PASSENGER

FOR SUSTAINABLE AND EFFICIENT RE-FREE MAGNETS

FACT SHEET

PASSENGER: Applications in automotive headlamp systems

HTTPS://PASSENGER-PROJECT.EU

BUSINESS CASE: AUTOMOTIVE HEADLAMP SYSTEM

integrating PASSENGER permanent magnets

Executive Summary

Modern automotive headlamp systems rely on compact, precise actuator motors to enable adaptive beam control, height adjustment, and dynamic lighting functions. These electromechanical systems are essential for safety, comfort, and energy efficiency in both conventional and electric vehicles.

Currently, most headlamp actuators use NdFeB-based permanent magnets to achieve the required torque and responsiveness within a small motor footprint. However, this dependence on Critical Raw Materials (CRMs) such as neodymium (Nd) and dysprosium (Dy) exposes manufacturers to price volatility and supply risk.

The PASSENGER project develops Rare Earth-free permanent magnets based on Manganese–Aluminium–Carbon (MnAlC) () and Strontium Ferrite (Sr-ferrite), offering sustainable, cost-stable, and EU-manufactured alternatives. This business case explores their integration in automotive headlamp actuators, assessing technical feasibility, economic potential, and environmental advantages.

Market need & challenge

Challenges and opportunities in automotive headlamp systems

Headlamp adjustment systems are integral to modern automotive design, particularly in LED and laser lighting technologies that require precise alignment. Actuators control functions such as beam height correction for variable loads, adaptive front-lighting and cornering systems, and dynamic range adjustment based on driving conditions.

The use of NdFeB (neodymium-iron-boron) magnets ensures compactness and high torque but presents several challenges:

High material cost due to volatile Rare Earth prices

Supply chain dependency on non-EU sources for Nd and Dy

Sustainability concerns related to mining and refining CRMs

Environmental footprint from energy-intensive magnet production

Developing Rare Earth-free alternatives aligns with Europe's industrial strategy, aiming to enhance self-sufficiency and reduce environmental impacts while maintaining performance standards in automotive components.

Market Size & Magnet Demand

Adaptive headlamp systems are increasingly integrated into electric and high-end vehicles, driven by safety regulations and smart mobility trends. Compact actuators enable functions such as beam height correction, cornering light adjustment, and adaptive driving beam (ADB) control — all relying on small permanent magnet motors.

Market segment	Size 2024	Size 2030	Compound annual growth 2024–2030
▲ Global Automotive Lighting	€29.8B	€42.4B	6.1%
▲ Adaptive Headlamp Systems	€7.2B	€11.8B	8.5%
▲ Global Automotive Lighting Actuators	$27.6B	$65.2B	8.1%
▲ European Automotive Adaptive Lighting Systems	$7.7B	$14.8B	>14%

Sources: Fortune Business Insights, 2024,
Markets and Markets 2024,
Automotive Lighting Actuators Market Size, Growth Report 2035,
Europe Automotive Adaptive Lighting System Market Size & Share Analysis, 2024

Modern vehicles equipped with adaptive lighting systems typically contain up to four actuators, with each actuator requiring 10–30 grams of permanent magnets. Across global automotive production, this creates an annual demand exceeding 2000 tonnes of permanent magnets.

This significant demand presents a large market opportunity for Rare Earth-free alternatives such as MnAlC and Sr-ferrite magnets to replace traditioe earth-based materials in automotive lighting applications.

