

# EU project greenSPEED: Pioneering sustainable battery production in Europe



The EU-funded research project greenSPEED, coordinated by Virtual Vehicle Research GmbH, has delivered a groundbreaking battery-cell manufacturing concept:

**By combining dry cathode coating, silicon-based anodes, and AI-driven digital-twin simulations, greenSPEED reduces energy use and carbon footprint, eliminates solvent emissions, boosts cell energy density, and lowers production costs — laying the groundwork for cleaner, more competitive European lithium-ion battery manufacturing.**

## Why greenSPEED?

*Graz, Austria, Feb. 09, 2026* – The rapid growth of electric mobility in Europe is increasingly constrained by environmental, cost-related and supply-chain challenges linked to lithium-ion battery production. Although lithium-ion technology powers battery-electric vehicles (BEVs) and supports the transition to sustainable mobility, conventional electrode fabrication remains energy-intensive and heavily reliant on organic solvents and energy-intensive drying.

Launched in July 2022 under the **EU's Horizon Europe programme**, greenSPEED brought together **11 partners across five countries** — combining industrial, SME and research expertise — with the ambition to redefine battery manufacturing in Europe. Coordinated by Virtual Vehicle Research GmbH (Austria), the project set out to develop a battery cell whose electrodes are produced via innovative, dry and solvent-free processes, thereby reducing energy consumption, cutting carbon emissions and eliminating volatile organic compound (VOC) emissions altogether.

**The central vision:** to enable Europe's leadership in battery cell production with a lower environmental footprint, competitive cost structure, and readiness for large-scale deployment.

## Main Achievements & Findings

### Sustainable Electrode Production: Cathode and Anode Innovations

- **Dry Cathode Coating:** greenSPEED developed a roll-to-roll dry electrode coating for a Ni-rich NMC composite cathode, fully eliminating the need for casting solvents and energy-intensive drying, condensation and transport steps associated with conventional fabrication.
- **Silicon-based Anode Technology:** For the anode, a high-capacity, pure-silicon layer was produced using a microwave-assisted, plasma-enhanced chemical vapor deposition (MW-PECVD) process — depositing porous silicon directly onto copper current collectors using locally produced silane gas (SiH<sub>4</sub>). This approach avoids conventional binders and conductive additives.
- The combination of these innovations enables a cell design that targets a **+69% increase in energy density**, together with **lower energy consumption (–32%)** and **reduced production cost (–21%)** compared to standard lithium-ion cells.

### Digitalization, Simulation & Process Optimization

From the earliest stages, greenSPEED employed advanced modelling and simulation techniques — including digital twins, artificial intelligence (AI), and machine learning — to predict and optimise cell performance and to guide manufacturing parameters. This approach helped minimize experimental iterations and accelerate process optimization.

Specifically, work packages addressed material behaviour under mechanical stress (e.g., current collector deformation), meso-mechanical modelling of full-layer cells, and AI-enhanced equivalent-circuit modelling. These efforts established a foundation for future upscaling, fine-tuning manufacturing parameters, and supporting industrial implementation.

### Cell Demonstration & Industrial Readiness Outlook

greenSPEED defined automotive-level cell requirements early on, including validation and testing protocols for performance, safety, cycling, and calendar life. Initial generation “Gen1”

cells were constructed: lab-scale stacked pouch cells and cells using standard electrolytes allowed testing of cathode and anode configurations. The pure-silicon anode concept was successfully demonstrated at laboratory cell level, showing promising performance (though with limited cycle life) - underlining both the potential and the challenges for further optimization.

On the cathode side, significant progress was made in optimizing binder type, foil surface treatment, adhesion and film uniformity; extrusion and roll-to-roll transfer processes were refined, adhesion enhanced (for example via primer-treated aluminium foils), and double-side coating became technically feasible.

Moreover, the project established sustainability and cost-assessment frameworks (CO<sub>2</sub>e and cost models), preparing for future partner alignment and large-scale adoption.

Through these achievements, greenSPEED moved its core technologies from TRL 2/3 toward ~TRL 5/6 — putting scalable, solvent-free, low-emission battery manufacturing within reach.

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## Statements

### **Dr. Alexander Thaler, Technical Project Coordinator, Virtual Vehicle Research GmbH (Austria):**

"Coordinating greenSPEED has allowed us to bring together automotive, industrial, and research partners across Europe around a shared vision: battery cells made without harmful solvents, with significant lower carbon footprint — while preserving high energy density and competitive cost. I'm proud to say we have demonstrated the technical feasibility of this vision and laid the groundwork for large-scale deployment across Europe."

