4th ASECAP SUSTAINABILITY FORUM

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Harnessing Roadside Potential: Integrated Photovoltaic Safety Barriers as a sustainable solution

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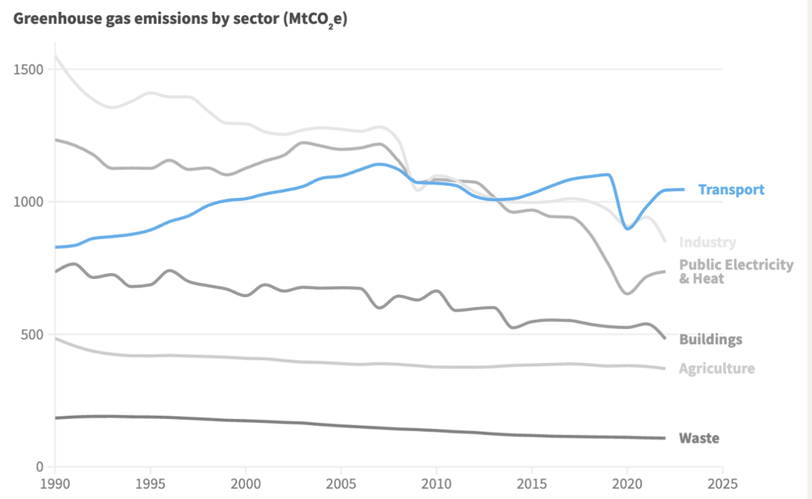
The Challenge

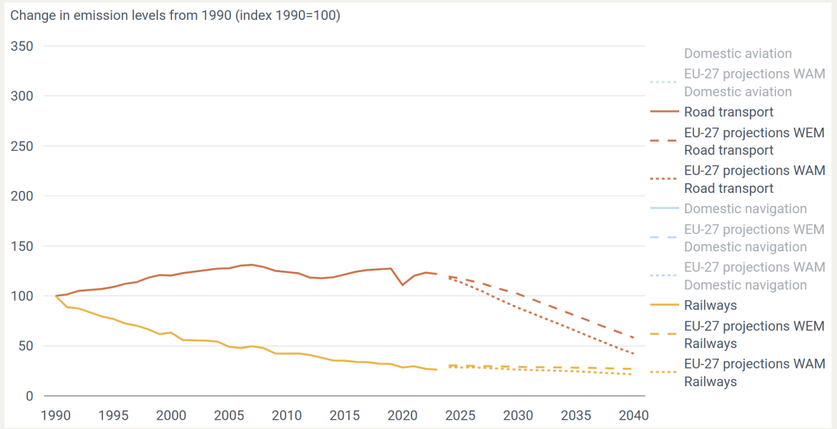
- **Transport infrastructures have a massive lifecycle footprint**, with high CO_2 emissions, intensive use of raw materials, and substantial waste across construction, operation, maintenance, and end-of-life.

- Current practices follow a **linear model** (build → use → discard), **lacking** a **systemic adoption** of **circular economy**, sustainable materials, and digital lifecycle-wide management.

- **Europe faces** a **deployment gap**: innovative green technologies exist, but they are **not** yet **integrated**, **standardized**, or **validated** at **scale** in real transport infrastructure.



*The transport sector accounts for about **25% of all EU greenhouse-gas (GHG) emissions***
(Source: European Environment Agency)



*Road transport generates about **73 % of total GHG emissions from transport within the EU &** Emissions from transport have declined only marginally since 2005*
(Source: European Environment Agency)

LIAISON in a nutshell (1/2)

- **LIAISON**: ***L****owering transport env****I****ronment****AI*** *Impact along the whole life cycle of the future tran****S****p****O****rt i****N****frastructure*
- Objective
  - to provide **knowledge** and **technical solutions** to significantly **reduce emissions** and **environmental impact** from transport infrastructures (roads & railways), throughout their **entire life-cycle** — from design and construction, through operation and maintenance, to decommissioning.

