FROST & SULLIVAN

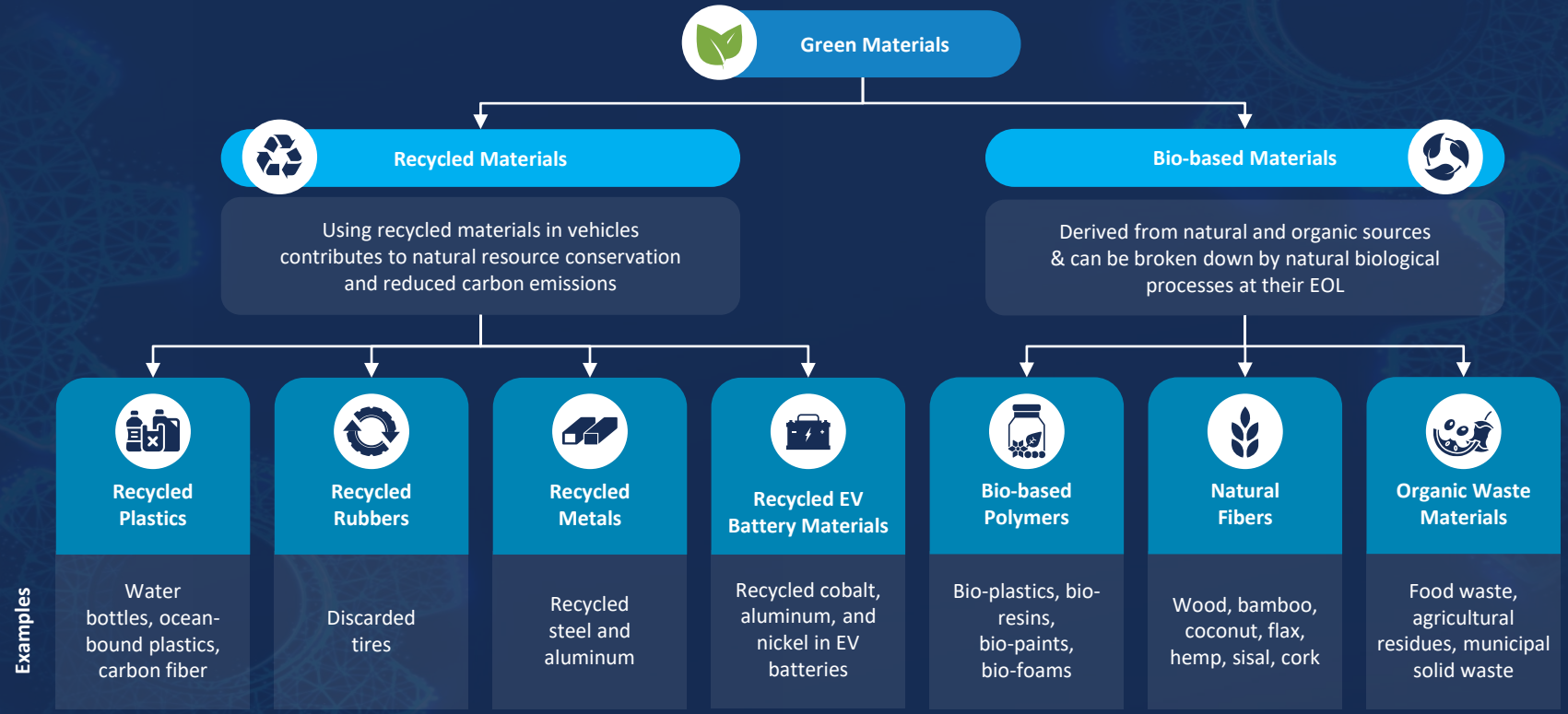
GREEN MATERIALS IN CARS: A STRATEGIC ANALYSIS

Government Regulations and Environmental Concerns Drive Future Growth Potential of Green and Eco-Friendly Materials

