# Leitat's innovative projects to optimise battery lifecycles

## The Leitat Technological Center participates in innovative battery development projects which aim to develop and bolster the competitiveness of companies in the field of technology and innovation

Founded in 1906, the Leitat Technological Center is one of the reference entities at state and European level in technology management. Its team is comprised of more than 500 professionals, experts in applied research, technical services, and management of technological and innovation initiatives.

Leitat provides social, industrial, economic, and sustainable value, offering comprehensive solutions in multiple sectors and areas, including: the development of new materials, eco-sustainable production, occupational health prevention systems, revaluation of waste and use of natural resources, interconnectivity and digitisation of industry, green energy, and the maximisation of energy efficiency.

Leitat is currently working on the LISA project, which aims to optimise lithium sulphur components and cells through new and significantly improved materials and innovative processes. LISA proposes the development of high-energy and safe lithium sulphur batteries, solving the problems of the cells developed in previous projects. The sustainability of the technology will be assessed from an environmental and economic perspective.

*The Innovation Platform* spoke to Leitat's Energy Storage Group to find out more about the organisation's work, including the details of the LISA project.

**Can you briefly summarise the work of Leitat's energy laboratory and its current key focuses?**

Leitat is a private technological centre based in Barcelona and is dedicated to R&D activities in the areas of biomedicine, biotechnologies, environment, surface treatments, material science, nanotechnology, and energies, with deep knowledge and experience in technological transfers to several industrial sectors.

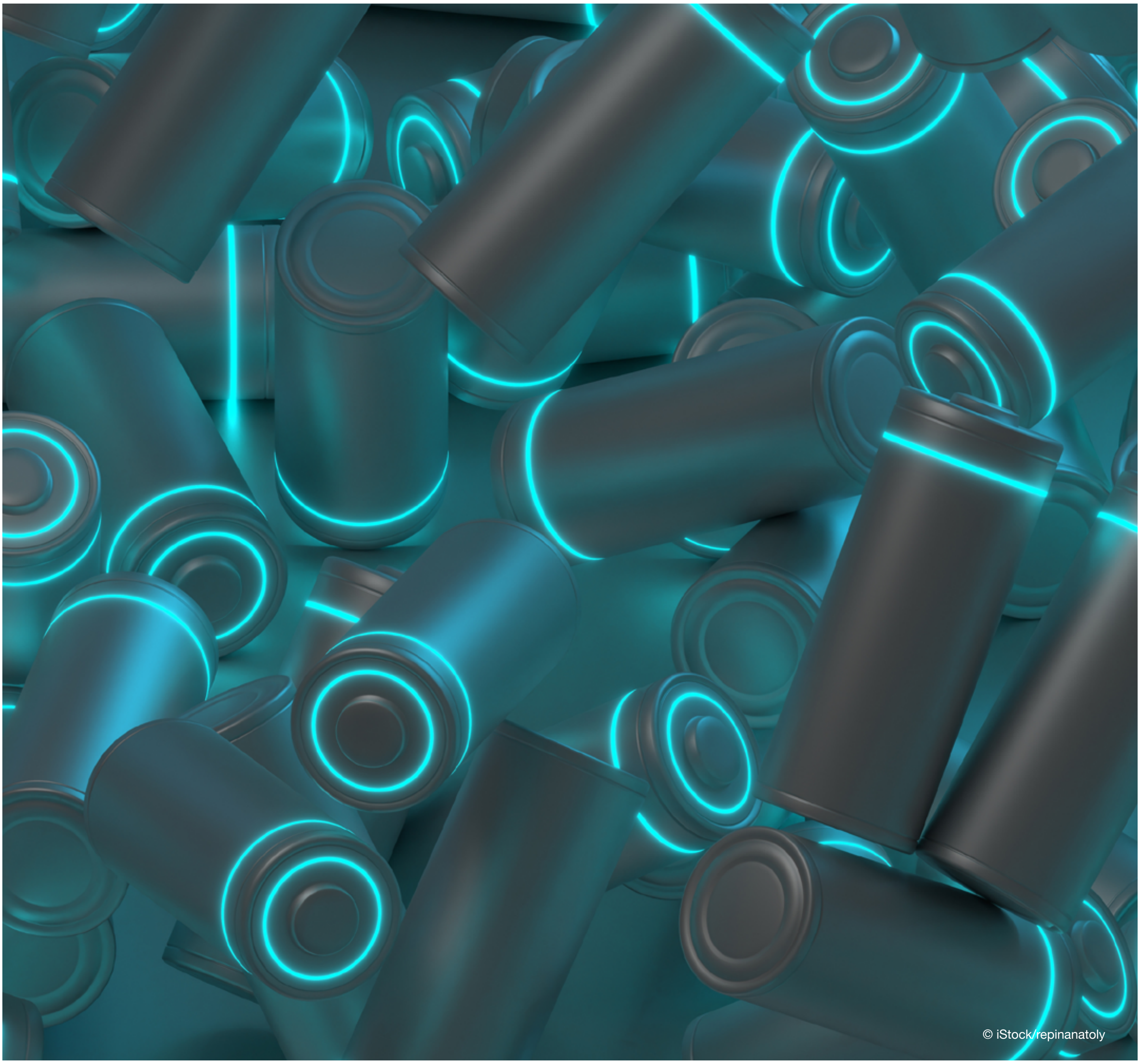
The energy storage team from Leitat is currently involved in national and European initiatives in battery material and manufacturing and lithium recovery. The energy storage team is in the process of completing a ten-year research project in post-lithium-ion technologies, including lithium sulphur (LiS), among others.

