Driving Circularity in the Automotive Value Chain: Design, Recovery and Second-Life Solution

Asmita Sathaye

Head- Material Science & TDBM

Tata Motors Passenger Vehicles Limited

13.06.2025

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Connecting Aspirations

OUR CULTURE CREDO

AT TATA MOTORS

We are connecting aspirations by being bold in thought and action, owning every opportunity and challenge, Solving together as one team and engaging all our stakeholders with empathy.

We are **MORE WHEN ONE!**

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BE BOLD | OWN IT | SOLVE TOGETHER | BE EMPATHETIC

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Agenda

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- Triggers for Circularity
- Circularity Attributes
- Vehicle Life Cycle Phases & Circularity
  - ➢ Material & Part Manufacturing Phase:
    - ✓ Material Breakdown & Hot Spots
    - ✓ Extended Producer's Responsibility – Targets for Collection & Circularity
    - ✓ Challenges in Material Recycling
  - ➢ Use Phase
    - ✓ Material Circularity by Extension of Life of the Product / part/ Commodity
    - ✓ Use/ ELV Phase : Secondary life of HV Battery
  - ➢ End of Life –Vehicle Phase
- Tata Motors Systems & Processes for Circularity
- Tata Motors : Major Circularity Initiatives
- Global Auto OEM Initiatives
- Roadmap for Automotive Circular Economy

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Triggers For Circularity

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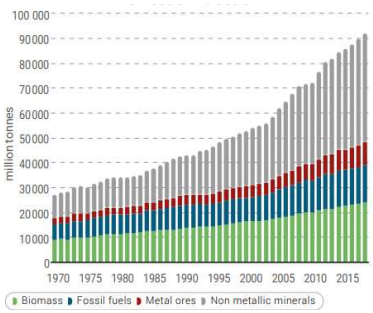
Depletion of natural resources | Land Pollution | Water Pollution | Air Pollution | Health Hazards

Global Material Extraction from 1970-2017



14 million tons of plastic end up in the Ocean every year

Mayapuri- Un-organized Waste storage & Disposal

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Project Aalingana - Sustainability Targets at Tata Group Level

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Driving Net-Zero

2030

25% REDUCTION IN ABSOLUTE CARBON EMISSIONS*

*From 2020 baseline (Scope 1 & 2); Tata Steel India to reduce emissions intensity by 28-30% from 2020 baseline