Global Automotive & Transportation Research Team at Frost & Sullivan

PFK2-44
May 2025

KEY CATEGORIES OF GREEN MATERIALS IN CARS



Source: Frost & Sullivan

REGULATIONS INFLUENCING ADOPTION OF GREEN MATERIALS IN AUTOMOTIVE INDUSTRY

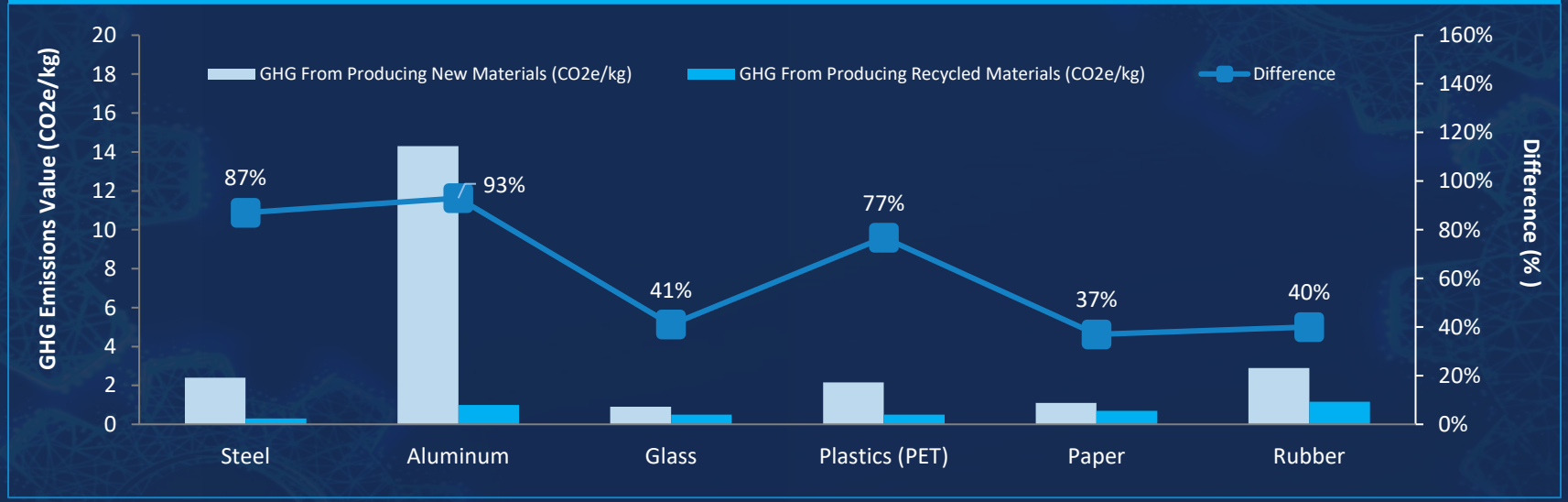
Regulation	Description	Impact on Adoption of Green Materials
EU ELV Directive	Requires new vehicles to be reusable and/or recyclable to a minimum of 85% by weight per vehicle	
EU Battery Directive	From 2030, batteries (automotive and non-automotive use) will need to contain a minimum recycled content of 12% for cobalt, 4% for lithium, 4% for nickel, and 85% for lead	
EU Circular Economy Action Plan	Promotes resource efficiency and waste reduction in the automotive sector, encouraging the use of recycled and renewable materials	
China's New Energy Vehicle (NEV) Mandate	Requires NEVs to comprise 45% of all new auto-sales by 2027	
Japan's Green Procurement Law	Encourages government agencies to purchase environmentally friendly vehicles	
South Korea's Act on the Recycling of Resources from Waste Vehicles	Promotes ELV recycling and reuse, encouraging the use of recyclable and sustainable materials	
US Corporate Average Fuel Economy (CAFE) Standards	Publishes fuel efficiency standards for vehicles sold in the US, indirectly promoting lightweight materials to improve fuel efficiency	
California Zero-emission Vehicle (ZEV) Mandate	California is aiming for 100% ZEV and clean plug-in hybrid vehicles by 2035	
Canada’s ZEV Mandate	Requires 100% of new light-duty vehicle sales to be zero-emission by 2035	

