PRESS RELEASE
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RHINOCEROS project identifies its most eco-efficient battery recycling technology

After 30 months of research and technical validation, the Horizon Europe-funded RHINOCEROS project has selected the most eco-efficient technology among four evaluated routes for recovering critical raw materials (CRMs) from end-of-life lithium-ion batteries. This selection marks a key milestone ahead of the prototype design phase for producing cathodic and anodic materials.

Following the technology development phases, the RHINOCEROS project evaluated four advanced processes recycling materials available in end-of-life (EoL) batteries using a comprehensive analysis lead by TECNALIA. This analysis considers the Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) methodologies, as well as the results obtained during the R&D phase of the project and the engineering simulations provided by ECORECYCLING – the partner responsible for building the RHINOCEROS prototype. These four processes were ranked according to their eco-efficiency index, their R&D performance and simulation results, validating the selection of the roadmap for scaling up sustainable battery recycling.

The R&D response to Europe's battery challenges

Launched in September 2022, RHINOCEROS project aims to develop, improve and demonstrate economically and environmentally viable routes for recycling EoL lithium-ion batteries (LIBs) from electric vehicles (EVs) and stationary energy storage systems. This EU-funded research initiative responds to the anticipated increase in battery demand driven by transport electrification – a sector highly dependent on CRMs. The current geopolitical and market context expose European carmakers and battery cell producers to supply chain disruptions, price volatile prices and limited access to cathode and anode materials. The EU expects to mitigate the battery materials scarcity by recycling EoL EV and stationary batteries.

Four distinct technological routes for recovering CRMs from battery black mass were subject to a comparative analysis that used the LCC and LCA assessments:

- Two hydrometallurgical routes: a solvometallurgical process developed by TECNALIA (TEC) using Deep Eutectic Solvents (DES) and the other developed by the Chemistry Department of Sapienza University of Rome (UoS), using a hydrometallurgical process.
- Two hybrid routes combining the TEC and the UoS technologies, each with VITO's proprietary Gas-diffusion electrocrystallisation (GDEx).

Among these four recovery routes evaluated, findings rank TECNALIA's standalone process first, offering the most balanced solution for CRMs recovery from black mass. It combines low operational costs – 76 % of which are material-related, with moderate capital expenditure and a manageable environmental footprint primarily linked to solvent production. Despite the efficient performance on CRM extraction yield and recovered precipitate purity showed by the processing route proposed by Univ. of Sapienza, its high operational costs, driven by effluent treatment, make it less viable for scale-up. Hybrid approaches combining individual technologies with VITO's GDEx added complexity and cost without proportional gains.

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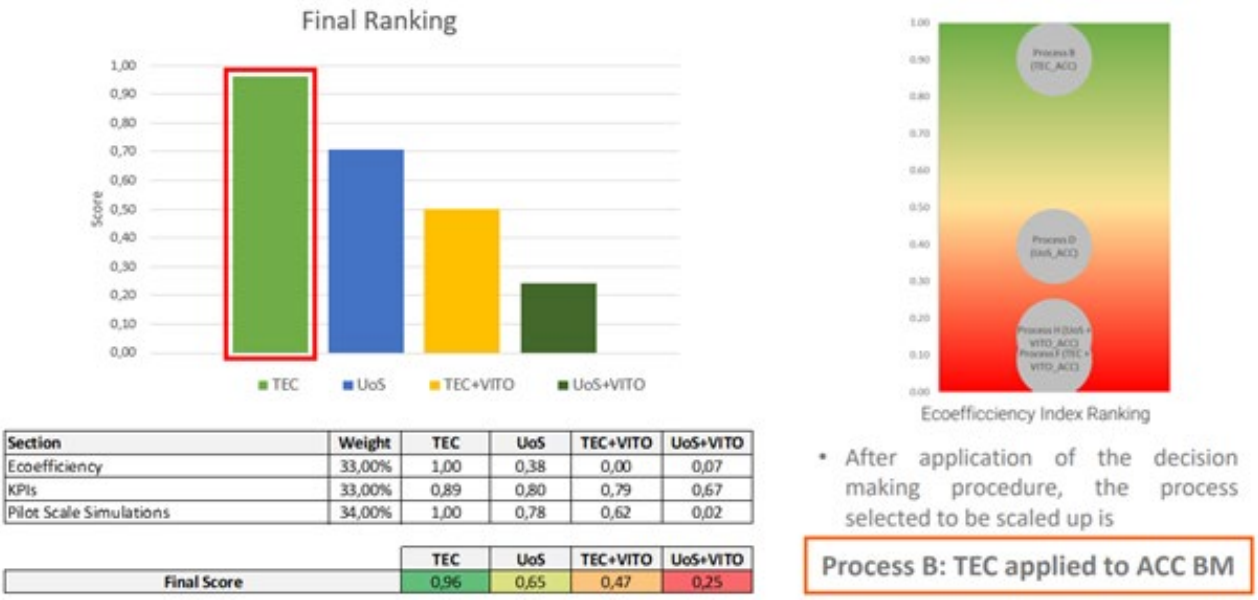
The RHINOCEROS consortium will now focus on integrating the selected technology into a prototype system for recovering cathode and anode materials. This will be tested in industrially relevant environments next year.

