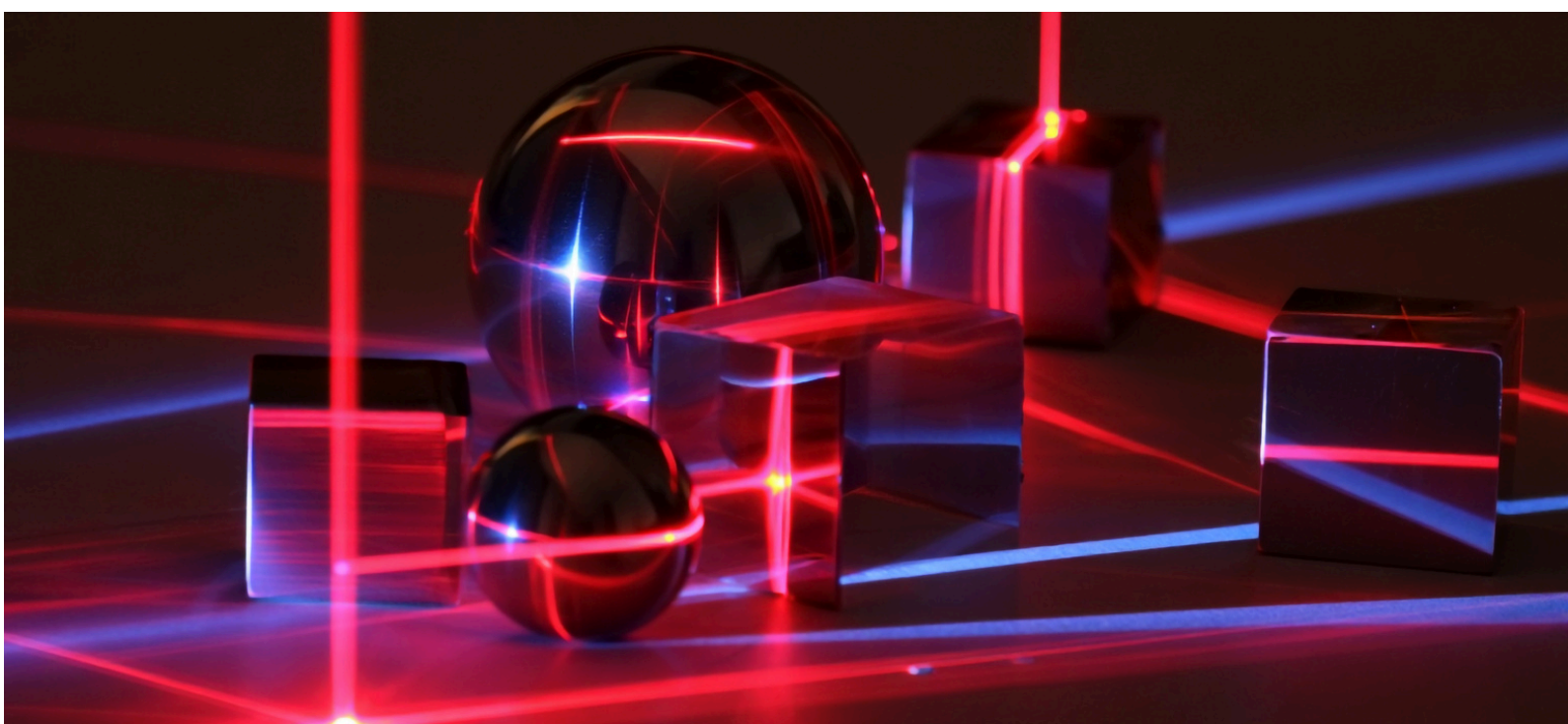


MagNEO

PROJECT NEWSLETTER

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Europe is entering a decisive phase in its transition to renewable energy and sustainable mobility, as outlined in the European Green Deal, Fit-for-55, and REPowerEU. Technological and socioeconomical aspects in application fields such as wind turbines, ship propulsion systems, heat pumps, and electric vehicles are central to this new energy landscape, yet at their core lies a strategic vulnerability: the permanent magnet.