2045

NET ZERO EMISSIONS ACROSS THE GROUP*

*Scope 1 & 2 across companies; scope 3 for JLR, TML, TCS, TCPL

Pioneering Circular Economies

2025

MORE THAN DOUBLE THE CONTENT OF RENEWABLE OR RECYCLED RESOURCES IN PRODUCTS*

*Over 2020 baseline

2030

REPLENISH FRESHWATER & ZERO WASTE TO LANDFILL*

*Freshwater target for India operations only

2040

REPLENISH MORE FRESHWATER THAN CONSUMED

Preserving Nature & Biodiversity

2024

ACTION PLANS FOR NET POSITIVE IMPACT

2025

INVEST IN NATURE-BASED SOLUTIONS (NBS) PROJECTS IN INDIA

2030

GROUP IS AN NBS LEADER AND HAS SUPPORTED NBS MARKET IN INDIA

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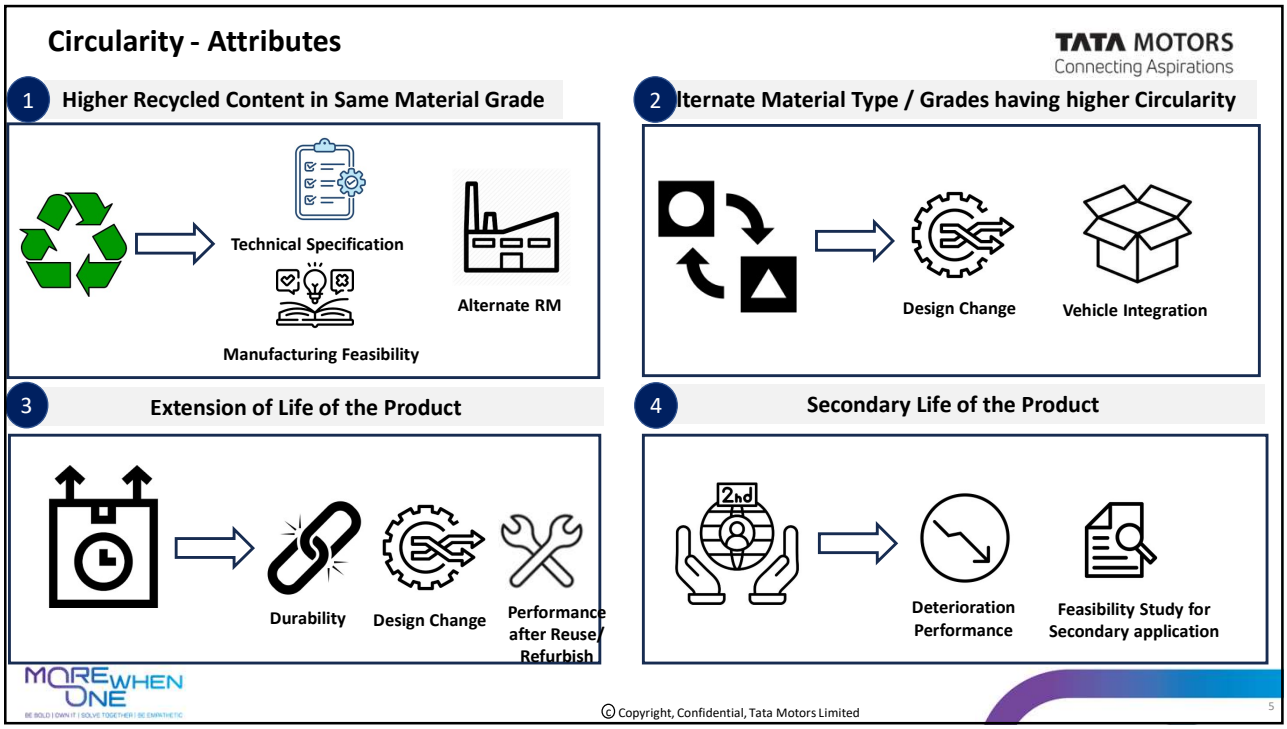
Circularity - Attributes
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1 Higher Recycled Content in Same Material Grade
Technical Specification
Alternate RM
Manufacturing Feasibility
2 Alternate Material Type / Grades having higher Circularity
Design Change
Vehicle Integration
3 Extension of Life of the Product
Durability
Design Change
Performance after Reuse/ Refurbish
4 Secondary Life of the Product
2nd
Deterioration Performance
Feasibility Study for Secondary application
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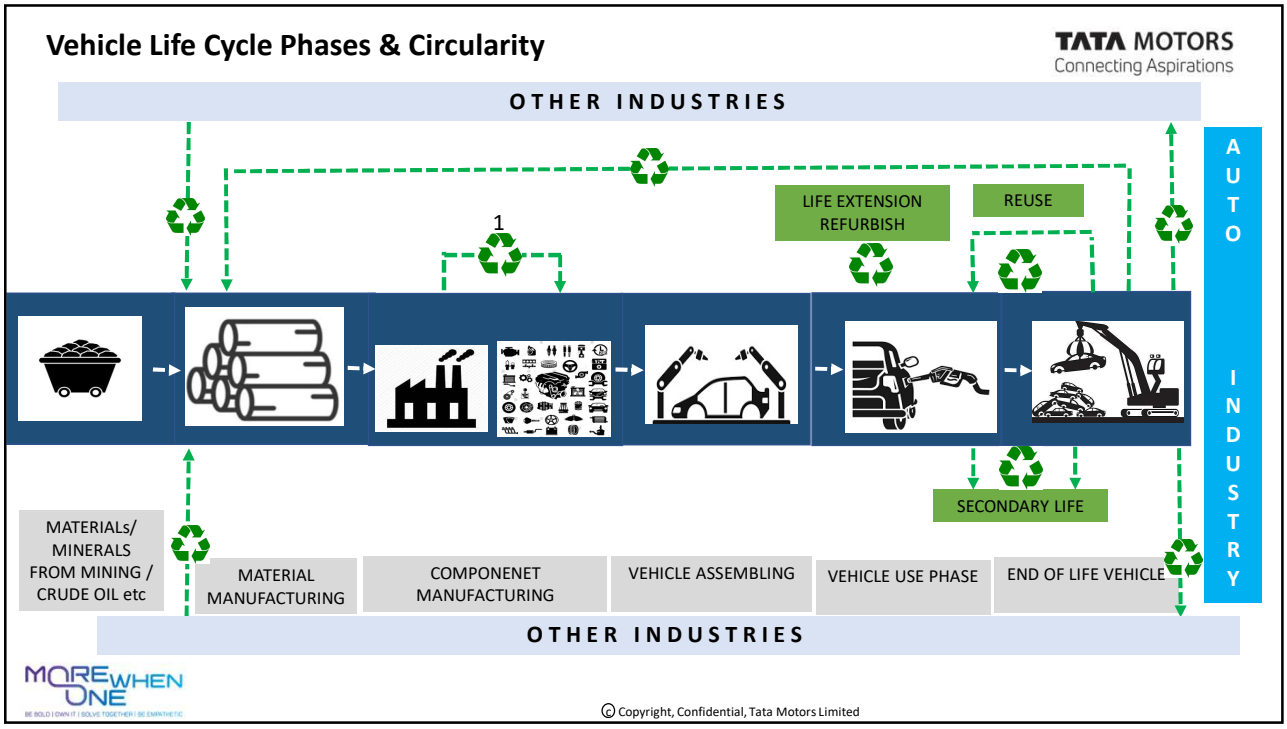
Vehicle Life Cycle Phases & Circularity
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OTHER INDUSTRIES
AUTO INDUSTRY
LIFE EXTENSION REFURBISH
REUSE
1
SECONDARY LIFE
MATERIALs/ MINERALS FROM MINING / CRUDE OIL etc
MATERIAL MANUFACTURING
COMPONENET MANUFACTURING
VEHICLE ASSEMBLING
VEHICLE USE PHASE
END OF LIFE VEHICLE
OTHER INDUSTRIES
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Vehicle Life Cycle Phases & Circularity

