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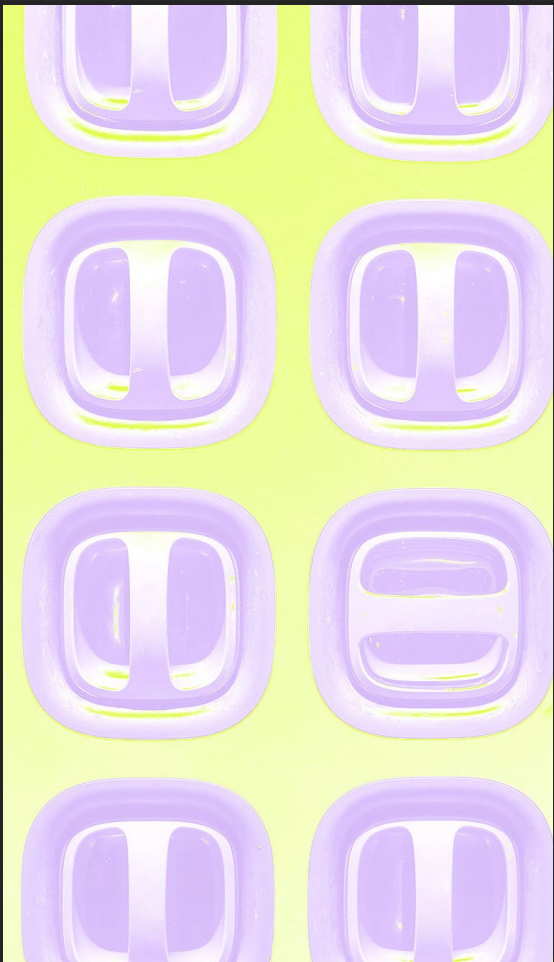
REBELION POLICY BRIEF

# Closing the Cell-Level Gap:

Why the EU Battery Passport Needs to Reach  
Disassembled Modules and Cells

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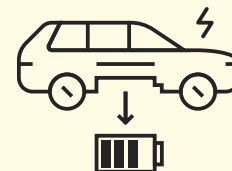
# Project Presentation

## A circular industry for used EV and light electric vehicle batteries

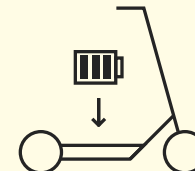
The **REBELION** project addresses the growing **waste management challenge** posed by **lithium-ion batteries (LIBs)** used in **electric mobility**. Up to 20% of electric vehicles sold globally are registered in Europe, yet the EU remains a net importer of critical raw materials.

For this reason, the project positions a robust **battery recycling** and **second-life industry** as both an environmental necessity and an economic opportunity: a European equivalent of domestic raw material extraction.

REBELION develops and validates two circular value chains. The first covers used **electric vehicle (EV) battery packs**. The second covers **light electric vehicle (LEV) batteries**, such as those from e-scooters. Both rely on a fast-testing technology developed by the project, Electrochemical Noise Analysis (ENA), enhanced with Current Interruption (ENA-CI). This technology sorts **cells and modules into four state-of-health categories**, ranging from minimal ageing, suitable for high-performance reuse, to severe ageing, which requires disassembly for recycling.



EV pilot line

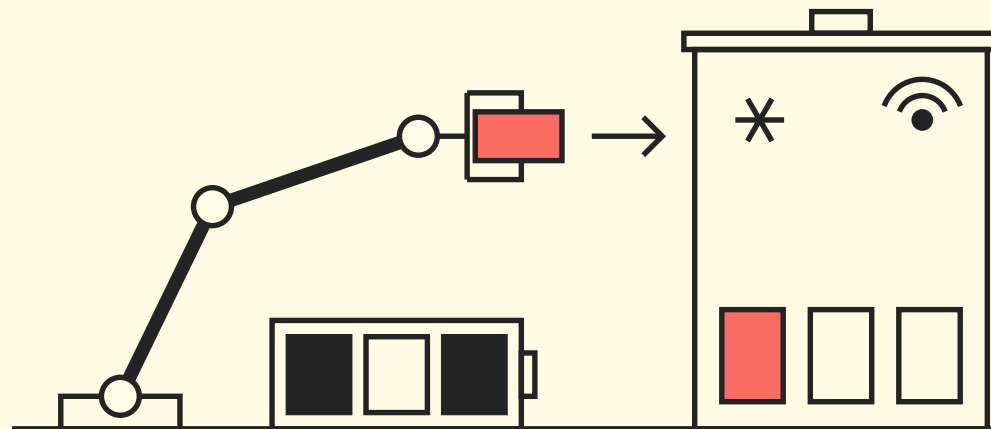


LEV pilot line

## Robotic dismantling, safe handling and a digital passport

The project also automates the physical handling of batteries. **Robotic dismantling lines** separate packs into **modules (for EV pilot line)** and into **individual cells (for LEV pilot line)**. This removes the need for mechanical shredding or pyrolysis. A dedicated **safety protocol** covers every step of the value chain. It includes the design of a **smart storage and transportation container** equipped with thermal and gas sensors, which trigger a cooling system when safety thresholds are approached.