 Low  Low to Medium  Medium  Medium to High  High

Source: Frost & Sullivan

RECYCLING IN AUTOMOTIVE: OVERVIEW

Greenhouse Gas Emissions (GHG) of Recycled Materials vs. Virgin Materials Production, Global, 2024



Key Takeaways

- Recycling aluminum results in maximum savings in GHG emissions
- Based on the above figures, recycling key materials such as plastics, steel, aluminum, and rubber from ELVs can save an average of **62%** of greenhouse gas emissions, thereby leading to reduced reliance on virgin materials and promoting a circular economy

Source: Frost & Sullivan

RECYCLED PLASTICS USE IN CARS: HIGHLIGHTS

Recycled Plastics

Standard Approach

Driven by sustainability goals, automakers are making efforts to include recycled plastics in their vehicles. However, current usage remains around 8 to 15%

Recycled Plastics—Usage

- Exterior Parts
- Chassis
- Powertrain
- Interior

Implications of Recycled Plastics

Every ton of recycled plastic saves 7.4 cubic yards of landfill space

70-80% carbon emissions reductions per kg compared to virgin plastics

Recycled Plastics—Main Sources

- ELVs
- Consumer plastics (PET bottles)
- Ocean-bound plastics
- Industrial wastes

Commonly Recycled Plastics in Cars and its Sources

- Polypropylene (PP)
- Polyethylene Terephthalate (PET)
- Polyamide (PA)
- Polycarbonates (PC)
- Acrylonitrile Butadiene Styrene (ABS)

Regulatory mandates

- By 2030, the EU Commission requires OEMs to use 25% recycled plastics in their vehicles, with a quarter of it coming from ELVs
- The Indian government mandated the use of 20% recycled materials in vehicles produced from 2026 onwards

Recycled Plastics Usage Key: Highly used | Not recommended/used

Source: Frost & Sullivan

RECYCLED PLASTICS APPLICATION IN CARS

Recycled Plastics

Car dashboards
Stellantis, Renault

Headliner surfaces
VW, Stellantis

Spoilers
Peugeot

Window support brackets
GM

Car seat upholstery
Fiat, VW, Nissan, Volvo, Audi, Skoda

Interior door skins
GM

Center console
GM, Renault

HVAC ducts
GM

Wheelhouse liners
GM, VW

Battery trays
Mitsubishi

Underbody shields
Ford, GM, VW, Renault, Toyota

Bumpers
Peugeot, Mitsubishi, Nissan, Toyota

Wiring harness clips
Ford

Upper bulkhead
Citroen

Floor carpets
Maserati, VW, Volvo, BMW, Kia, Fisker Ocean

Consumer plastics/ industrial wastes/EOL cars

Ocean bound plastics/ discarded fishing nets

FROST & SULLIVAN

Source: Frost & Sullivan

RECYCLED PLASTICS USE AND FUTURE VISION BY KEY OEMS

Recycled Plastics			
OEM	**Type of recycled plastics**	**Component used**	**Future vision**
Ford	Recycled consumer plastics	Underbody shields, engine shields, and radiator air deflector shields	20% use of recycled and renewable plastics in NA, EU by 2025
	Recycled ocean plastics	Wiring harness clips	
GM	Recycled plastics	Underbody shields, fans, generator covers, wiper shields, center console, HVAC ducts, wheelhouse liners, window support brackets, and interior door skins	24 million pounds of recycled plastics used in GM vehicles today; plans to increase recycled content in future
VW	Recycled PET bottles and marine plastic	Carpets, seat textiles, door trim, roof linings, and wheel housing liners	Following ID. Buzz, recycled innovations will be extended to ID. family
	Recycled polyester	Headliner surfaces, floor coverings	
Nissan	Recycled PET bottles	Seat covers	Long-term goal of sourcing 70% of materials for new vehicles from recycled sources
	Recycled plastics from bumpers	New bumpers	

Source: Frost & Sullivan

RECYCLED METALS USE IN CARS: HIGHLIGHTS

Recycled Metals

Standard Approach

Metals can be recycled infinitely without compromising quality, making them vital green materials. Aluminum and copper are highest recycled metals in the industry.

