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VOLTCAR PROJECT NEWSLETTER

The VOLTCAR project continues to make strong progress as the consortium advances toward the final demonstration phase of its next-generation electric traction motor for passenger cars and light commercial vehicles. Building on earlier design and digitalisation milestones, the project has now entered a more advanced stage of prototype assembly, high-speed validation, thermal refinement, vibro-acoustic testing, and circularity implementation.

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VOLTCAR remains focused on delivering a **compact, highly efficient, digitally enabled, and circular traction motor solution** aligned with Europe's strategic ambitions for sustainable and competitive electric mobility. Recent achievements demonstrate that the project is successfully translating ambitious design targets into practical, industrially relevant validation results.

Progress towards the project objectives

Objective 1: Creation of highly compact and efficient VOLTCAR traction motors with reduced amount of rare materials for passenger cars and vans (nominal power 50–120 kW)

The VOLTCAR consortium has made significant progress in transforming its advanced motor concept into tangible prototypes. The project continues to target a highly compact and high-performance electric traction motor, with specific power above 7 kW/kg and power density above 23 kW/litre, while reducing dependence on rare earth permanent magnets and maintaining industrial feasibility.

Prototype Development Accelerates

- The 50-kW validation platform has progressed substantially, with two motors already ready, while work continues on the third and fourth assemblies.
- Testing of the 50-kW motors has begun, including back-to-back measurements and further work on cooling system requirements, providing valuable data for performance validation and thermal optimisation.
- The final 120-kW demonstrator continues to advance as the project moves toward full-system validation and demonstration.

Figure 1. Stator assembly of the VOLTCAR traction motor prototype, showing the laminated core and special directly liquid cooled hairpin windings.

High-Speed Compact Motor Concept Confirmed

VOLTCAR's final concept is based on a high-speed radial-flux machine designed for 800 V operation, direct liquid cooling, and integration with gearbox and inverter.

The target performance remains highly ambitious:

- 120 kW continuous power with 7 kW/kg specific power and minimal use of rare-earth materials
- Above 200 kW peak power with close to 12 kW/kg peak specific power
- 12,000 rpm rated speed
- 30,000 rpm maximum operating speed
- Tolerance up to 36,000 rpm during acceptance testing

This high-speed approach is central to achieving the project's compactness and power-density targets, enabling a smaller and lighter motor while maintaining the required output power.

Objective 2: Development of circular technologies for next generation electrical traction motors

Circularity remains at the heart of VOLTCAR's innovation strategy. The project continues to integrate ecodesign principles that reduce permanent magnet use while improving the potential for reuse, repurposing, recycling, and remanufacturing of motor materials across the lifecycle.

Circularity Built into the Motor Concept

The VOLTCAR ecodesign approach aims to reduce permanent magnet use while enabling more sustainable end-of-life strategies.
Current work focuses on:

- Direct reuse of magnets in existing or new motor designs
- Intact magnet removal with or without encapsulation
- Material recovery and remanufacturing, including blending with virgin material where required

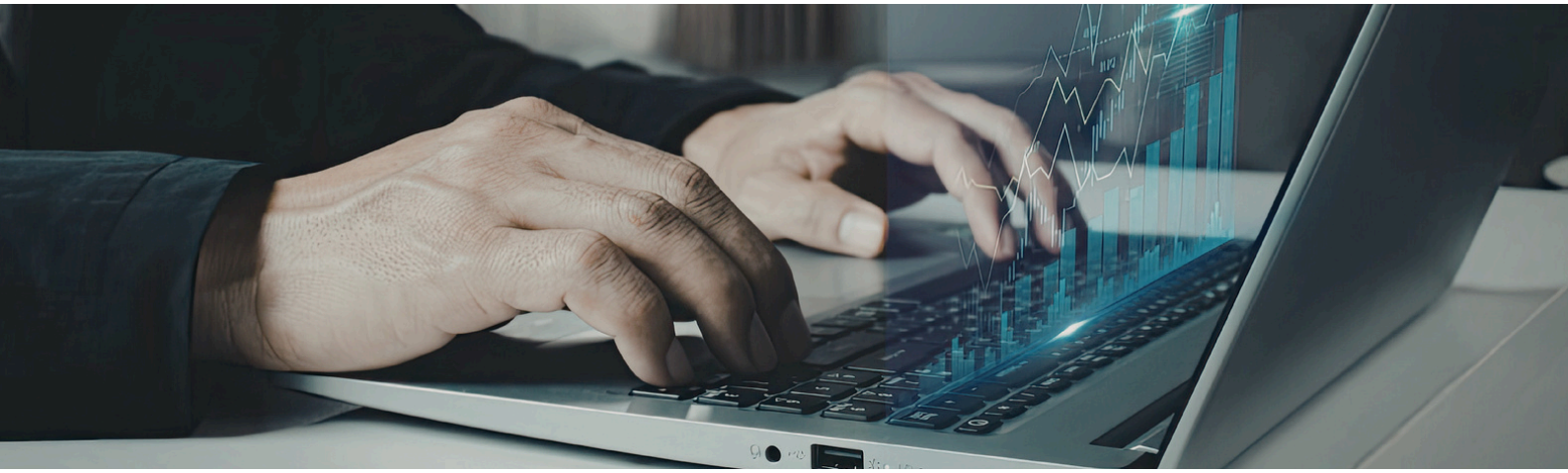
These approaches are designed to shorten recycling routes and maximise the value retained in rare-earth materials already embedded in existing drivetrains.