Towards Sustainable, REE-Free Permanent Magnet Technologies

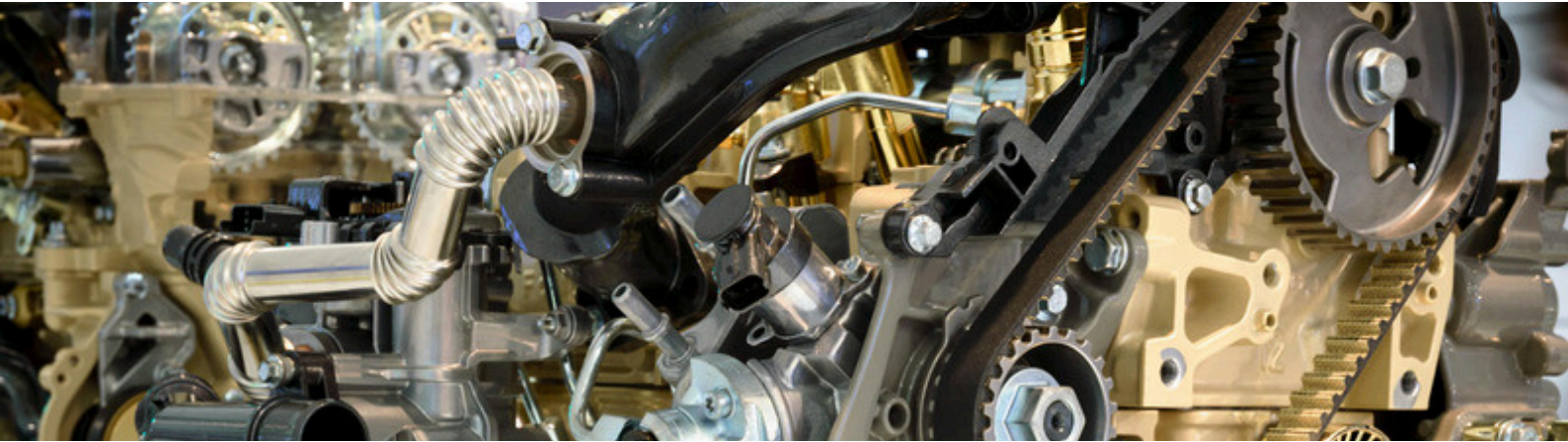
Today, over 98% of rare-earth-element (REE) based magnets are produced in China, creating a critical supply-chain dependency that risks Europe's industrial resilience and technological sovereignty.

MagNEO addresses this challenge by developing high-performance, REE-free permanent magnets based on novel AlNiCo compositions that outperform current materials of the same family. By combining multiscale modelling, machine learning, and high-throughput synthesis, the project accelerates alloy design and establishes processing routes aiming at delivering magnets with $(BH)_{\max}$ above 60 kJ/m^3 while reducing cobalt content.

Sustainability is central to MagNEO: recycling strategies will recover critical metals and extend magnet lifetimes, supporting EU circular economy objectives. The project's outcomes will be validated in end-user demonstrators, including low-speed generators, high-speed rotors, and automotive ABS sensors and headlight systems. By enabling REE-free magnets at TRL 6, MagNEO aims at enhancing Europe's industrial autonomy, reducing import dependence, and unlocking market opportunities estimated at €6.5 billion by 2030, while ensuring adoption aligns with societal and environmental expectations.



18 Months of MagNEO



During the first 18 months, the project **advanced across alloy development, powder production, additive manufacturing (AM), modelling, application analysis, and sustainability work.**



A multiscale methodology was developed to identify AlNiCo-based compositions and microstructures with tailored micro and nanoscale geometries, enhancing magnetic anisotropy.



High-throughput arc melting synthesis was combined with advanced characterization (SEM, TEM, X-ray dispersive spectroscopy, micro/nano electron diffraction) and modelling at quantum mechanical, micromagnetic, thermodynamic, and microstructural levels. This approach enabled the study of numerous arc-melted alloys and revealed several promising compositions with Co contents below 24 wt%, now under experimental validation. Cracking issues in AM were also investigated.



Modelling supported powder atomization, AM microstructure evolution, and electric machine behaviour. Simulations guided the design of a new atomizer nozzle, identified parameters affecting powder quality, and defined critical LPBF conditions.



System-level simulations assessed how material properties and geometries influence generator and motor performance.



AlNiCo 5, AlNiCo 8, and modified alloys were successfully atomized, and LPBF processing windows achieving 95–98% density were established, though cracking persists.



Initial thermomagnetic treatments (TMT) on LPBF samples highlighted the need for further optimization.



WP4 advanced recycling by identifying waste streams and sourcing end-of-life (EoL) AlNiCo magnets. These were crushed and compounded with polymer matrices to produce filaments and granulates for FFF and FGF, achieving high loading fractions of 70% and 82%.



Selective recovery of critical metals from EoL magnets and other waste streams is planned.



Sustainability and socio-technical activities began in Month 12.



A state-of-the-art assessment of environmental and cost impacts was completed, LCA/LCC data collection is ongoing, and socio-technical analysis progressed through literature review, protocol development, and initial interviews.