Recycled Metals—Usage

- Exterior Parts
- Chassis
- Powertrain
- Interior

Implications of Using Recycled Metals

- Requires 5-10% of the energy needed to produce virgin metals
- 85-95% reduction in carbon emissions by using recycled steel and aluminum

Recycled Metals—Main Sources

- ELVs
- Industrial Scrap
- Construction & Demolition Waste

Common Applications in Cars

- Body Panels
- Engine Block
- Cylinder Heads
- Wheels & Bumpers
- Seat Frames

Regulatory mandates

- According to Indian Ministry of Environment mandate, starting from 2025 to 2026, automakers must ensure that at least 10% of steel used in vehicles sold two decades prior (2005 to 2006) is recycled or recovered.
- India has mandated all new products (including automotive) made from non-ferrous metals should contain minimum 5% recycled content from 2028.

Recycled Plastics Usage Key: Highly used | Not recommended/used

Source: Frost & Sullivan

SIGNIFICANCE OF METAL RECYCLING IN AUTOMOTIVE INDUSTRY

Manage ELVs
Every year, steel industry recycles more than 14 million tons of steel from ELVs. Recycling steel scrap from ELVs and using it back in vehicle production is an important step towards sustainability.

Recycling Rate
The recycling rate for steel in the automotive industry (United States and Europe) is close to 100%. Aluminum has the next-highest recycling rate—90%.

Closed-loop vs Open-loop Recycling
The majority of steel recovered from ELVs is reused in production of car components. In the case of aluminum, only 60% of sheets sent to automotive press shops is made into car parts, while the remaining 40% is recycled through open-loop system for secondary applications.

Environmental Benefits
Metal recycling conserves natural resources, reduces carbon emissions by up to 95% compared to virgin materials, and allows for endless reuse of metals, thereby reducing dependency on raw materials mining.

Energy Savings
Recovery of one kg of aluminum through recycling methods can save up to ~14KWh of power. Recycling steel scrap from vehicles can save up to 1.4 MWh per ton, which is an estimated 25% energy savings compared to production from ore.

NATURAL FIBERS USE IN CARS: HIGHLIGHTS

Natural Fibers

Standard Approach

Natural fibers derived from plants and animals are environmentally friendly materials and are adopted by OEMs to provide lightweight benefits in cars.

Natural Fibers—Usage

Exterior Parts

Chassis

Powertrain

Interior

Implications of Natural Fibers

20-30% lighter in weight when compared to traditional glass fibers

Overall weight of the cars can be reduced by 50-100kg, if used in various vehicle parts

Natural Fibers—Main Sources

Bast (flax, hemp)	Tress and Leaf (sisal, coir, wood)	Seed (cotton)	Grass and Reed (wheat, bamboo)

Common Applications of Natural Fibers

- In-vehicle dashboards
- Door panels
- Seat upholstery
- Headliners

Regulations and Best Practices

- **EU's ELV directive** promotes circular design of vehicles by facilitating recovery and removal of materials, parts, and components for reuse and recycling.
- **US Corporate Average Fuel Economy standards** sets fuel efficiency guidelines in vehicles, which indirectly promotes the use of lightweight materials.

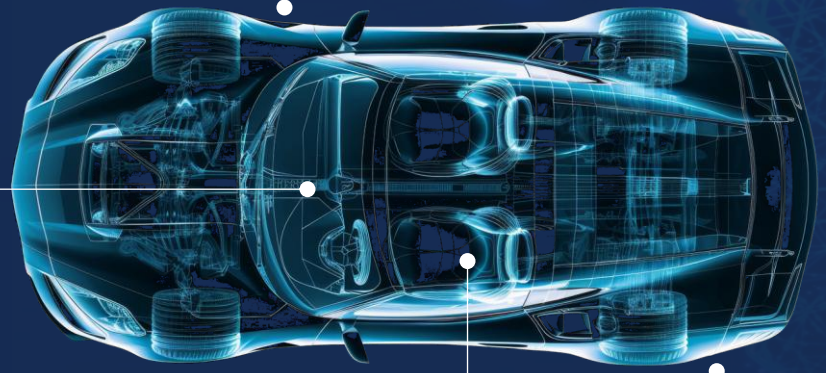
Recycled Plastics Usage Key: Highly used | Not recommended/used