Lifecycle Perspective Strengthens Design Decisions

- VOLTCAR continues to apply Life Cycle Analysis (LCA) and Life Cycle Costing (LCC) to assess energy use, emissions, and cost impacts over the motor lifetime.
- These methods are helping the consortium quantify the sustainability benefits of material reduction and circularity strategies, while also supporting future industrial uptake.

Objective 3: Demonstration of a cost efficient, durable, over the life cycle digitalised motor

Digitalisation continues to play a key enabling role in VOLTCAR. The project's digital approach supports the full ecological lifecycle of the motor—from design and manufacturing through operation, validation, and dismantling—ensuring that physical development is tightly connected to data-driven optimisation.



Digital Thread Supports Full Lifecycle Understanding

The project's Digital Threads (DThs) remain a foundational part of the VOLTCAR concept. These interconnected digital structures describe the complete ecological lifecycle of the motor, including:

- Production and assembly
- Operational behaviour
- Integration with vehicle, battery, gearbox, and inverter
- Dismantling and end-of-life considerations

This enables more realistic simulation of motor behaviour and supports better lifecycle-informed design decisions.

Physical and Digital Validation Continue to Converge

Experimental data from testing activities is being used to improve simulation fidelity and strengthen the connection between measured behaviour and predictive modelling.

The project's digital tools support:

- Faster design optimisation
- Reduced development effort
- Improved confidence in scaling toward industrial demonstration
- Better integration between design, testing, and lifecycle sustainability assessment

VOLTCAR's digitalisation approach remains a strong differentiator, ensuring that the motor is not only efficient and compact, but also robustly engineered across its entire lifecycle.

Objective 4: Comprehensive testing and validation of VOLTCAR traction motors and systems according to automotive standards with advanced and virtual testing methodologies

VOLTCAR has now entered one of its most important phases: practical validation of prototypes and critical subsystems. Recent achievements show strong progress in confirming the feasibility of the high-speed motor concept under demanding conditions.

Major Milestone: Successful Rotor Spin Testing

One of the project's most significant recent milestones is the successful completion of rotor spin tests for both the 50-kW and 120-kW motor prototypes.

The spin test campaign included:

- Up to 20,000 cycles
- Approximately 350 hours of testing
- Rotational speeds ranging from 5,000 rpm to 36,000 rpm

Both rotor designs successfully passed the tests, confirming the mechanical robustness of the high-speed concept and representing a major step toward industrial validation.

Thermal Management Refinement

Achieving high specific power in such a compact motor requires highly effective cooling. VOLTCAR continues to refine its direct oil cooling strategy, targeting stator conductors, hollow rotor shaft, and bearings.

The external cooling circuit has also been improved, moving from simplified design assumptions to more realistic **component-based configurations** and evaluation of multiple circuit layouts.

Vibro-Acoustic Validation Strengthens Durability Confidence

The consortium has carried out modal and vibro-acoustic measurements on the stator with and without windings to better understand structural dynamics, noise behaviour, and durability.