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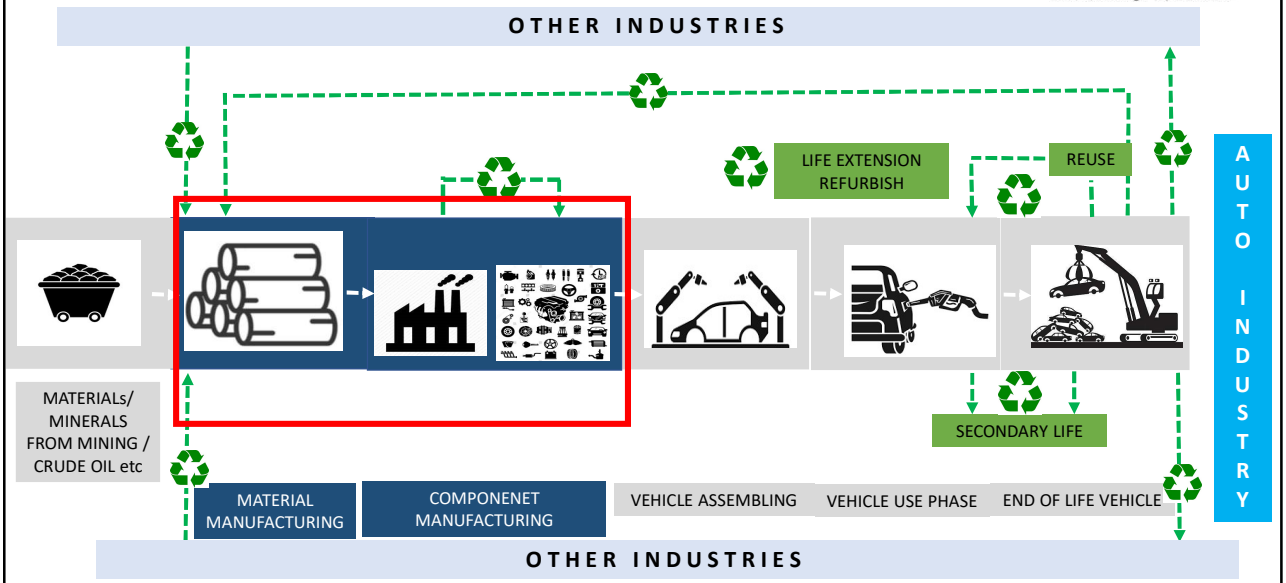

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Material Breakdown of Typical PV- ICE Model