- **15** partner
- **6** EU countries
- Budget: **~5.8M€**, ~ 5M€ funded by CINEA
- Start Date: 1 May 2023
- End Date: 30 April 2026

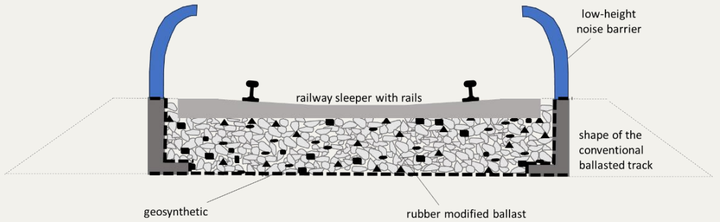
LIAISON in a nutshell (2/2)

- LIAISON is **developing and demonstrating innovative technical solutions** — e.g. “smart & sustainable beams”, rigid road pavements, improved ballast, bio-asphalts, smart pavement inspection systems, intelligent tunnel-control systems, photovoltaic guardrails — with the goal **to lower material consumption, reduce carbon footprint, optimize energy use** (potentially making infrastructures energy-prosumers), and **extend infrastructure lifespan**.
- ASPI will provide an area to test and validate the Photovoltaic guardrail in order to effectively use this kind of barrier.

- Through **demonstration in real “demo-sites” across several European countries** (roads & rail), LIAISON seeks to show that **sustainable, circular transport infrastructures are technically and economically viable** — paving the way for wider adoption across the EU.

- Smart precast concrete pavement with geopolymers, in Toledo (Spain)
- Pedestrian bridge with smart concrete beams, in Toledo (Spain)
- Bio-asphalt pavement, in Cantabria