A **blockchain-based Digital Battery Passport (DBP)** and standardised **labelling system** underpin the entire chain. It gives recyclers, second-life operators, and end users traceable, verifiable data throughout a battery's lifecycle, from first use to reuse, repair, or final recycling.



Robotic dismantling line separating a pack into modules or individual cells, and the smart storage and transportation container with thermal and gas sensors and a cooling system.

## Background

### Why second-life batteries need a passport of their own?

Growing numbers of electric vehicles and industrial batteries are reaching end of life, creating both an environmental challenge and a valuable recovery opportunity. Current data systems are fragmented: recyclers, refurbishers, and regulators cannot easily access the battery information they need. This fragmentation creates **safety risks, operational inefficiencies, and barriers to circular economy adoption.**



Mobile app



Data repository



Data upload



Ecolabels &amp; QR



Blockchain

Within REBELLION, the Advanced Design and Manufacturing Engineering Centre (ADMEC) team at Nottingham Trent University is building a **web-based, cross-platform Digital Battery Passport (DBP) system designed specifically for second-life batteries.** Unlike existing DBP applications, which focus on batteries still in their first use, this system captures **data across the full lifecycle**, from manufacture through dismantling, diagnostics, and recycling. The platform includes a **mobile app**, a structured **data repository** organised by battery data category, a **data upload module** for operators, dynamic ecolabels ranking environmental impact, and blockchain-integrated security. A dedicated software tool automatically generates **customised ecolabels and QR codes for individual battery units**, linked to a centralised database that filters information by process stage.

# Regulatory Context

## What the Battery Regulation requires, and when

Regulation (EU) 2023/1542 provides the **legal basis for the Battery Passport**. Article 77 establishes the passport requirement, while Article 78 creates the EU Digital Product Passport (DPP) Registry. Implementation is phased, with the main milestones summarised below.

18 Feb 2025

Jul 2026

18 Feb 2027

Mandatory carbon footprint  
declaration per battery model/plant  
(not yet stored in the passport)

EU DPP Registry goes live

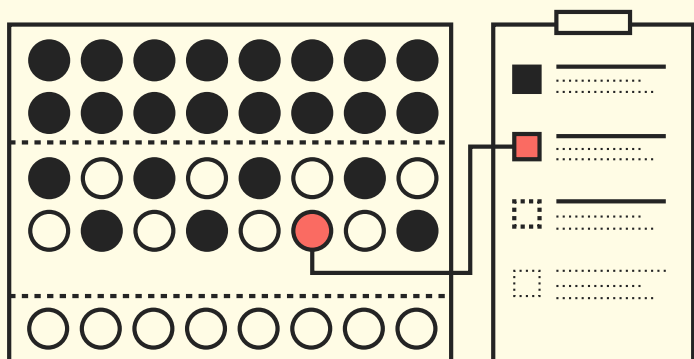
Full battery passport obligation  
enters into force for EV, LMT,  
and industrial batteries >2 kWh

| POLICY BRIEF                                                                                                                                                                                               |  | PROJECT PRESENTATION                                                                                                                                                                                                                                    | BACKGROUND | REGULATORY CONTEXT                                                                                                                                                                                                                                                                                                                                                                                                                | CHALLENGES | RECOMMENDATIONS                                                                                                                                                                                                                                                                                                                          | CONCLUSION | 7 |
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| 1                                                                                                                                                                                                          |  | 2                                                                                                                                                                                                                                                       |            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                 |            | 4                                                                                                                                                                                                                                                                                                                                        |            |   |
| <b>ONLY BATTERIES CARRY A PASSPORT</b><br>The battery passport obligation under Article 77.1 applies only to products that qualify as batteries under the Regulation, not to every physical sub-component. |  | <b>MODULES COUNT ONLY IF THEY ARE BATTERIES THEMSELVES</b><br>A module falls within the scope only if it qualifies as a battery under the Regulation and meets the applicable battery passport requirements, including the relevant capacity threshold. |            | <b>DISMANTLED MODULES AND CELLS LOSE THE PASSPORT</b><br>In practice, once a battery pack is dismantled, its constituent modules and cells are not carried over from the original passport: the passport was issued for the pack as placed on the market, and neither cells nor modules retain individual passport data after separation, unless a module was independently placed on the market as batteries in their own right. |            | <b>NO PASSPORT AT CELL LEVEL TODAY</b><br>As a result, there is currently no legally mandated battery passport for individual cells or modules. This creates a <b>traceability gap for recyclers and second-life operators</b> , who cannot rely on structured passport data at cell level to support diagnostics, reuse, or compliance. |            |   |



## CASE STUDY

## LEV pilot line



Cells sorted by state of health in a tray: each cell is identified only by its position, not by a marking of its own.