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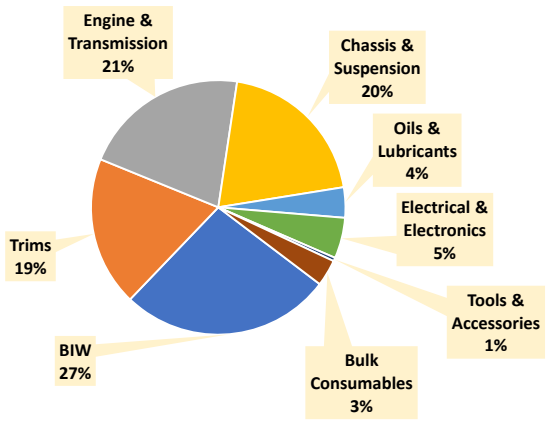
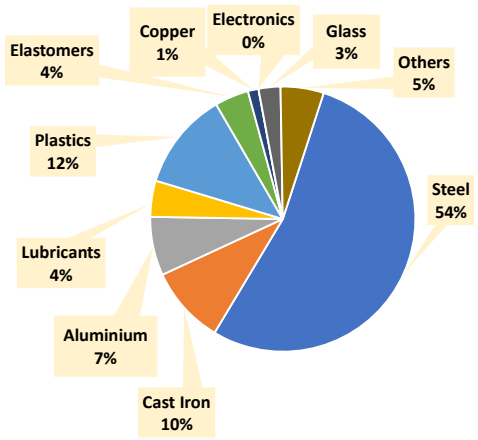
Typical ICE Vehicle Aggregate wise weight breakup



Typical ICE Vehicle Material Weight breakup



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Material Breakdown of Typical PV- EV Model

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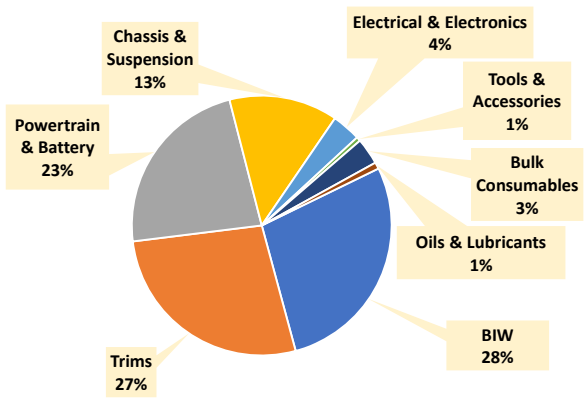
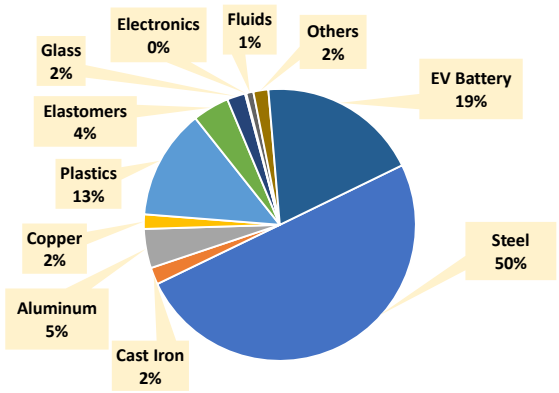
Typical EV Aggregate wise weight breakup



Typical EV Material Weight breakup



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Aggregate wise Material Hot Spots

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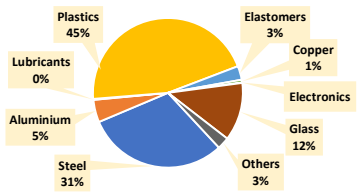
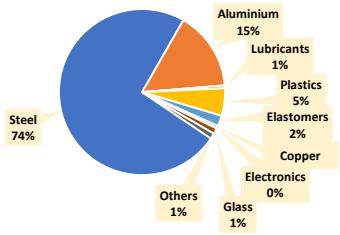
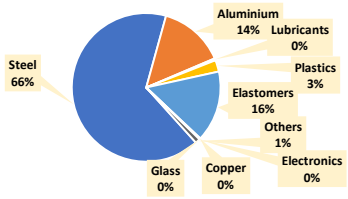
Trims



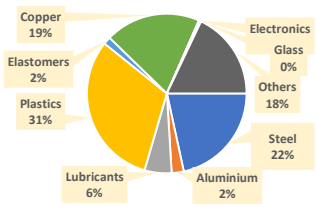
Engine & Transmission



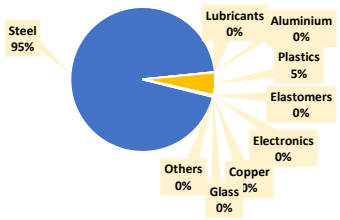
Chassis & Suspension



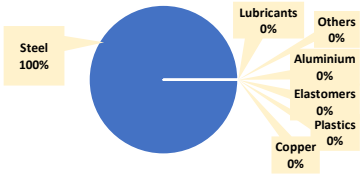
Electrical & Electronics



Tools & Accessories



BIW



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Extended Producer's Responsibility – Targets for Collection & Circularity