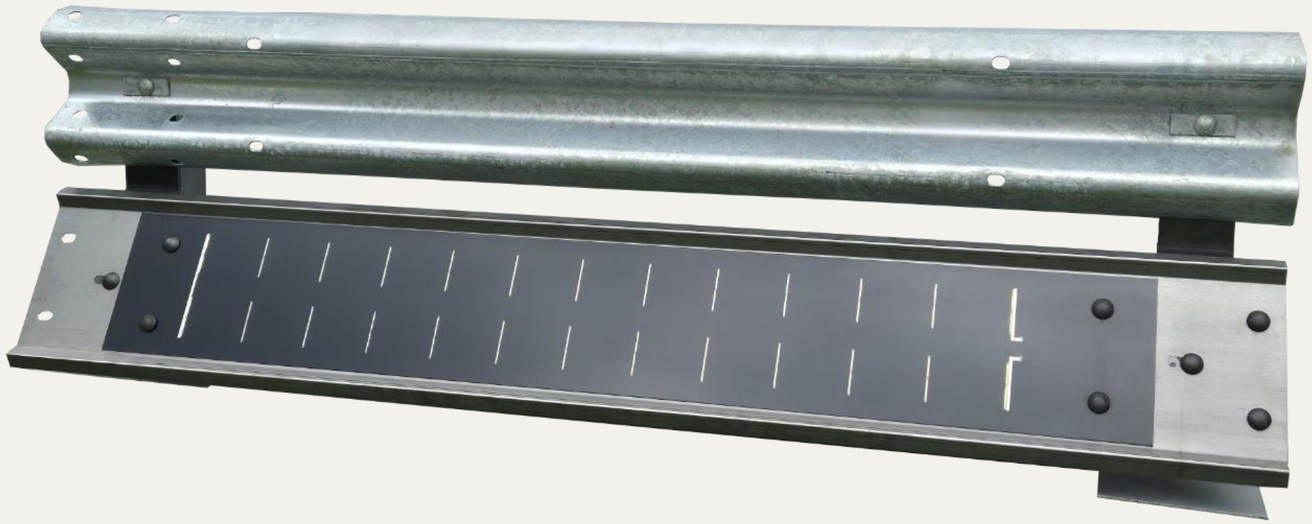
- Ballasted track railways in Slovenia



- Photovoltaic Safety Barrier

The Concept: PV barriers

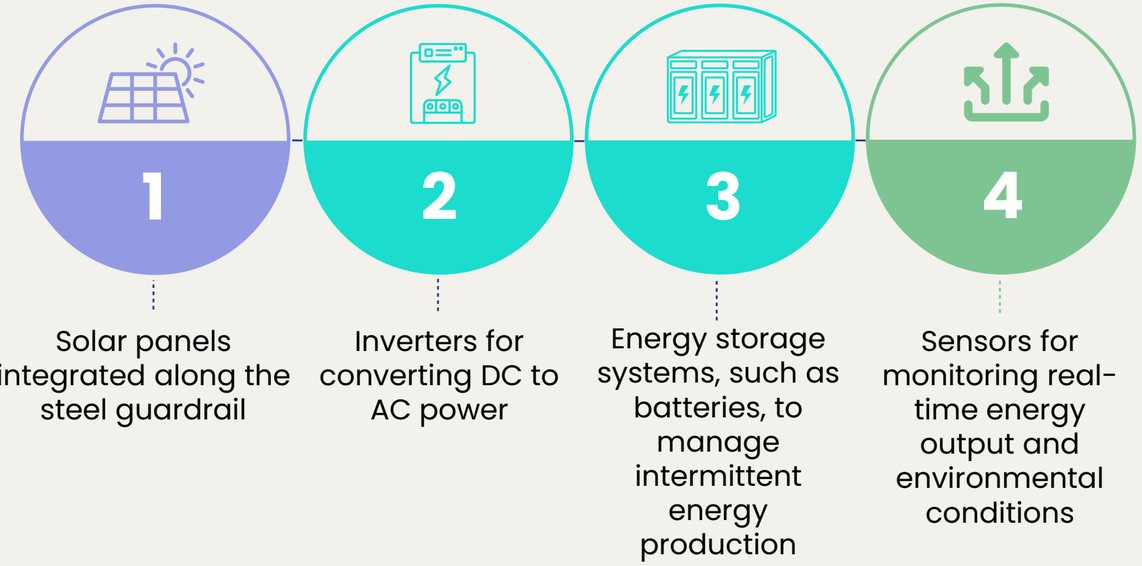
- Enhance road safety by absorbing impact energy and incorporating protection for vulnerable road users such as motorcyclists.
- Harvest solar energy for use in roadside infrastructure and grid integration.
- Be scalable and adaptable for different road environments and climates.



- Material: GFRP (glass fiber reinforced composite)
- Dimensions: 1920 x 280 mm x mm
- Module area: 0,54 m^2
- Solar cells technology: Back-Contact, MAXEON 3, SUNPOWER
- N° of cells: 24
- Thickness: around 1 mm
- Weight: 1,3 Kg (2,5 Kg/m^2)
- Nominal output power: 80 W

System Architecture and components

- The PV Guardrail System consists of:



KPI 1
SAFETY PERFORMANCE

KPI 2
STRUCTURAL INTEGRITY

KPI 3
ENERGY GENERATION

KPI 4
ENVIRONMENTAL IMPACT AND SUSTAINABILITY

KPI 1 – SAFETY PERFORMANCE

Key Metric

- Impact Absorption and Energy Dissipation – measuring the guardrail's ability to absorb impact energy during collisions.

Objective

- Ensure the system meets or exceeds existing safety standards for motorcyclists and vehicles

Data Collected

- Based on simulations and real-world testing under controlled conditions.

Materials Used

- Integration of LED lights for better night visibility and hazard detection sensors.

KPI 2 – STRUCTURAL INTEGRITY

Key Metric

- Deformation and Durability – tracking guardrail deformation after impact and material integrity over time.

Objective

- Ensure long-term durability under environmental stresses and impact conditions.

Data Collected

- Stress and strain measurements on structural components.

Materials Used

- High-strength steel, composite materials, and corrosion-resistant coatings.

KPI 3 – ENERGY GENERATION

Key Metric

- Performance Ratio (PR) – the ratio of actual energy output to theoretical energy output based on available sunlight.