Application-oriented work defined magnet requirements for key industrial cases. End-user data-enabled specifications for a MW class shaft generator, a high-speed motor for heat pumps, and a claw stepper motor for automotive lighting.



Technical data collection and comparative model analysis identified the required magnetic properties and produced complete technical descriptions.

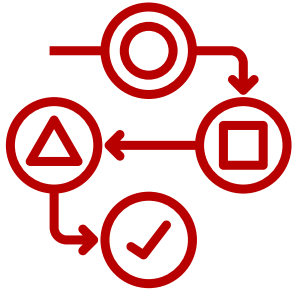


Representative machine models were established to guide upcoming validation and optimization.

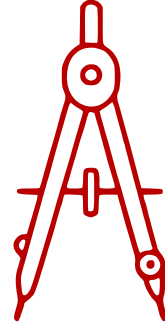
Overall, the project has built a strong technical foundation across synthesis, modelling, powder production, AM, recycling, and application analysis, preparing the next phase focused on composition refinement, improved LPBF routes, and system-level validation.

Strong Foundations and Early Advances

The first 18 months have built a solid foundation, with early results confirming the potential of the project's technological directions.



A methodology combining theoretical work and characterization in WP1 shows a promising path toward higher-performance AlNiCo magnets with reduced Co content, supporting rare-earth-free solutions.



Modelling in WP1–WP2 delivered major advances, including a conical nozzle design, predictive AM frameworks, and system-level analysis tools for electric machines.

These results guide the next phases and will benefit from experimental validation, broader datasets, and industrial input.



Activities in powder production, AM, recycling, and sustainability are progressing steadily. **WP3** is preparing upcoming AM and recyclability experiments, while **WP4** has completed an initial literature-based environmental assessment, informing later LCA/LCC work. **WP5** has defined technical specifications, identified current limitations, and outlined improvement actions to ensure alignment with industrial needs.

Overall, early achievements show strong experimental and modelling progress and position the project well for the next stage, where continued research, demonstration activities, and industrial engagement will be key to achieving broader impact.

MagNEO

Consortium

MagNEO consortium is an intersectoral team of 16 partners from 10 different European countries and has a team of professionals including research organisations, technology providers, manufacturing companies, and universities, standardization specialists and experts for skill development, communication, dissemination and exploitation.



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About VTT

VTT is one of Europe's leading research institutions. It is owned by the Finnish state. They advance the utilisation and commercialisation of research and technology in commerce and society. Through scientific and technological means, they turn large global challenges into sustainable growth for businesses and society. They bring together people, business, science and technology to solve the biggest challenges of our time. This is how they create sustainable growth, jobs and wellbeing and bring exponential hope. Their role in MagNEO is the development of additive manufacturing (AM) AlNiCo and HEA based hard magnets, AM and post-AM heat-treatment development, activities on multiscale modelling, advanced characterization, high throughput synthesis.



Interview with Atte Antikainen of VTT



Atte Antikainen

Senior Scientist at VTT

Expert in alloy development, metallurgical thermodynamics and additive manufacturing

In which areas will MagNEO go beyond the state of the art and make contributions to scientific developments?

MagNEO dives deep into spinodal decomposition and other phase transformations of additively manufactured rare-earth-free magnetic alloys to optimize their performance and processability.

Why is the MagNEO project timely, relevant and important?

MagNEO aims to optimize the performance of AlNiCo's and HEA magnets without rare-earth elements through alloy design and manufacturing.

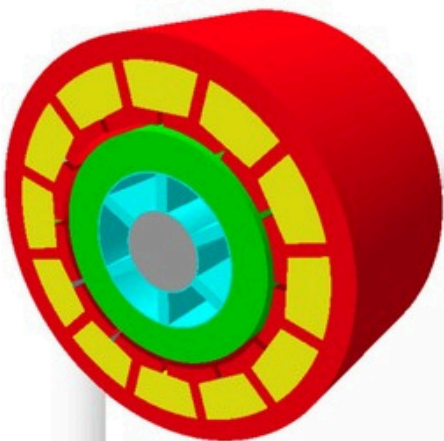
How does your expertise and research work connect to MagNEO?

Experience in additive manufacturing and Calphad is a good fit for optimizing magnetic performance and processability via alloy design.



About 3D-Components AS

Founded and bred in Oslo, Norway, 3D-Components AS has been developing since March 2015. They have been engaged in many activities to have their unique technology established and promoted. Additive manufacturing (AM) is a technological field that requires knowledge from many engineering disciplines such as robotics, materials science, computer and cybernetic sciences, mechanical engineering, and many more. That is how their cross-disciplinary team got together to make it happen. Their role in MagNEO is on activities on the modelling of the magnetic properties and system level design of the permanent magnet drives.