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Sr.no	Material	Collection Targets	Use of Recycled Content Targets	Stakeholders who can improve Recycled Content ?		
				Raw Material Suppliers	Compounders/ Blenders	Tier-1- Suppliers
1	Steel	✓	✓ Under Discussion	✓	NA	×
2	Cast Iron	×	×	✓	NA	✓
2	Aluminum casting	×	×	✓	NA	✓
3	Plastic	✓ (Only for packaging materials)	× (EU-Draft ELV: 25% recycled content by 2030)	✓	✓	× (Industry waste not considered)
4	Glass	×	×	✓**	NA	✓**
5	Oil	✓	×	✓* (with Additive Dosage)		NA
6	Tyre	✓	×	✓	NA	✓
7	Battery	✓	✓	✓	✓	×

*In case of Oil, raw material & compounder are same
** In case of Glass, Raw Material & Tier 1 Supplier are same

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Challenges in Material Recycling

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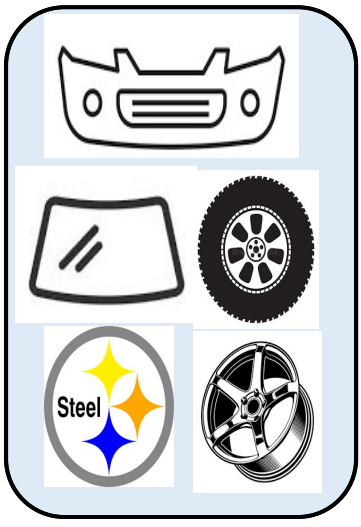
- Limited Market Demand
- Material Complexity
- Technology Limitations
- Contamination
- Recycled Material Availability



- Economic Viability
- Infrastructure & Capex
- Sorting
- Dynamic Hazardous Materials Regulation

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Vehicle Life Cycle Phases & Circularity

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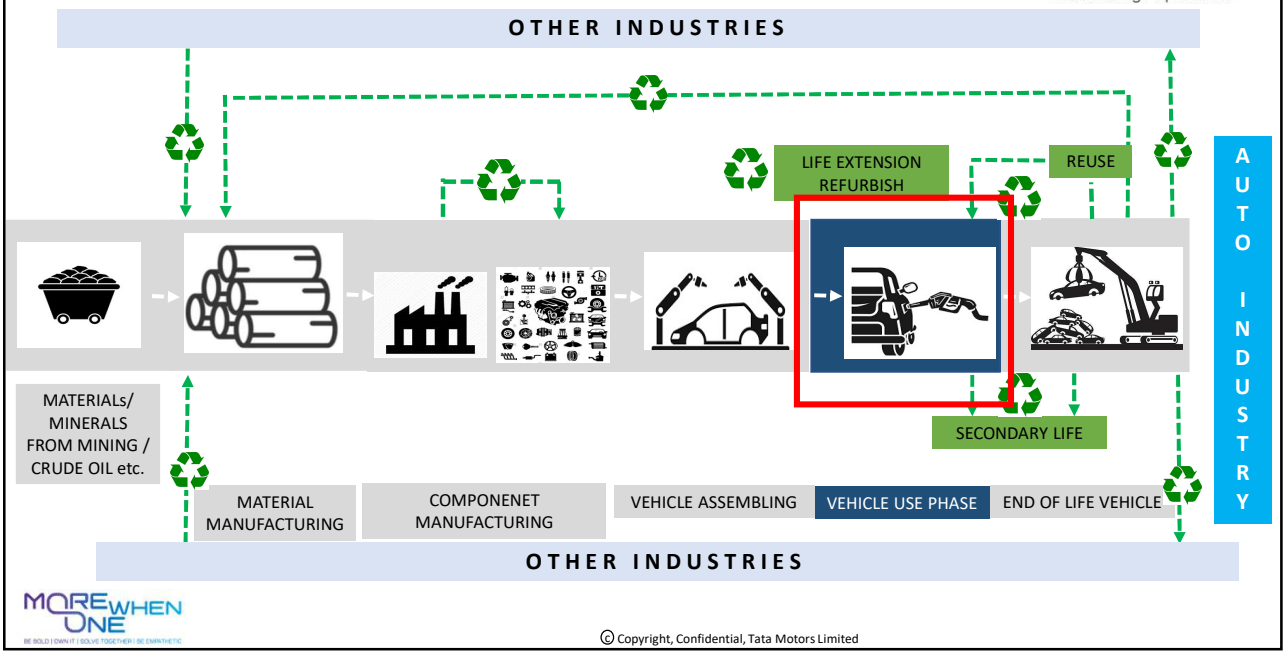