Objective

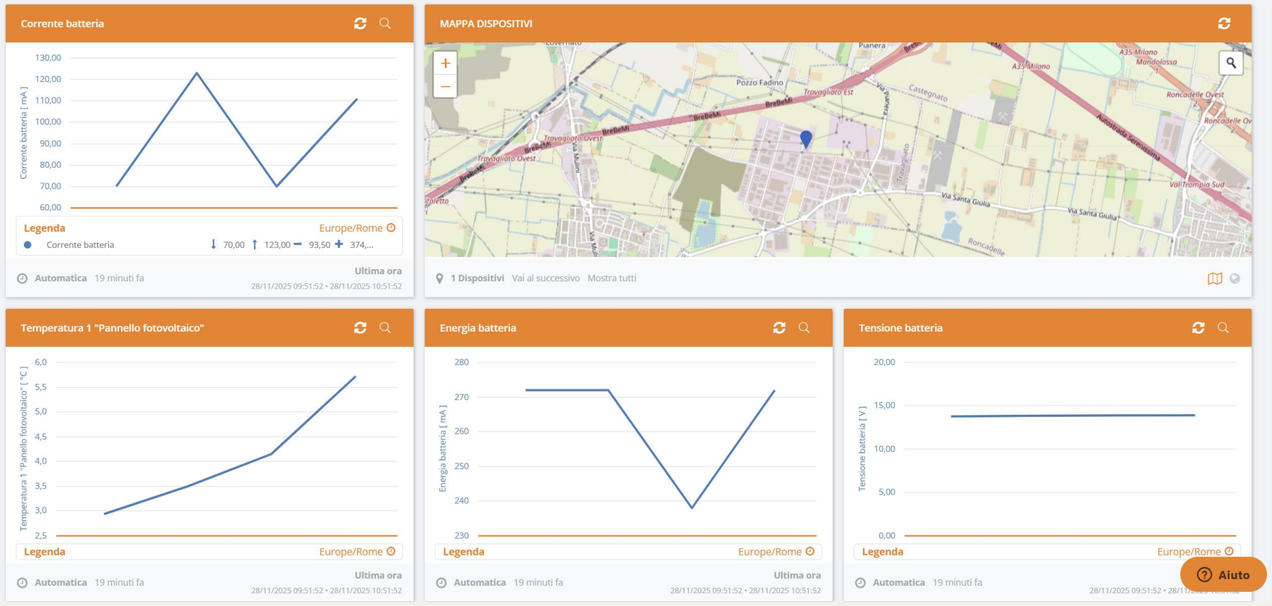
- Quantify energy generation by optimizing the placement and orientation of the PV equipped guardrails.

Data Collected

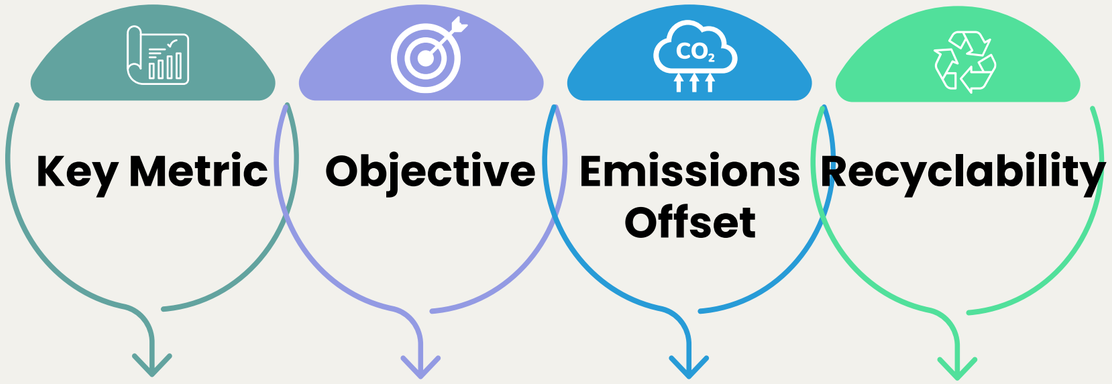
- Daily, monthly, and annual energy production