Representatives of TECNALIA underlined: *"After 36 months of intensive development and fruitful collaboration, the project has successfully delivered several processing routes. A decisive step has now been taken with the selection of the most suitable route, setting the stage for its validation at pilot-plant scale next year."*



Section	Weight	TEC	UoS	TEC+VITO	UoS+VITO
Ecoefficiency	33,00%	1,00	0,38	0,00	0,07
KPIs	33,00%	0,89	0,80	0,79	0,67
Pilot Scale Simulations	34,00%	1,00	0,78	0,62	0,02

	TEC	UoS	TEC+VITO	UoS+VITO
Final Score	0,96	0,65	0,47	0,25

Figure 1. Eco-efficiency ranking, © TECNALIA

About the RHINOCEROS project

The RHINOCEROS project – short for "Batteries reuse and direct production of high-performance cathodic and anodic materials and other raw materials from batteries recycling using low-cost and environmentally friendly technologies", will demonstrate a smart sorting and dismantling robot that will enable the automation of a battery repurposing production line. When direct reuse and repurposing of batteries is not feasible, the project will investigate innovative recycling routes aiming at the recovery of all materials present in LIBs: metals, graphite, fluorinated compounds, electrolytes, polymers and active materials.

Website: https://www.rhinoceros-project.eu/

About RHINOCEROS partners

TECNALIA is a private, independent, non-profit applied research centre of international excellence and member of the Basque Research and Technology Alliance (BRTA). Legally a Foundation, TECNALIA is the leading private and independent research and technology organisation in Spain (over 777 patents and promoted more than 30 spin-off companies, participates in 352 H2020 projects, coordinating 73 of them, and in 35 HORIZON EUROPE projects under negotiation[1], coordinating 6 of them) and one of the largest in Europe, employing around 1,472 people (266 PhDs) and with income of 113,5 Million € in 2020.

Website: https://www.tecnalia.com

Sapienza University: Founded in 1303, Sapienza is the oldest university in Rome and the largest in Europe. There are around 120.000 students enrolled and more 3500 professors and researchers. Sapienza currently offers 300 degree programmes (Bachelor's and Master's) and over 90 PhDs and 80 specialization schools, which are run by 11 Faculties and 58 Departments.

Sapienza participates in RHINOCEROS mostly with researchers from Department of Chemistry. This group has a consolidated expertise on the development of hydrometallurgical recycling processes and the synthesis of electrode materials for energy storage.

Website: https://www.uniroma1.it/en | https://www.chem.uniroma1.it/en

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VITO (Flemish Institute for Technological Research), is a leading European independent research and consultancy centre in the areas of cleantech and sustainable development, elaborating solutions for the large societal challenges of today. Sustainable chemistry, energy, health, materials management and land use: these are the five topics VITO focuses on. These topics have been set out in five research programs. They offer an answer to the challenges that mankind and society are confronted with today and in the future. Each program builds up a strong base of knowledge and skill, with added value for industry and society. The result is new and innovative research and a comprehensive range of scientific services.

Website: https://vito.be/en

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Consortium members

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