THE BATTERY CHRONICLES

STREAMS
SUSTAINABLE TECHNOLOGIES FOR REDUCING EUROPE'S BATTERY RAW MATERIALS DEPENDANCE

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Leitat is the oldest technological center in Europe, with over 100 years of history and a reference point at both the national and European levels. It has a team of more than400 professionals, experts in applied research, technical services, and the management of technological and innovation initiatives. Leitat's primary mission is to become a tool to improve the competitiveness of the country's companies through innovation and technology transfer. Leitat provides social, industrial, economic, and sustainable value, offering comprehensive solutions to multiple sectors and fields:
health and biomedicine, development of new materials, eco-sustainable production, occupational health prevention systems, waste revaluation and utilisation of natural resources; interconnectivity and digitalisation of industry, green energy, and maximisation of energy efficiency. Leitat develops R&D&I projects for companies and institutions, as well as leads research projects with competitive funding both within the framework of the European Union and the Ministry of Science, Innovation, and Universities.

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LEITAT & STREAMS

In WP2 LEITAT is focused on dismantling recycled batteries using a VR-Robotics solution. In WP3, LEITAT put its efforts on the development of two processes for Li-Recovery: Electrochemical Li-recovery system (ELR) and supported liquid membranes (SLMs). In WP4, LEITAT put its efforts on the development of liquid membranes (SLMs and/or PIMs) for the recovery of Co, Ni, Mn and their precipitation in form of sulphate salts. Finally, in WP7 LEITAT is focused on Environmental and Social impact Assessment of the STREAMS developed solutions.

Dismantling and Recovery of battery modules

Leitat's Robotics Unit specializes in the design and integration of advanced robotic systems that combine automation, artificial intelligence, and immersive control interfaces. The unit has extensive experience in human-robot interaction (HRI), virtual and augmented reality teleoperation, and ROS2-based robotic architectures for industrial and research applications. Its expertise covers robot perception, motion planning, simulation and digital twin development, and sensor fusion for autonomous operation. Leitat Robótica's facilities are equipped with industrial and collaborative robotic platforms, enabling the validation of new robotic technologies in safe, flexible, and scalable environments. Through its multidisciplinary approach, the unit contributes to advancing safe automation, remote manipulation, and robotic systems for hazardous or precision tasks across various sectors, including energy storage, manufacturing, and recycling.

In the STREAMS project, Leitat Robotics has developed and validated an immersive VR-based teleoperation system to support the safe dismantling and recovery of battery modules. The system integrates virtual reality interfaces with robotic control to enable operators to perform complex manipulations in hazardous environments without direct exposure utilizing precise robotic manipulators. Using custom 3D simultaneous localization and mapping SLAM algorithms and depth sensing cameras, detailed digital twins of battery modules were generated for precise utilization in robot path planning in simulation and in the Lab. The setup, implemented within the ROS2 ecosystem, incorporates adequate motion planners, digital twin-simulation model, and OptiTrack motion capture for validation and performance analysis. Experimental demonstrations successfully showcased VR-guided robotic milling for layer removal and delicate handling of damaged cells, achieving sub-millimeter accuracy while maintaining operator safety assuring sustainable and automated battery recycling, bridging the gap between human expertise and robotic precision.

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Electrochemical Li recovery (ELR)

The Energy Storage research group focused on materials for energy storage applications in both Li-ion and post-lithium technologies. It has extensive experience in developing materials for safer and more sustainable batteries, including the development of photocurable polymers as solid electrolytes and lithiophilic current collectors for solid-state batteries. Other key areas of activity for the Energy Storage group are the research of battery recycling processes through electrochemical methods, with a specific focus on lithium recovery; contactless battery sorting through X-ray techniques allowing battery chemistry identification and safer dry discharging processes without the use of cables.

In STREAMS an electrochemical lithium recovery (ELR) process has been developed. This approach leverages electrochemical principles to selectively extract lithium ions from various sources (e.g. black mass leachate, mining wastewater, brine, seawater). The ELR is based on the insertion and desertion of lithium in a host ceramic structure by electrochemical process. This two-step technique consists of capturing lithium from a feed solution, to then be released in a clean recovery solution. The Li salt can be recovered in a further step by precipitation. In STREAMS, different host structures have been evaluated for optimization and selectivity. ELR process has been successfully validated in the flow system using both model solutions and real feed solutions coming from the STREAMS partners and Li_2CO_3 has been recovered.

Novel supported liquid membranes (SLMs) for the extraction of Co, Ni, Mn and Li.

Leitat's research group of Functional Materials and Processing specializes in both membrane and nanomaterials design and development for several environmental and energy applications. LEITAT has expertise in novel applications from the materials development and basic research to scalable fabrication processes for their validation in real environment. LEITAT has strong expertise in nanomaterials and membrane research for metal recovery, gas separation and purification, electrochemical processes or water treatment among other applications, optimizing processes and integrating new materials into our portfolio through collaborations and public projects.

Liquid membranes technology (LM) presents a promising alternative to conventional metal ion separation and purification methods in hydrometallurgy, particularly for treating waste solutions. LMs hold significant potential as a sustainable and efficient alternative to liquid-liquid extraction for recovering valuable metals from hydrometallurgical residues, waste materials, and wastewater streams. This approach integrates extraction and stripping into a single, streamlined operation, using minimal amounts of organic extractants. In STREAMS, different LM have been developed and evaluated for selective recovery of the target elements (Co, Ni, Mn, Li). This LMs has been successfully validated in different liquid streams and metal sulphates are being generated.

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Environmental and Social impact Assessment

The Sustainability Area of LEITAT is made up of an interdisciplinary team specialised in efficiently assessing and responding to the sustainability needs of organizations across various sectors. The team provides innovative and science-based solutions to complex environmental challenges, turning them into opportunities for competitive advantage. Its main fields of expertise include environmental quantification methodologies, such as Life Cycle Assessment (LCA) of new technologies, products and services, carbon footprint calculation, social impact assessment and circularity assessment. In addition, this area also develops projects focused on environmental strategies including circular business models, environmental communication and ecolabelling, as well as sustainable production practices such as eco-design, energy efficiency, waste reduction and resource efficiency.

In STREAMS, the Sustainability Area leads the task of environmental and social impact assessment and contributes to other tasks within the sustainability work package such as the eco-design framework and technoeconomic assessment. By applying the Life Cycle Assessment methodology and following the Safe and Sustainability by Design (SSbD) framework developed by the European Commission, potential environmental and social impacts of the different technologies developed in the project are analysed. This allows the identification of their main hotspots—those aspects contributing most significantly to the overall impacts—and based on this, recommendations to partners are provided on strategies to reduce them. The results of this work will be compiled in two public reports that will be published next year.

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