### **Medina Ćustić, Administrative Project Coordinator, Virtual Vehicle Research GmbH (Austria):**

"Combining knowledge and experience across the entire battery value chain within the greenSPEED project has allowed us to reach a broad audience with our project results. EU-funded projects like greenSPEED are essential for fostering collaboration across industry, SMEs and research institutions, enabling Europe to develop sustainable, low-carbon battery technologies. Looking ahead, we are confident that the progress made in this project will help accelerate the transition to cleaner, more competitive battery manufacturing."

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## Conclusion & Outlook

As greenSPEED concluded its project cycle in December 2025, the initiative will leave a strong legacy: a portfolio of optimised, environmentally friendly manufacturing processes, demonstrator cells combining dry cathode and silicon-based anode technology, a digital backbone for process optimisation, and a clear path toward cost-effective, scalable battery cell production in Europe.

By addressing critical hurdles — toxic solvents, high energy consumption, low energy density, and high cost — greenSPEED contributes significantly to the EU’s ambition of sustainable and competitive battery supply chains. Its results not only benefit battery manufacturers and automotive OEMs, but also support Europe’s energy and climate goals by enabling greener mobility and reducing CO<sub>2</sub> emissions over the entire battery lifecycle.

The consortium looks forward to industry partners and battery cell manufacturers building upon greenSPEED’s findings — scaling up production, refining stability and cycle life, and bringing solvent-free, more sustainable battery cells to the market.

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## Project Key Facts:

- Project Duration: 42 Months (07/2022 – 12/2025)
- Budget: € 5.3 million
- Consortium: 11 Partners
- Countries: 5
- Coordinator: Virtual Vehicle Research GmbH, Austria

## Project Partners:

[Virtual Vehicle Research GmbH](#) - Project Coordinator

[AVL List GmbH](#)

[Center for Solar Energy and Hydrogen Research Baden-Württemberg \(ZSW\)](#)

[Circuit Foil Luxembourg](#)

[Arkema](#)

[LeydenJar Technologies](#)

[Bayerische Motoren Werke Aktiengesellschaft \(BMW AG\)](#)

[VARTA Innovation GmbH](#)

[Forschungszentrum Jülich GmbH](#)

[Speira GmbH](#)

[Umicore AG & Co. KG](#)

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**Website:** <https://greenspeed-project.eu>

**EU Cordis Database:** <https://cordis.europa.eu/project/id/101069528>

**LinkedIn:** <https://www.linkedin.com/company/greenspeed-eu-project/>

**Youtube:** [https://www.youtube.com/channel/UCiBJCO\\_syQ4-AfuEW9G0YPw](https://www.youtube.com/channel/UCiBJCO_syQ4-AfuEW9G0YPw)

**Introduction Video:** [https://youtu.be/8WuU1a\\_4ePo](https://youtu.be/8WuU1a_4ePo)

## Acknowledgement & Disclaimer

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[www.virtual-vehicle.at](http://www.virtual-vehicle.at)

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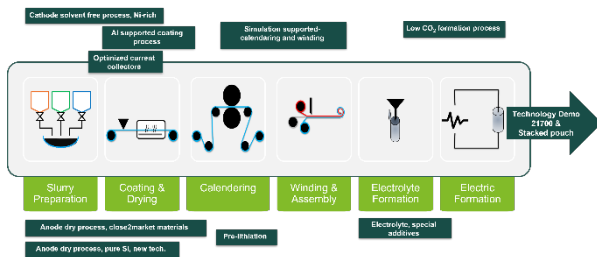
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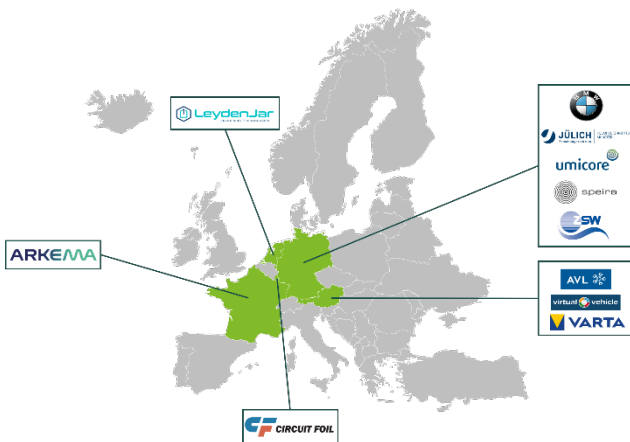
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