PERMAMENT MAGNETS

10-30 grams
per actuator

up to 4 actuators
per vehicle

GLOBAL DEMAND

>2000 tonnes /year

PASSENGER Business Potential

PASSENGER develops Rare Earth-free magnets compatible with small, high-precision actuators used in adaptive headlamp systems. These magnets are optimized for magnetic stability, manufacturability, and corrosion resistance in compact motor environments. Key advantages:

- **COST STABILITY:** shield component costs from volatile NdFeB and Dy markets
- **SUPPLY CHAIN AUTONOMY:** 100% EU-based raw materials and processing
- **CORROSION RESISTANCE:** improve resistance to humidity and condensation
- **MAGNETIC STABILITY:** provide precise, low-torque control applications
- **COMPACT INTEGRATION:** enable actuator miniaturization without redesigning the motor assembly

PASSENGER'S MAGNET VALUE

MAGNET TYPE	COMPOSITION	KEY ADVANTAGES
MnAlC	Manganese–Aluminium–Carbon	Strong thermal and magnetic stability, suitable for miniaturized actuators
Sr-ferrite	Strontium Ferrite	Cost-efficient, corrosion resistant, robust under varying ambient conditions

COST & SUPPLY CHAIN BENEFITS

PASSENGER's magnet portfolio offers a cost-stable and scalable alternative to NdFeB magnets, eliminating dependence on Critical Raw Materials (Nd, Dy), ensuring low supply risk and strengthening European industrial resilience.

NdFeB	MnAlC	Sr-ferrite
€ 70-150/kg	€ 20/kg	€ 6/kg
High, volatile cost CRM dependent	EU-sourced Cost stable	EU-sourced Cost stable

REVENUE ESTIMATE (based on conservative EU market adoption scenarios)

MnAlC magnets	~€1.2.-1.6 million/year	Sr-FERRITE magnets	~€0.4-0.5 million/year

Sustainability

PASSENGER magnets in automotive systems help Europe achieve sustainability and industrial resilience by lowering reliance on imported CRMs and promoting circular, eco-friendly production.

LIFECYCLE SUSTAINABILITY BENEFITS OF PASSENGER MAGNETS

Green fabrication

Avoidance of harsh chemical processing of NdFeB magnets, reducing hazardous waste in manufacturing.

Sustainable lifecycle design

With a simplified composition, PASSENGER magnets enhance repair and sustainable remanufacture.

Climate friendly performance

Research indicates up to 80% lower CO_2 footprint with MnAlC magnets and up to 90% reduction with Sr-ferrite compared to conventional NdFeB.

CLOSED-LOOP ECONOMY IN AUTOMOTIVE UTILITIES

Headlamp systems offer distinct advantages with integrating advanced magnets:

PASSENGER magnets:
Support modular replacement of components without risk of contamination
Enable safe and clean end-of-life disassembly
Allow future closed-loop recovery of magnets

STRATEGIC ALIGNMENT WITH EU PRIORITIES

PASSENGER supports the EU's long-term strategic goals by enabling safer, more resource-efficient production. Through CRM substitution and simplified material design, it helps manufacturers comply with emerging EU sustainability frameworks.

EU POLICY CONTEXT		PASSENGER MAGNETS
European Green Deal	⇨	Lower CO_2 footprint in actuator production and support sustainable automotive supply chains
Critical Raw Materials (CRM) Strategy	⇨	Replace NdFeB magnets, reducing EU dependence on rare-earth imports and strengthening industrial sovereignty
Circular Economy Action Plan	⇨	Promote repair, reuse, recycling; extend material lifecycles
Sustainable Product Initiative	⇨	Support durable, repairable, and maintainable designs for automotive applications
Horizon Europe & EU Industrial Strategy	⇨	Promote innovation, advanced manufacturing, technological sovereignty by offering competitive magnet technologies for high-performance systems

The PASSENGER Advantage

PASSENGER magnets represent a **viable, scalable and environmentally responsible European alternative** to NdFeB in automotive headlamp actuator systems. By combining technical performance, cost stability, and supply chain independence, they support sustainable electrification and reinforce the competitiveness of Europe's automotive industry.

Engineered for **seamless integration** into existing systems, PASSENGER magnets enable easy industrial adoption while advancing the EU's objectives for **resilient, low-emission, and resource-efficient vehicle production**.

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More information

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