Source: Frost & Sullivan

NATURAL FIBERS: SELECT INITIATIVES BY OEMS

Natural Fibers

OEMs	Green Material used	Components
Peugeot	Natural hemp fibers	Dashboard reinforcements
Citroen (concept car)	Cardboard	Bonnet and roof
Stellantis	Wood fiber composite materials	Cargo load floor in trunks
Ford	Coconut coir	Storage bins, door trims, seat trims, center consoles
Toyota	Bamboo-based materials	Interior trims
BMW	Flax fibers	Cooling shaft
Ford	Kenaf fibers	Door interiors
Audi	Flax and sisal fibers	Door trims
Rolls-Royce	Wood, bamboo fibers	Interiors, rear-seat upholstery



CASE STUDY: USE OF BIO-MATERIALS IN KIA'S VEHICLES

- Kia implements eco-friendly materials in its vehicles (such as EV9, Niro) and plans to expand the use of these materials to other models like EV6. **A total of 10 sustainable materials will be used in Kia's future vehicles.**
- In addition to biomaterials, recycled PET bottles, consumer plastics, old fishing nets and paper fibers will be featured.

A. Biomass plastics
Made from renewable biomass sources such as vegetable oils, corn starch, and sugarcane extracts

Use: Dashboards, consoles, structural pillars, and interior elements

B. Bio polyurethane
Made from plant materials or natural oils and is used as animal leather alternative in Kia's interiors