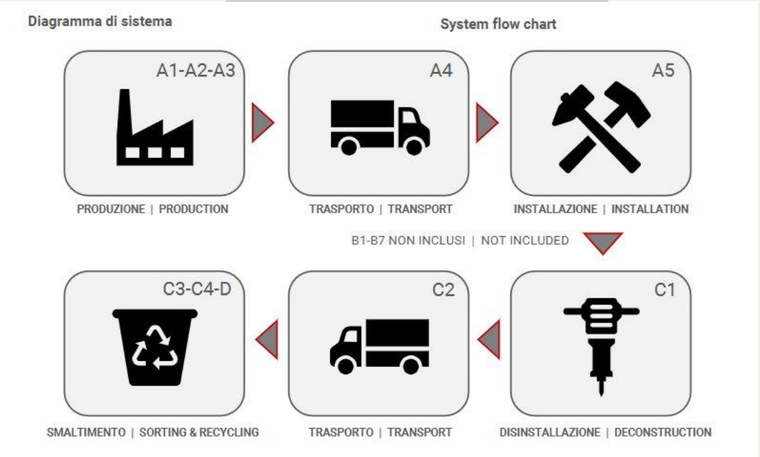
Materials Used

- Inverters and microinverters monitor real-time output.



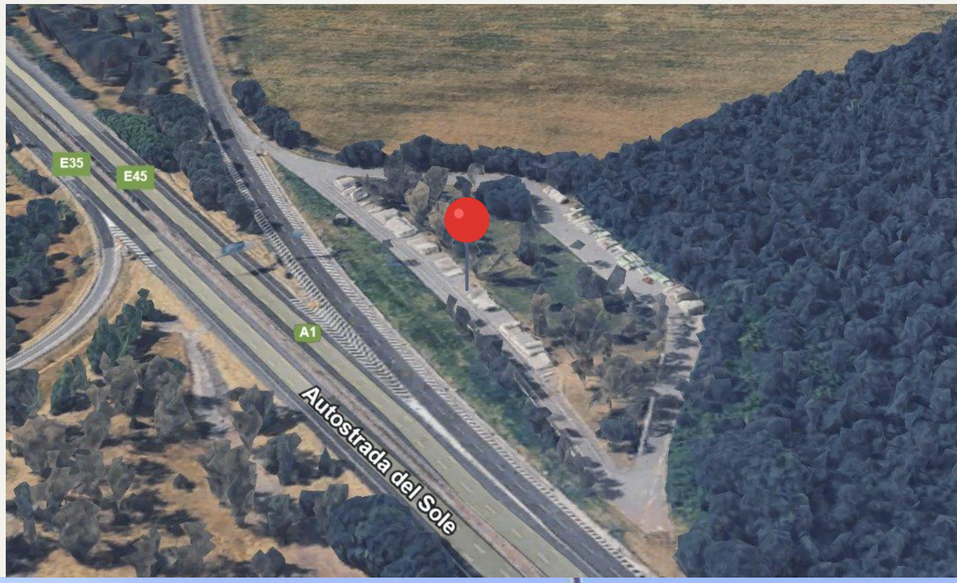
KPI 4 – Environmental Impact and Sustainability





ASPI Application

A1 Diramazione Roma Nord



Details

- Partially closed area near the carriageway
- Area size: length of over 200 meters
- The Photovoltaic Guardrail is now ready for final demonstration within an ASPI testing area

Link 42°09'57.9"N 12°36'52.0"E

Takeaways

- **Transport infrastructure** is a major source of **environmental impact** — not just from vehicles, but also through the **materials, construction, maintenance**, and **waste associated with roads/railways**.

- By **rethinking the infrastructure life-cycle** with **sustainability** and **circular economy** in mind, **LIAISON** intends to **contribute to EU climate targets** and cleaner, more sustainable mobility for decades to come.

- By embedding **innovation & sustainability** into every phase of infrastructure development, **Road Operators can accelerate progress** toward EU **climate targets**, enhance **resilience**, and **position** themselves as **leaders** in the transition to **sustainable mobility**.

THANK YOU

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