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Use Phase: Material Circularity by Extension of Life of the Product / part/ Commodity

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Typical list Parts / Commodities for Preventive Maintenance

Components to be replaced as per service manual	Replacement frequency	No. of times parts are getting replaced in 150,000 km / 15 years
Fuel Filter	24 months	7
Air Filter	36 months	4
Oil Filter	12 months	14
Engine Oil	12 months	14
Coolant	36 months	4
Timing drive kit	36 months	1
Transaxle oil	60 months	2
Brake fluid	24 months	4
AC filter (Pollen filter)	12 months	14
LV Battery	36 months	4
Tyre	35,000 km	4

Typical list Parts / Commodities for Extensive Maintenance

Typical Parts for Extensive Maintenance	Replacement Frequency	No. of Times Parts Getting Replaced in 150,000 km / 15 years
Wiper Blade	?? months	??
Shock absorbers	?? months	??
AC Compressor	?? months	??
Compressor Oil	?? months	??
Suspension Bushes	?? months	??
Clutch Plate	?? months	??
……		

Every OEM needs to find out top replaced part during extensive maintenance

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Use Phase/ ELV Phase : Secondary life of HV Battery

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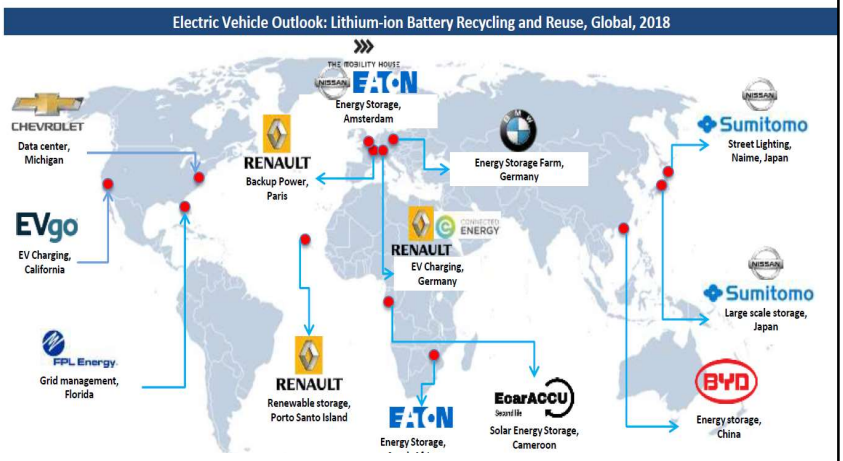
OEM	Recycling Partners	Second life Application
	Bosch, Vattenfall	Grid, Residential
	ACCUmotive/ Daimler AG, The Mobility House AG and GETEC	Residential, storage
	Duke Energy, ABB	Grid backup and levelling system
	Renault & Powervault	Home Energy Storage
	Mitsubishi Motors, Electricité de France, PSA, and Forsee Power.	Home storage, V2G
	Eaton, Green Charge	Home Energy Storage
	SNAM previously; In-house recycling division	No second life; remove pure substances

Global OEM Secondary Usage: Repurposing- Reusing



Curtesy: Frost and Sullivan

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Vehicle Life Cycle Phases & Circularity

