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# European Produced sustainable SODium-ion battEries for stationary applications


## EPISODE - Deliverable report

### D2.1. – Material design freeze

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**Project Scientific Abstract**

The main mission for Episode is to develop a non-lithium battery technology based on abundant available low-cost materials, with attractive energy density and power metrics (close to that of LFP-based Li-ion batteries counterparts), that are durable (> 15 years and > 5,000 cycles), have a high round-trip efficiency (> 95%), are non-toxic, non-critical, intrinsically safe and recyclable. A further aspect of this mission is that the production processes for the anode, cathode, electrolyte solutions and binders as well as cell production will be sustainable, energy-efficient and demonstrated at industrial mass manufacturing scale. Combining all of this leads to a non-lithium modular battery system with favourable CAPEX (< 150 €/kW storage capacity), OPEX (approx. 0.03 €/kWh/cycle) and carbon footprint (< 100kg $CO_2$eq/kWh), enabling energy storage applications, ranging from domestic installations (multiple units of 6.2 kWh/unit to be demonstrated in the project with projections towards large utility installations of multiple MWh. As a consequence, this will establish a European-based, globally competitive battery supply- and value chain that supports economic prosperity and the net-zero transition. The integrated material-manufacturing and sustainability assessment approach in Episode will transform the existing (Li) battery manufacturing process into a sustainable one to meet the future needs of the sustainable and resilient EU battery industry.

# Public summary

The primary mission of the Episode project is to develop next-generation sodium-ion (Na-ion) battery technology based on abundant, low-cost raw materials, while achieving energy density and power performance comparable to state-of-the-art LFP-based lithium-ion (Li-ion) systems. In addition to relying on inherently safe and recyclable materials, Episode's technology aims to deliver a non-toxic, stable (lifespan > 15 years and > 5,000 cycles), and highly efficient solution, targeting round-trip efficiencies above 95%.

To accomplish these objectives, the project focuses on the development and optimization of the key components that constitute the Na-ion technology. This includes achieving a cathode with more than 95% active material, a practical areal capacity above 3 mAh $cm^{-2}$ and 140 mAh $g^{-1}$, as well as an anode with less than 15% excess.

Within the framework of the project, two cathode active materials (CAM) have been successfully developed, both exhibiting promising electrochemical performance for future integration into Na-ion battery cells. Notably, the GEN1 cathode material demonstrates a practical specific capacity of 141.6 mAh $g^{-1}$ and a first-cycle efficiency (FCE) of 92.6%. In parallel, three different anode materials (AAM) have been produced using distinct synthesis approaches, with the GEN1 anode active material achieving a practical specific capacity of 319.72 mAh $g^{-1}$.

These active materials were combined with a set of binders also developed within the project. Their formulations were evaluated and optimized to achieve suitable rheological properties, enabling future electrode upscale and manufacturing at pilot-plant level for pouch-cell fabrication.

As a result, first-generation anode and cathode electrodes with promising electrochemical and physicochemical properties were obtained. It is worth highlighting that the cathode development was carried out both under dry-room and ambient conditions. Despite the challenge posed by the high moisture sensitivity of the cathode active material, electrodes fabricated under ambient conditions delivered practical capacities comparable to those produced in a dry-room environment at least during first cycles.

Finally, it is included the evaluation of full-cells (FCC) combining the developed electrolyte, anode and cathode electrodes, as a crucial step preceding pouch-cell manufacturing and subsequent benchmarking.

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**Project partners:**

| # | Partner short name | Partner Full Name |
|---|---|---|
| **1** | FAAM | FIB SPA |
| **3** | EnBW | ENBW Energie Baden-Wurttemberg AG |
| **3.1** | SEN | SENEC GMBH |
| **4** | EGP | ENEL GREEN POWER SPA |
| **4.1** | EnelX | ENEL X SRL |
| **5** | ARK | ARKEMA FRANCE SA |
| **6** | UPC | UP CATALYST OU |
| **7** | CID | Fundacion CIDETEC |
| **8** | ISE | Fraunhofer Gesellschaft zur Forderung der Angewandten Forschung EV |
| **9** | UAH | Universidad de Alcala |
| **10** | WMG | University of Warwick |

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