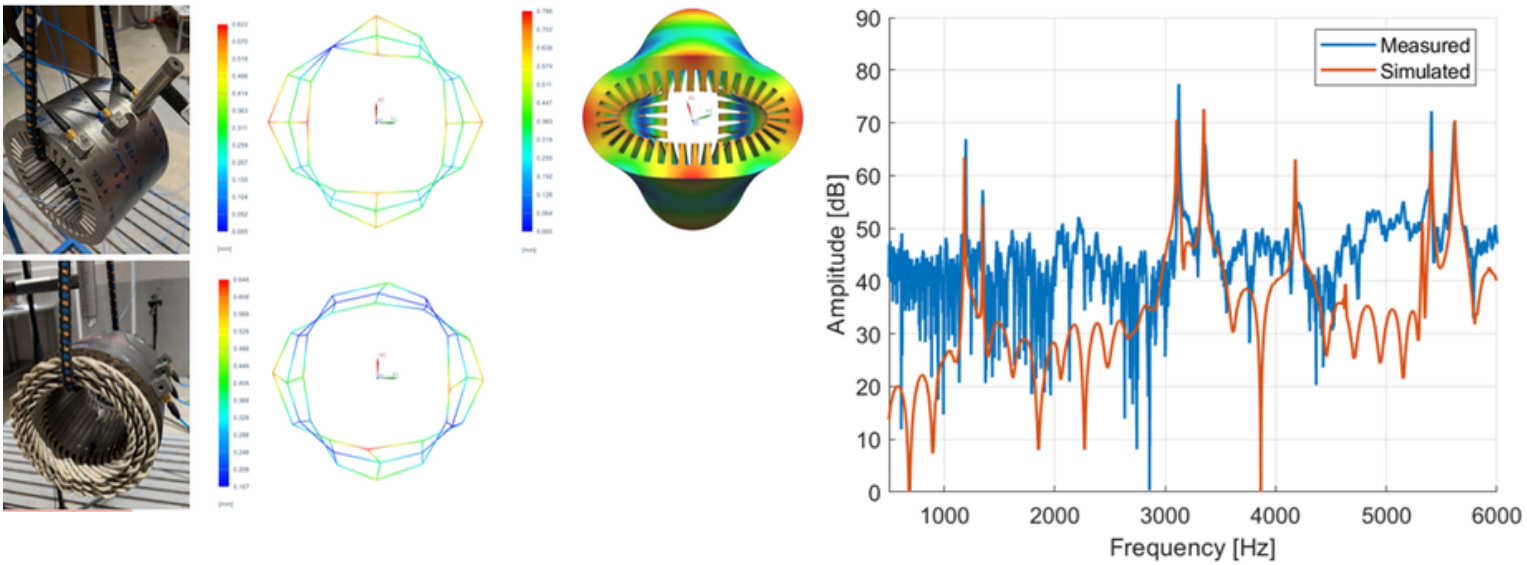


Figure 2. (left) modal analysis of the VOLTCAR stator with and without windings, with updated finite element model of the stator without windings, and (right) vibro-acoustic validation of the stator finite element model without windings.

From Design to Demonstration: A High-Speed Circular Motor Becoming Reality

A key strength of VOLTCAR is the way it integrates advanced motor design, practical testing, digital lifecycle engineering, and circularity strategies into one coherent development pathway.

This integrated development cycle is helping VOLTCAR move steadily toward a final demonstrator that is not only technically ambitious, but also aligned with the real needs of future EV manufacturing in Europe.

Strengthening Europe's Position in Electric Mobility

VOLTCAR continues to address one of the most important trade-offs in future electric mobility: how to combine low mass, high efficiency, reduced dependence on critical raw materials, manufacturability, and circularity in one traction motor platform.

Recent project outputs show strong potential impact:

- Standardised LCA approaches for traction motors
- Practical circularity strategies for magnet reuse and recycling
- Development and testing of two motor designs and one inverter
- Digital motor-design tools that reduce development effort
- Estimated 74 kg CO_2eq reduction per motor unit
- Potential cumulative impact of approximately 582 tonnes CO_2eq by 2030 under mass-production conditions

By addressing efficiency, sustainability, and supply-chain resilience together, VOLTCAR is contributing to Europe's technological leadership in next-generation electric propulsion systems.

Further updates will follow as the project progresses toward its final demonstration phase.

VOLTCAR Consortium

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About KU Leuven

KU Leuven is a research-intensive and internationally-oriented university that performs both fundamental and applied scientific research. KU Leuven was founded in 1425 and now is one of Europe's oldest universities.
Within the VOLTCAR project, KU Leuven is represented by its Mecha(tro)nic System Dynamics (LMSD) research group. LMSD aims at creating added value during every phase (design - manufacturing - operations) in the lifetime of mecha(tro)nic systems by understanding, monitoring and controlling their dynamic (motion-vibration-acoustics) behaviour.

