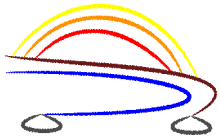
CAPSTONE PROJECT: Helianthus – Solar-Powered Lightweight Rail System



Proponente: ISTrain – Núcleo de Estudantes

Challenge:

Railway vehicles are traditionally propelled by diesel engines or powered electrically. Currently, most electric rail vehicles collect energy from overhead catenary systems, requiring expensive infrastructure. However, the rail industry is increasingly exploring alternative energy sources, such as hydrogen fuel cells, to diversify and decarbonize propulsion systems. Research and development of these alternative energy solutions are crucial for advancing the rail sector, ensuring it remains a sustainable mode of transportation, as outlined in the agenda published by the European Railway Research Agenda Council (ERRAC).

The development of solar-powered rail vehicles remains sporadic on a global scale. Hungary pioneered the concept with a tram operating at speeds of up to 25 km/h, while Australia introduced a full-scale solar-powered train capable of reaching 50 km/h. These projects serve as proof-of-concept demonstrations, integrating energy from solar panels and regenerative braking, supplemented by station-based solar arrays. However, neither initiative has advanced to the industrialization stage.

This CAPSTONE project addresses key challenges in promoting the widespread adoption of solar-powered rail vehicles. These challenges include designing advanced solar panel systems to optimize energy collection, improving energy storage and management capabilities, and integrating autonomous driving technology. The scaled vehicle, named Helianthus after the scientific name of the sunflower, aims to showcase cutting-edge technology that is both innovative for the rail industry and aesthetically appealing. By prioritizing user-friendly features, the project intends to encourage more people to choose public transport as their preferred mode of travel.

Advisory Team

DEM: Hugo Magalhães (Coordinator), Virgínia Infante, António Andrade, Frederico Francisco, Patrícia Baptista

DF: Horácio Fernandes

DEEC: João Fernandes, Alberto Vale

(Note: DEM - *Departamento Engenharia Mecânica*, DF - *Departamento de Física*, DEEC - *Departamento de Engenharia Eletrónica e de Computadores*)

Masters where this proposal is offered

MEMec (*Mestrado em Engenharia Mecânica*)

MEEC (*Mestrado em Engenharia Electrónica e de Computadores*)

MEFT (*Mestrado em Engenharia Física e Tecnológica*)

MEAmb (*Mestrado em Engenharia do Ambiente*)

Master thesis 1:

Optimal Structural Design of a Scaled Light Rail Vehicle

1 student from MEMec

Supervisors: Virgínia Infante and Hugo Magalhães

Master thesis 2:

Optimal Suspension Design of a Scaled Light Rail Vehicle

1 student from MEMec

Supervisors: Hugo Magalhães and Virgínia Infante

Master thesis 3:

Dedicated Solar Panel Mechanism Design for Rail Vehicles

1 student from MEMec or MEFT

Supervisors: Hugo Magalhães and Horácio Fernandes

Master thesis 4:

Propulsion System Design for Minimizing Wheel-Rail Damage

1 student from MEEC or MEMec

Supervisors: João Fernandes and Hugo Magalhães

Master thesis 5:

Regenerative Braking System Design for Solar-Powered Rail Vehicles

1 student from MEFT or MEEC

Supervisors: Horácio Fernandes and João Fernandes

Master thesis 6:

Energy Management of a Scaled Solar-Powered Rail Vehicles

1 student from MEMec or MEFT or MEAmb

Supervisors: Patrícia Batista and Horácio Fernandes

Master thesis 7:

Operational Autonomous Driving Design of a Solar-Powered Rail Vehicle

1 student from MEEC

Supervisors: Alberto Vale and João Fernandes

Master thesis 7:

Reliability Analysis of a Solar-Powered Rail Vehicle Service

1 student from MEMec or MEEC

Supervisors: António Andrade and Alberto Vale

Master thesis 8:

Aesthetic Design for Optimal Rail Passengers Seat Layout

1 student from MEMec

Supervisors: Frederico Francisco and Virgínia Infante