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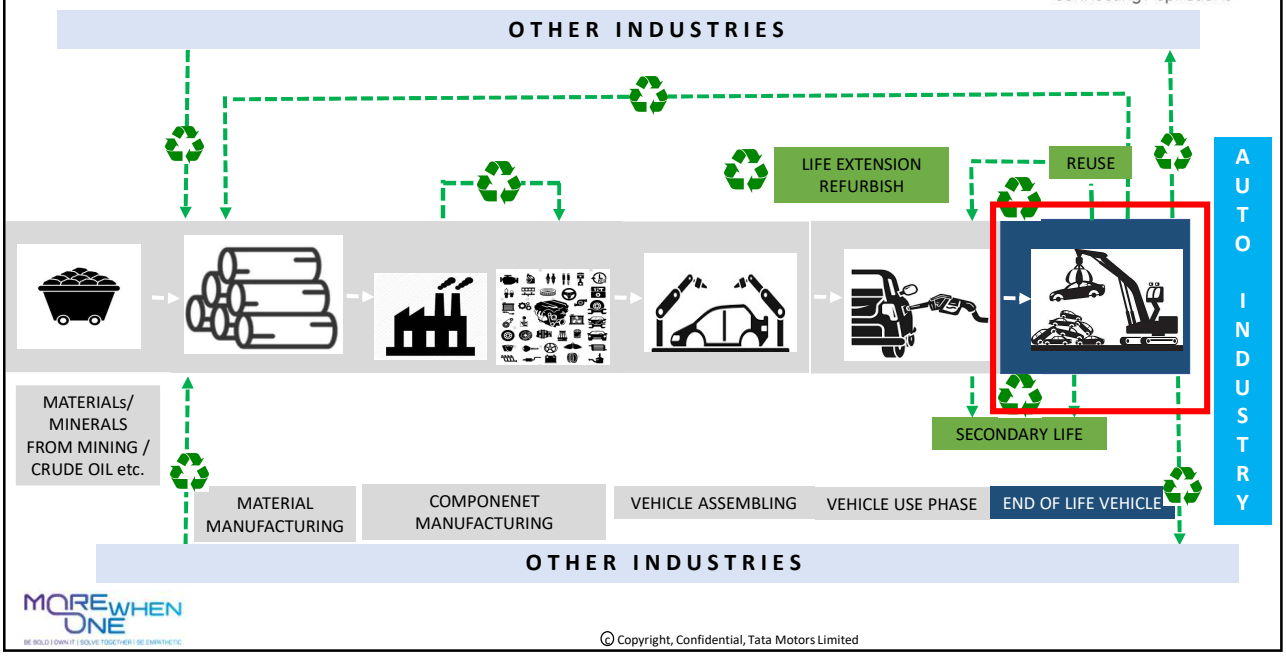

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End of Life –Vehicle Phase

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Tata Motors RE.WI.RE - Features

Location	Annual Capacity (No's)
Surat	15000
Jaipur	15000
Chandigarh	12000
Bhubaneshwar	15000
Pune	21000
Guwahati	15000
Delhi	18000

RE·WI·RE RECYCLE · WITH · RESPECT

1,10,000 vehicles
Annual dismantling capacity

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Tata Motors Systems & Processes for Circularity

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Vehicle level RRR Calculations as per ISO standard 22628

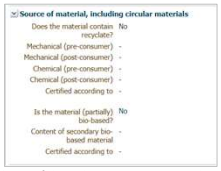
IDIS **Vehicle dismantling data**

- Disclosure of material, weight, line sketches, fasteners, tools

Supplier declaration on Material Circularity

Recycled content information through IMDS

IMDS DATA



IT system for data management e.g. IMDS, Environext

- Extract Vehicle level Data from IMDS

Knowledge Documents

- Design for Recycling
- Hazardous material compliance
- Recycled material grade properties
- Drawing recommendations & templates

Vehicle Level Target setting

- RRR Calculations
- Extension of Life
- Material Circularity
- Decarbonization

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Tata Motors : Major Circularity Initiatives

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Steel

- Use of Recycled Steel in BIW & other Parts

Plastic

- Use of Recycled Plastic in trim Parts
- Paint elimination from polymeric parts
- Utilizing natural fiber composites
- Repurposing pre-consumer waste for textile

Aluminum

- Use of Recycled Aluminum in Alloy wheels

Glass

- Use of Recycled Glass

Others

- Elimination of Hazardous Fame Retardants
- Streamlining design for longer life & End-of-Life management
- Identification of hotspots & strategic steps towards further increasing recyclability
- Alignment with EPR
- RVSF – Circularity Projects

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Tata Motors : Major Circularity Initiatives

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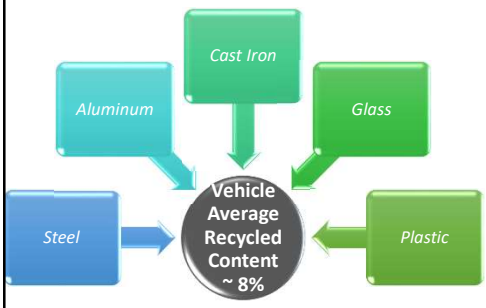
Vehicle Level Recycled Content