To this end, the research conducted at LMSD spans a broad spectrum from methodologies, over theoretical foundations, to various application domains.
The KU Leuven Mecha(tro)nic System Dynamics research group strives for international leadership in engineering dynamics through excellent research, education and services; building upon an expertise of five decades and with the Digital Twin concept playing a central role in its roadmap. Dynamic behaviour models, validated and enriched with dynamic measurement data, allow for a continuously updated virtual replica of a structure or system.

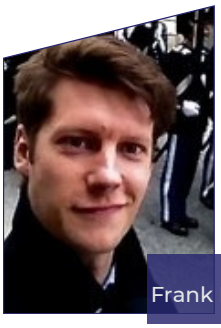
Website: www.kuleuven.be and www.mech.kuleuven.be/lmsd

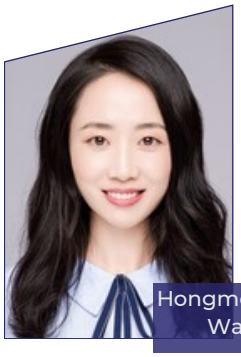
Role in the project

Within VOLTCAR, KU Leuven LMSD focuses on modelling and testing of the dynamic (noise, vibration, NVH) behaviour of the E-motor and its mechanical components. LMSD will exploit its expertise in drivetrain multi-physical modelling, including flexible multibody and contact modelling, virtual sensing, and structural dynamic and vibro-acoustic testing of component and full systems.

KU LEUVEN

TEAM


Dr. ir. Frank Naets


Hongmei Wan


Dr. ir. Fabio Di Giusto


Dr. ir. Lucas Van Belle


Dr. ir. Bert Pluymer

About the KU Leuven team:

Prof. Dr. ir. Frank Naets, Senior researcher, assistant professor, Virtual Sensing, Model Reduction, Numerical Mechanical Simulation, Vehicle Dynamics

Hongmei Wang, PhD candidate, Gear transmission, dynamic simulation and gear vibration analysis

Dr. ir. Fabio Di Giusto, Postdoctoral researcher Acoustics, auralization and spatial audio, vibro-acoustic modeling and testing

Dr. ir. Lucas Van Belle, Senior postdoctoral researcher, Project lead. Vibro-acoustic modeling, analysis and design, advanced noise and vibration solutions, finite element analysis

Dr. ir. Bert Pluymers, Industrial research manager, Dynamics 4.0

What is KU Leuven LMSD's vision on Mecha(tro)nic System Dynamics?

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What will be the role of your organisation in the project?

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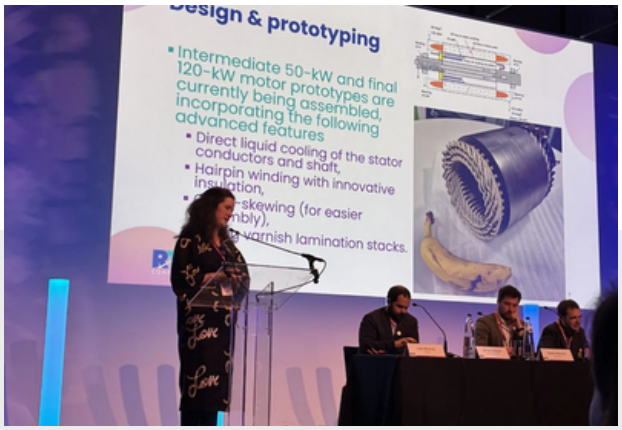
Dissemination Communication and Networking

RTR Conference 2026

The VOLTCAR project coordinator, Jenni Pippuri-Mäkeläinen had the opportunity to present the project on the first day of the conference (February 10th), in a parallel session by 2Zero, along with EM-TECH and HEFT projects.

The presentation highlighted the project's progress toward a high-speed, circular traction motor and reinforced VOLTCAR's role within Europe's research landscape for sustainable e-mobility.



E-VOLVE Cluster Collaboration

VOLTCAR continues to collaborate with other European projects through the E-VOLVE Cluster, strengthening synergies around efficient, low-cost, and sustainable e-mobility technologies.
As noted in the project's impact activities, VOLTCAR continues to pursue joint actions and coordinated dissemination with peer projects to maximise exploitation potential and accelerate industrial uptake.

VOLTCAR Face-to-Face Consortium Meeting – Lappeenranta, Finland

The VOLTCAR face-to-face consortium meeting took place on Tuesday 3 March – Wednesday 4 March in Lappeenranta, Finland.

The meeting gave project partners the opportunity to see the first motor prototypes demonstrated, review the latest technical progress, and exchange information across the project's different work packages.

VOLTCAR

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