumb rubber is a substantial environmental consideration.	Eco-friendliness of devulcanisation is highly dependent on the effectiveness of its liquid waste management

9 CO – Carbon monoxide; SOx – Sulphides; NOx – Nitrogen oxides; PM – Particulate matter; VOC – Volatile organic compounds; PAH – Polycyclic aromatic hydrocarbons

B. Conversion Factor Calculation for EPR

Table B1: Conversion Factor Calculation (Source: CPCB)

Entities	Crumb rubber	Reclaimed Rubber	CRMB	Recovered carbon black	Pyrolysis oil and Char (Continuous)	Pyrolysis oil and Char (Batch)
Waste Tyre (tonnes)	100	100	100	100	100	100
Recovered end product (tonnes) (QP)	75	77	500	27.2	Oil - 35 Char - 32	Oil - 35 Char - 32
Weightage (WP)	1	1.3	1.1	1.25	0.8	0.5
Equivalent Certificate (tonnes) (QEPR)	100	130	110	125	80	50
Conversion Factor (CF)	1.333	1.298	0.2	3.676	1.49	1.49

The Conversion Factor (CF) is meant to equate the quantum of waste tyres going in as input to the amount of recycled product derived from it as output. As such, the formula for CF is relatively straightforward:

$$C_F = \frac{(\text{Waste Tyre (tonnes)})}{Q_P}$$

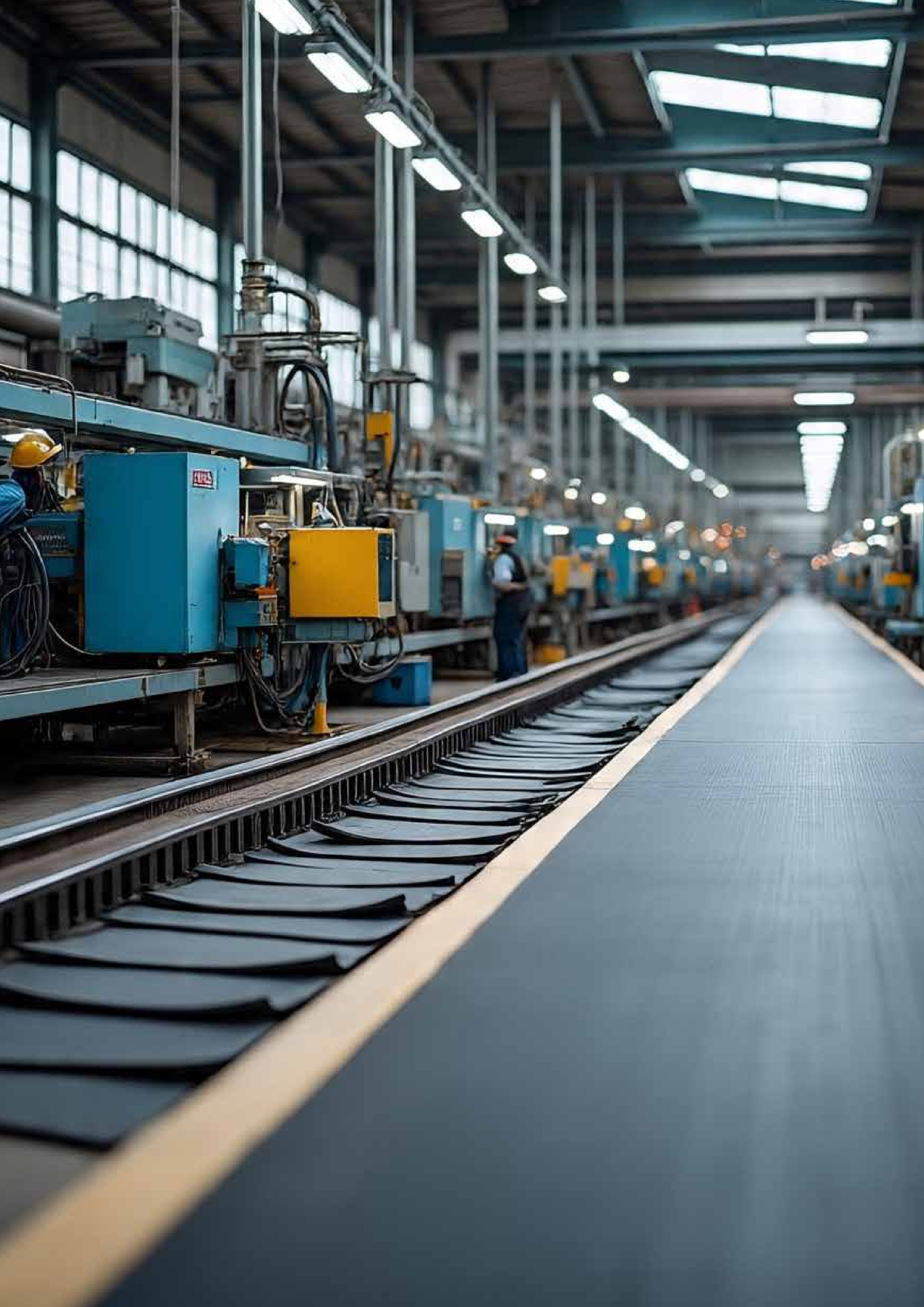
where Q_P – Recovered end product (tonnes). The values were taken from industry stakeholder consultation, as per the CPCB