Out Associations / Partners

JAYA HIND Casting End-to-End Solutions
ENDURANCE Complete Solutions
Nemak Innovative Lightweighting
CMR For a better tomorrow
OSWAL
Sunalco
JSW Steel
TATA STEEL #WeAlsoMakeTomorrow
ArcelorMittal
posco
DSM
APPL PLASTIC ENGINEERING
SAINT-GOBAIN
Asahi
PETRONAS

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Global Initiatives On Automotive Circularity

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Skoda & Volkswagen

Polymers:
- Seat textiles made of up to 100% recycled PET
- Headliners, fabrics, carpets, seats, door trim panels and decorative inlays made up from recycled material
- Textile materials are made from 100% recycled polyester

Metals:
- For ENYAQ iV's: Recycled steel 40% & recycled aluminum 60%

Hyndai (Global)

Polymers:
- Recycled PET used in seat covers and upholstery
- Recycled PP for bumpers and wheel arches
- Underbody using 50% recycled plastic

Metals:
- 35% of recycled steel and aluminum parts used

Toyota Kirloskar Motors

Polymers:
- Recycled polymers used in luggage compartment

Metals:
- 2% recycled steel

Kia (Global)

Polymers:
- Recycled PET used in seat covers and upholstery
- Recycled PP for bumpers and wheel arches

Metals:
- 25% recycled steel

Renault (Global)

Polymers:
- Recycled plastics from vehicle used to make bumpers, wing trims, and dashboards

Metals:
- Cast Iron upto 100% recycled content

Mahindra & Mahindra

Polymers:
- Planning to implement recycled PP in B- class areas

Metals:
- Planning to Implement recycled Aluminum & recycled Steel in BIW

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Reference: Based on published sustainability reports 2024-25

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World Economic Forum: Roadmap for Automotive Circular Economy (2020)

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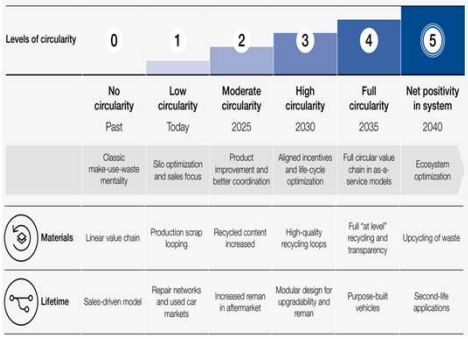
The five-level classification proposed for automotive circularity ranges from single owner use and disposal (Level 0) to an aspirational goal of an auto mobility ecosystem that has net positive impacts (Level 5)



Source: https://www3.weforum.org/docs/WEF_Raising_Ambitions_2020.pdf

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Level of Circularity	Materials without waste	Lifetime of components and vehicle
Level 1 circularity – today's reality	- Production scrap is recycled	- A network of repair shops and second-hand markets - Repairs are conducted on a per-event basis and cost case
Level 2 circularity – the next step	- Recycled content selectively increased - Cross-value chain collaboration to improve recycling and high-quality recyclability. - End-of-life processing is more carefully considered during the design	- Remanufactured components are used more in the aftermarket - Reparability of vehicles is improved through design
Level 3 circularity – transformational shift	- High-quality end-of-life recycling is implemented through passports and network collaboration. - Materials-as-a-service solutions align ecosystem incentives.	- Modular design facilitates upgradability, disassembly and remanufacturing. - Remanufactured components are, as far as possible, used in new vehicle production.
Level 4 circularity – end-to-end revolutionary change	- 100% of end-of-life materials are reprocessed or recycled within "same-quality" - Transparency and traceability are ensured, with standardized, global product passports.	- Design is highly optimized to application. - A significant proportion of vehicle content consists of remanufactured components and recycled materials.
Level 5 circularity – net-positivity	- Lower-value materials or waste streams from other industries (e.g. end-of-life wind turbines) are upcycled. - Their utility is improved at end of life.	- Suitable components of vehicles, such as electronics, motors or batteries, are enabled for external second-life applications at scale

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In 2019, the global economy consumed more than 100 billion tons of resources—primarily virgin metal ores, fossil fuels, biomass and minerals—and only 8.6% of this was cycled back into use.

The Circularity Gap Report 2021, Circle Economy

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Thank You

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