A Collaborative Effort

The MAXIMA project brings together a diverse consortium, including research teams, raw material suppliers, designer and manufacturer of electrical machine, car manufacturers, and a recycling company. This multidisciplinary approach enables the project to tackle technological and scientific challenges across electromagnetic, mechanical, and thermal fields accounting for the product life cycle. By combining expertise from various stakeholders, MAXIMA aims to deliver solutions that are close to market readiness.

MAXIMA's Goals: Powering a Sustainable Future

- **Designing two prototypes:** In the range of 60 kW - 120 kW*, adaptable to different markets and modular in concept.
- **Impressive power & torque densities:** Over 23 kW/litre, 7 kW/kg, 50 Nm/litre, and 20 Nm/kg for peak performance.
- **Reduced losses:** Targeting 20% reduction during vehicle operation for greater energy efficiency.
- **Resource optimization:** Aiming for 60% decrease in scarce resource utilization to minimize environmental impact*.
- **Energy consumption cut:** 2% reduction* through optimal electrical machine control during driving cycles.
- **Cost-effective mass production:** Unit cost below € 6/kW for 100 000 units per year, promoting EV adoption.
- **High recyclability:** Targeting over 60% recyclability* for Critical Raw Materials to conserve resources.
- **Ecodesign framework:** Outlining best practices to assess and reduce environmental impacts, fostering sustainability.

**Percentages with respect to automotive state of the art in 2020.*

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MAXIMA

Modular AXIal flux Motor for Automotive

The MAXIMA Project

The MAXIMA project aims to create a comprehensive methodology for designing and producing electrical machines tailored for the automotive core market. This methodology addresses diverse challenges, including efficiency, cost reduction, high power/torque density, and recyclability of critical raw materials. By focusing on the innovative Axial Flux Synchronous Machine (AFSM) topology, MAXIMA strives to unlock new opportunities and improve existing options in terms of topologies and materials.

Enhancing Performance and Cost

Currently, Axial Flux Synchronous Machines are known for their efficiency, but they remain limited to niche markets due to high manufacturing costs. The MAXIMA project will optimize the design and manufacturing/recycling processes to enhance the performance and cost-effectiveness of AFSM. This ambitious endeavor will pave the way for higher-performing and more affordable electrical machines while minimizing their environmental impact.

Benefits and Innovations

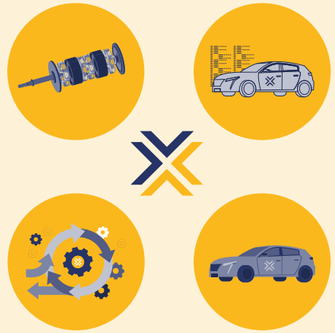
At the conclusion of the MAXIMA project, significant advancements will be realized. High TRL5 prototypes will be developed, showcasing the capabilities of AFSM technology. Moreover, the project will provide a validated methodology that accelerates electrical machines design, reducing time to market and fostering faster electric vehicles adoption. Additionally, cutting-edge technologies like digital twins will empower optimal operation, to optimize performance and efficiency.

Axial Flux Synchronous Machine

The goal of MAXIMA is to create an affordable and adaptable axial flux electric machine for the automotive industry that offers enhanced performance, incorporates strategies to reduce the use of critical rare earth metals, and has minimal environmental impact.

Life Cycle Assessment

The end-of-life considerations for the electrical machine, including the recycling of rare earth metals used in permanent magnets, will be thoroughly examined. The Life Cycle Assessment will be conducted to analyze the environmental impact of each solution throughout its entire life cycle. Recommendations for mitigating impacts across various environmental impact categories will be provided, with a primary focus on reducing impacts related to climate change and mineral resource scarcity.



Multiphysics and digital twin

To enhance performance, an innovative multiphysics design process will be employed, incorporating novel thermal management concepts. Furthermore, a Digital Twin will be constructed, to facilitate the development of an optimal control strategy for operating the electrical machine at its maximum potential. To minimize costs, the electrical machine and its manufacturing process flow will be jointly designed.

Prototype Manufacturing

Upon completion of the MAXIMA project, prototypes will be produced to conduct testing, assessment, and validation of the novel concepts explored in the project, including the modular design of the electrical machine, the optimal control based on Digital Twin, and the manufacturing/recycling process flow.

Work Packages (WP)

To facilitate achieving the different goals, the project activities are structured across 8 work packages.

01 **WP1 -** Project Management

02 **WP2 -** Requirements and specifications

03 **WP3 -** Electrical machine design

04 **WP4 -** Digital Twin for optimal control

05 **WP5 –** Magnetic Materials and Manufacturing/Recycling Processes for mass production

06 **WP6 -** Life cycle management

07 **WP7 -** Drive prototypes Assembly and Testing

08 **WP8 –** Communication, Dissemination & Exploitation