As part of the LISA project, Leitat is involved in material development related to thermal fuse, lithium metal cleaning and functionalisation, the development of electrospun material for lithophilic anode, and sulphur-carbon cathode composites. These developments are commune for the so-called GEN3, 4, and 5 battery types.

**How is your research driving innovation in battery development?**

Leitat is involved in research projects to treat short-term market demand and to anticipate enhanced, or disruptive, materials and technologies in the longer term. We are currently involved in industrial projects for the development of membranes (battery manufacturing and metal separation), and other sustainable electrode fabrication (aqueous cathode) to answer to an immediate demand.

Leitat is also involved in the electrification of the mobile robotic and other automatisation processes regarding battery dismantling for recycling. At a lower technological readiness level, Leitat is developing new material, cell components, and devices with superior energy (solid state, metal-air, and LiS) or superior power (e.g. Al-ion). Today, Leitat is co-ordinating the LISA project on lithium sulphur; AM4BAT on GEN4b solid-state batteries by additive




**The energy storage team from Leitat is currently involved in national and European initiatives in battery material and manufacturing and lithium recovery**

manufacturing; BATRAW on EV battery recycling; ZABAT on Zn-Air secondary; and $O_2$-free Al-Air batteries.

Since 2011, the Leitat Energy Storage group has contributed to around 15 industrial private projects with European and Asian companies and around 25 founded projects, including seven EU project co-ordinations.

### Why is the energy density of batteries an important focus of your work?

Energy density limits the application of batteries in both volume and weight, and principally their autonomy and driving range. Commercial lithium-ion (Li-ion) batteries are performing well in volume but are limited in weight. LiS might be an alternative to Li-ion, as the weight of the pack has an impact like in aeronautic or other buses, designed to transport passengers and not only batteries.

LiS is twice as light as Li-ion (GEN3) and has reached only 10% of the sulphur theoretical energy density (2600Wh/kg) at cell prototype level (250-300Wh/kg), with potentially 800Wh/l (600Wh/kg) achievable by improving materials, components, and manufacturing.