Use: Passenger seats and headrests

C. Vegan leather
Made from mixing the vegetable components of eucalyptus trees and combined with PU artificial leather

Use: Kia Niro's seats

D. Mycelium
Produced from the roots of mycelium fungus and cultivated in a mold to provide the required shape

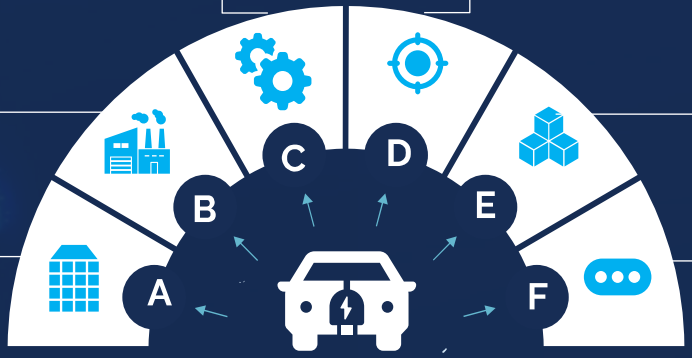
Use: Prototype console of EV3

E. Natural dyes
Recycled cotton colored using natural dyes made from roots of rubiaceous plants and walnut shells

Use: Concept EV4's interior cabin

F. Bio-based paints
Paints made from rapeseed oils, which are free from carcinogens (benzene, toluene, xylene)

Use: Niro's door trim and exterior body

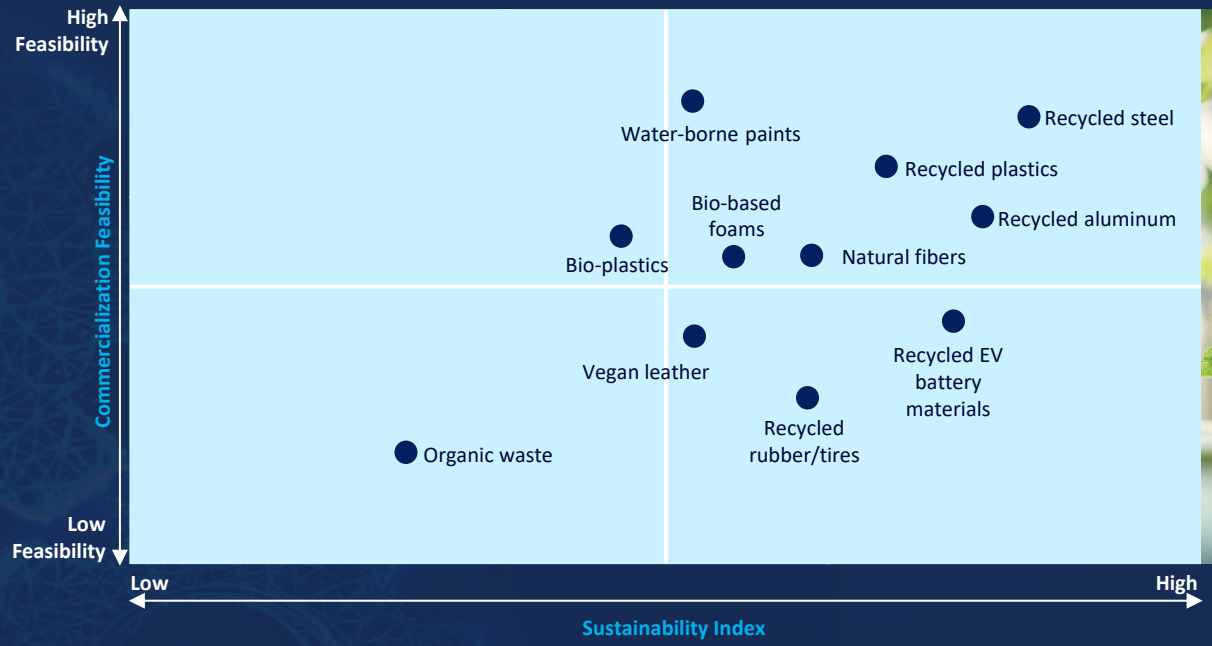


Use of bio-materials in Kia's vehicles

FROST & SULLIVAN

Source: Frost & Sullivan

FUTURE GROWTH POTENTIAL FOR GREEN MATERIALS IN CARS



- **Commercialization feasibility:** Indicates a qualitative assessment of green materials' financial viability, technical feasibility, market demand, and scalability in automotive applications; higher feasibility indicates higher commercial success.
- **Sustainability index:** Indicates whether they are environmentally sustainable throughout their life cycle, right from sourcing, production, manufacturing, and EOL disposal; higher feasibility indicates higher sustainability.

KEY TAKEAWAYS

Automotive OEMs are increasingly prioritizing the use of recycled materials: Recycled plastics and metals are the most widely used green materials in the auto industry. They are cost-effective, low-carbon emissive, and support circular economy, making them a top choice for OEMs. Their growing use is driven by government regulations aimed cutting landfill waste, and maximizing recycling benefits.

Naturally sourced plant fibers are eco-friendly but costly alternatives: Natural fibers (flax, hemp, kenaf, sisal) offer lightweighting benefits in vehicle manufacturing. However, supply chain limitations and high processing costs currently restrict their application to premium and luxury vehicles.

Economic uncertainties and changing government policies: Current economic headwinds, such as recession and inflation, have introduced uncertainties around consumer spending in green vehicles. Recent changes in the US government could relax environmental regulations and new tax tariffs could increase overhead costs for OEMs, thereby making eco-friendly vehicles less popular.

LINK TO THE STUDY

GREEN MATERIALS IN CARS: A STRATEGIC ANALYSIS

Subscriber: Link to Download

Non-Subscriber (Store): PFK2 Link to Purchase

Appendix

How does your organization identify and prioritize Growth Opportunities?

CONTENTS

CONTENTS (CONTINUED)

CONTENTS (CONTINUED)

CONTENTS (CONTINUED)

CONTENTS (CONTINUED)

CONTACT US

Sathya Kabirdas
Associate Partner - Research
Mobility - Automotive & Transportation
Email : Sathyanarayanak@frost.com

Podcast | Videos | Twitter | Events