## CHALLENGES ADDRESSED: GRANULARITY MISMATCH &amp; RECYCLING FINANCING

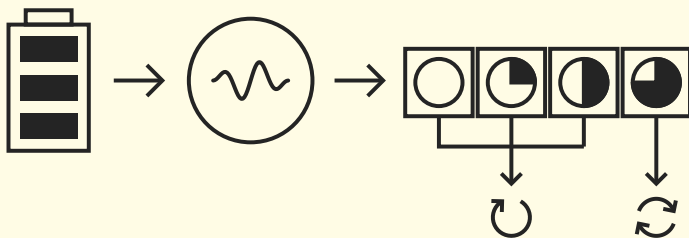
In the LEV pilot line, dismantling e-bike battery packs extracts cylindrical cells such as the Samsung INR18650-35E and INR21700-50E whose only identifying mark is the manufacturer's laser-etched type code, with no unique serial number linking the individual cell to its pack, to the pack's QR-based passport, or to its service history. Because EU battery regulation obliges the pack but not the disassembled cell, cells of identical type code drawn from different packs,

batches or use histories become indistinguishable once separated, so sorting cannot proceed on origin or history and **every cell must be treated as uncharacterised until ENA-CI testing assigns it a state-of-health category.**

| POLICY BRIEF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROJECT PRESENTATION | BACKGROUND | REGULATORY CONTEXT | CHALLENGES | RECOMMENDATIONS                                                                                                                                                                                                                                                                  | CONCLUSION | 10 |
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| <div>CASE STUDY</div> <div>LEV pilot line</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                      |            |                    |            |                                                                                                                                                                                                                                                                                  |            |    |
| <p>For second-life applications, batteries and modules are typically dismantled down to cell level, since <b>it is the individual cells, rather than the modules, that are reused to assemble second-life batteries.</b> Once a cell has been diagnosed, its estimated state of health, expressed as a percentage of nominal capacity, is not attached to the cell through a physical marking such as engraving or stickers. Instead, it is tracked through <b>virtual labelling</b>, that is, by recording the cell's position within a tray or storage container and indexing that position against its diagnostic result. Physical labelling is deliberately avoided to reduce cost. In one such application, on <b>NTC's</b> dismantling line, cells are sorted into three groups</p> |                      |            |                    |            | <div>REUSED TO ASSEMBLE SECOND-LIFE BATTERIES</div> <div>93-100%</div> <div>state of health</div> <div>REUSED TO ASSEMBLE SECOND-LIFE BATTERIES</div> <div>85-93%</div> <div>state of health</div> <div>SENT FOR RECYCLING</div> <div>below 85%</div> <div>state of health</div> |            |    |

## CASE STUDY

## EV pack second-life assessment



ENA-CI screening assigns each module or cell to one of four state-of-health categories, from high-performance reuse to recycling.

## CHALLENGE ADDRESSED: WHO INHERITS THE DATA GAP

For retired EV packs entering second-life assessment, the state of health and remaining capacity of individual modules are not available from any existing system: OEMs do not share usage or thermal history, and the mandatory passport dataset does not include state-of-safety parameters such as thermal history, harmful-event tracking or deep-discharge events.

REBELION therefore reconstructs this information through **diagnostic testing**. ENA-CI screening, for example, assigns each module or cell to one of four state-of-health categories, ranging from high-performance reuse to recycling. Measured condition, rather than declared history, becomes the basis of the sorting decision.

## Recommendations

## Three actions to close the cell-level gap

These recommendations are addressed to EU policymakers responsible for the Battery Regulation's implementing and delegated acts, as well as to the standardisation bodies developing the technical specifications for the DPP registry.

# 1

## EXTEND PASSPORT GRANULARITY

Dismantled modules and cells should retain a machine-readable identity, at least for the chemistries that dominate second-life and recycling streams.

2

## MANDATE MINIMUM DATA CAPTURE AT THE DISASSEMBLY POINT

Component identifier, chemistry, and measured state of health should be recorded into the DPP registry before separated components leave the dismantling facility.

3

## EXTEND FINANCING TRACEABILITY

Recycling fee mechanisms managed by Producer Responsibility Organisations should be able to track module-level removal and substitution, not only the pack as originally placed on the market, to prevent double counting and ensure that financing remains sufficient to cover the recycling of substituted modules.

# Conclusion

## Closing the gap before February 2027

The EU Battery Regulation is a significant step towards a transparent and accountable battery value chain. However, its current scope stops short of where the circular economy most needs it: the level of the individual cell. Disassembly and second-life practices are scaling up ahead of the February 2027 deadline. Yet no obligation exists to track components once they are separated from their original pack or module. This risks leaving recyclers and second-life operators to work with incomplete information, precisely at the stage where safety and material recovery decisions matter most.

REBELION's work on Electrochemical Noise Analysis diagnostics and on a lifecycle-spanning Digital Battery Passport shows that the **technical building blocks for closing this gap already exist**. What is missing is the regulatory mandate to apply them consistently, and the industry practice to feed them with reliable data down to cell level. Addressing this gap before the 2027 deadline, rather than after, would allow the passport system to **support the circular economy** it was designed to enable, rather than stopping one step short of it.

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## REBELLION POLICY BRIEF

# Closing the Cell-Level Gap: Why the EU Battery Passport Needs to Reach Disassembled Modules and Cells

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