Major challenges for LiS are its low cycle life and limited charging/discharging speed rate. Today, LiS is beating records by turning to UAV[1]. Increasing the cycle life of LiS technology will support the implementation of this technology from drones to eBuses. Combined with a faster rate of charge and discharge, LiS might be also an alternative for electric vertical take-off and landing (eVTOL) or battery electric vehicles (BEVs).

**LISA proposes the development of high-energy and safe lithium sulphur batteries, to offer high efficiency for application such as electric vehicles**

### What is the LISA project and what are its key aims? Why was it launched?

LISA aims to develop high energy and safe LiS battery cells, with hybrid solid state non-flammable electrolytes, validated at 5Ah cell level, according to safety industrial standards for automotive integration.

LISA's activities are related to metallic lithium protection and reaching higher power rate and volumetric energy density. The sustainability of the technology is assessed from an environmental and economic perspective.

The technology will be delivered ready for use within the corresponding state of charge (SoC) estimator facilitating battery pack integration. The LISA project is working to meet the needs for battery manufacturing in Europe and to propose an alternative to commercial technology.

LISA proposes a technology where sulfur is the active cathode material, versus nickel and cobalt for Li-ion cathode. LiS is twice the energy density of Li-ion. Sulphur is at least 1,000 times cheaper compared to nickel or cobalt, and came from the waste of the local European oil and chemical industry. LiS' potential rests on using a conventional battery manufacturing process based on ink, coating, and cell staking.

The LISA was built considering the full value chain from material to cell manufacturing, and is incorporating manufacturability concepts that enable integration in future manufacturing lines. Moreover, the outcome of the project in terms of new materials, components, cells, and manufacturability will be transferable to other lithium-anode based technologies, such as Li-ion and solid-state lithium technologies.

### What are the major challenges in ensuring the safety of battery cells? How have you overcome these?

The safety of batteries is limited by different cell components and operating conditions. Using sulphur at the cathode solves the problem of the cathode self-heating, due to conventional intercalation material, which is limited in rate of charge and discharge. The LiS chemistry resists internal short circuits, or other impacts, where no hazards are observed after the internal short circuit. A voltage is measured to return to its open circuit voltage.[2]

LiS is using lithium metal and other chemicals that might release toxic gases. The use of lithium metal limits the battery's system, in terms of temperature and capacity to charge faster. It also impacts the life of the system, because lithium is not stabilised through the cycling.

In LISA, at least four strategies have been considered to make LiS safer. Research on multi-layered lithium coating is investigated by a physical process, known as pulsed laser deposition. Hybrid ceramic and polymeric layers coated on a membrane separator is manufactured by coma bar techniques. Full solid state LiS cell configuration is also investigated in the LISA programme.

### What are some of the most standout achievements from your energy storage projects?

LISA partners have delivered proof of its manufacturability concept for hybrid ceramic and polymeric layers. These developments, at a relevant scale, include specific knowledge along all steps regarding the preparation of the chemical precursors, their mixture and coating allowing homogenous and chemically stable layers.

This new cell component is transferable to other cell chemistries. LISA partners have upscaled processes, from lab to pilot scale, for lithium infiltration processes. LISA partners have investigated the concept of full LiS cells, including composite cathodes with solid state electrolytes and specific capacity at the limit of the theoretical capacity of the active material used.

New pulsed laser deposition techniques have been used in LiS cell component manufacturing, where lithium and other amorphous ceramic layers have been developed. New nanocellulose membranes have been developed by electrospun, with enhanced thermal behaviour compared to polyolefin membrane separators.

Milestones of >400 Wh/kg and >450 Wh/L, for 18Ah pouch cells, were achieved in November 2020. In January 2022, 5Ah LiS pouch cell generation was demonstrated at 1,200 cycles, 50% depth of discharge, and 80% beginning of load. State of charge and state of health estimators have been developed for LiS. Environmentally-friendly and additive-free water leaching have reached up to 92% lithium recovery yield for LiS pouch cells.

### References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**Energy Storage Group**
**Leitat Technological Center**