In the case for CRMB, where 500 tonnes of product are produced relative to 100 tonnes of waste tyre due to the low requirement of crumb rubber in the modifier for the bitumen mixture (20-25% at most). Similarly, continuous and batch pyrolysis have the same conversion factor and it is arrived at by addition of the Q_P of both oil and char for the above formula, instead of distinct products as is for the other categories.

C. International Specifications for Tyre Pyrolysis Oil (TPO)[10] Uptake

Analysis	Method	Unit	Min	Preferred	Max	Comment
Density 15°C	-	kg/m³	> 910	-	-	Lower the better
Flash point	DIN EN ISO 3679	°C	> -10	> 40	-	-
50% Boiling Point	DIN EN 15199	°C	250	> 340	-	-
Nitrogen (N)	ASTM D5291	mg/kg	-	< 5.000	6.500	-
Sulphur	-	wt%	-	< 0.9	1.1	-
Halogens	DIN EN 15408	mg/kg	-	< 20	30	-
Chloride (Cl)	DIN EN 15408	mg/kg	-	-	-	-
Fluorine (F)	DIN EN 15408	mg/kg	-	< 1	-	Under investigation
Bromine (Br)	DIN EN 15408	mg/kg	-	< 10	-	-
Total Acid Number	ASTM D 664	mg KOH/g	-	< 4	8	-
B(a)P	DIN EN 16143 (based on)	mg/kg	-	< 20	50	-
Water content	DIN 51777-01	%(m/m)	-	-	0.5	No free water allowed
Particles	Visually	-	-	-	none	-
Solids	ASTM D7579	wt%	-	-	0.2	-
Ash	ASTM D482	wt%		< 0.01	< 0.05	-
Pour point	DIN EN ISO 3016	°C	-	-	0	-
Silicon (Si)	DIN 51399-1	mg/kg	-	< 10	30	-
Zinc (Zn)	DIN 51399-1	mg/kg	-	< 3	10	-
Aluminum (Al)	DIN 51399-1	mg/kg	-	< 3	10	-
Iron (Fe)	DIN 51399-1	mg/kg	-	< 3	10	-
Copper (Cu)	DIN 51399-1	mg/kg	-	< 3	10	-
Other metals	DIN 51399-1	mg/kg	-	Each < 1	Each < 3	-
Oxygen (O)	DIN 51732 mod.	%(m/m)	-	< 0.5	< 1	-

10 From purchase specification of TPO for H&R Group (Germany) (as on 19.03.2025)



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NITI Aayog