Interview with Dr. Amin Azar of 3D-Components AS



Dr. Amin Azar

CEO of 3D-Components AS

Expert in additive manufacturing technologies

How does your expertise and research work connect to MagNEO?

At 3D-Components AS, we are contributing to MagNEO by leading various modelling activities, including powder atomization, AM processes, microstructural and PM drive system modelling. Our aim is to understand how material properties and microstructure of the additively manufactured magnets affect machine performance. This work is crucial for optimizing magnets for applications in wind turbines, ship propulsion, and automotive systems.

How will the MagNEO project contribute to making Europe more sustainable?

MagNEO will establish a European capability to produce novel REE-free permanent magnets and process them through innovative additive manufacturing technologies, supporting wind turbines, electric vehicles, and heat pumps. Our technology will enable sustainable, cost-effective solutions for Europe's growing electrification needs.

Why is the MagNEO project timely, relevant and important?

MagNEO addresses Europe's critical need to reduce dependency on import of rare earth elements for permanent magnets. With demand set to triple by 2040, our project develops sustainable REE-free magnets using innovative additive manufacturing, supporting EU's green transition and industrial sovereignty.

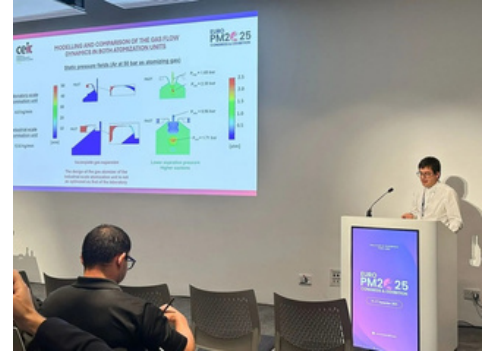
In which areas will MagNEO go beyond the state of the art and make contributions to scientific developments?

MagNEO aims to advance the field of materials science by developing innovative routes for crafting REE-free permanent magnets. The project will explore processing techniques, including additive manufacturing of AlNiCo and High Entropy Alloys, complemented by machine learning to enhance magnetic properties and achieve precise microstructure control. Additionally, MagNEO seeks to establish sustainable recycling strategies to support environmental conservation.

News & Activities

EURO PM2025

The EURO PM2025 congress took place on 14-17 September in Glasgow, Scotland. The MagNEO project attended the event and was represented there by Ernesto Urionabarrenetxea of CEIT, who presented his work “From Laboratory To Industrial-scale Gas Atomization Process: Experimental Results, Numerical Modelling And Lessons Learned In The Pursuit Of Higher Productivity”. This research is part of the MagNEO Project and showcases experimental and numerical results obtained with the industrial-scale atomization unit.



Magnetic Material Modelling workshop

The Magnetic Material Modelling workshop (workshop 4) took place on November 24–28, 2025, in Linz, Austria as part of the Special Semester on Computational Methods for Electric Machines. The MagNEO project participated at the workshop through a poster

Formnext 2025

From 18 to 21 November, Frankfurt once again became the international meeting place for Additive Manufacturing and other future-oriented production technologies with over 800 exhibitors and over 38000 visitors! Formnext 2025 showcased the impressive progress of Additive Manufacturing’s ongoing evolution.

MagNEO definitely had to be part of it! CEIT and NIKON SLM Solution showcased MagNEO at their booths, and numerous partners attended the event.



Antti Vaajoki (VTT)



CEIT's booth



NIKON SLM Solution booth

News & Activities

MagNEO x Innovation Platform magazine

The MagNEO project is featured in Innovation Platform magazine, Issue 25 (pp. 196–199)! The article highlights the project's work on developing rare-earth-free permanent magnets using advanced manufacturing to support a more sustainable and resilient materials ecosystem.



Click to read the article

New Article Published by Conify and IRES Teams

The teams of Conify and IRES with Leonidas Gargalis, Leonidas Karavias, Aikaterini Argyrou, Evangelia K. Karaxi and Elias P. Koumoulos have published a new article highlighting the progress and key findings from Work Package 1.

This publication marks an important milestone for the MagNEO project, showcasing collaborative research and early technical achievements.



Click to read the article

PRj Repository Journal ft MagNEO

The MagNEO project is featured in an article in the latest issue of PRj Repository Journal – Vol. 25 (page 158)! The article includes the MagNEO vision, Innovative material compositions, Additive manufacturing for magnet production and much more.



Click to read the article



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