BATTERY2LIFE

Battery Innovations for a Sustainable Europe: Key Insights from six Horizon Europe Projects [**Battery2Life**]

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Funded by the European Union

ICCS

Institute of Communication and Computer Systems (ICCS) of the National University of Athens (NTUA)

- 20+ years of Research in ICCS
- More than 90 ongoing research projects
- More than 150 highly qualified researchers
- 10 research divisions

i-SENSE GROUP

Research & International Profile

Important research results with numerous awards and prizes of excellence, having participated in more than 4000 EU projects.

4000+ Projects

Research Funding

Ranked among the top 20 European Organisations in terms of research funding and within the top 3 positions in Greece.

Top 20 EU Research institutions

Personel & Infrastructure

More than 800 researchers, scientists and Faculty Members. 41 Labs in the fields of Electrical Engineering. 6 Research Groups/Units

800+ Researchers

Innovation & Partnership

ICCS actively supports the creation of startups, spin offs and clusters

6 Spinoffs & clusters

- Cooperative Connected Automated Mobility
- Intelligent Network Systems
- Multimodal Logistics & Maritime Operations
- Circular Economy & Tracing
- Industry 5.0 & Smart Manufacturing
- **Smart Mobility Applied Systems**
- Extended Reality (AR/VR/XR)
- Health Technologies
- Earth Observation & Environmental Monitoring
- Crisis Management & Secure Societies

BATTERY2LIFE (B2L) in a Nutshell

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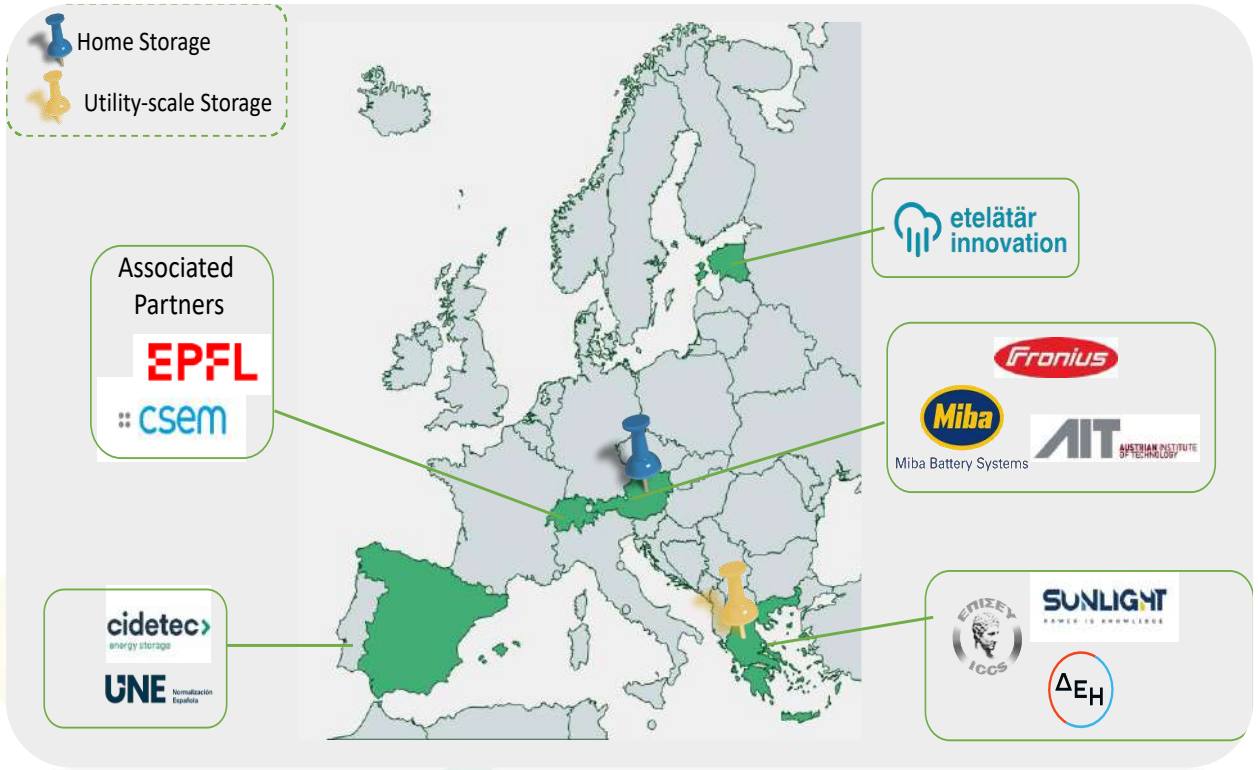
- **Call identifier:** Cross-sectoral solutions for the climate transition (HORIZON-CL5-2023-D2-01)
- **Topic:**HORIZON-CL5-2023-D2-01-04-Battery management system (BMS) and battery system design for stationary energy storage systems (ESS) to improve interoperability and facilitate the integration of second life batteries (Batt4EU Partnership)
- **Scope:** Battery2Life aims facilitate *the smooth transition of batteries to 2nd life use* and *boost the innovation of the European Battery Industry by providing enablers to implement open adaptable smart BMSes* and improved system designs towards *reliable reconfiguration of used batteries*.
- **EC funding:** ~4M€ / **Duration:** Jan 2024 – Dec 2026

5 countries / 11 Partners / 2 pilots



Motivation

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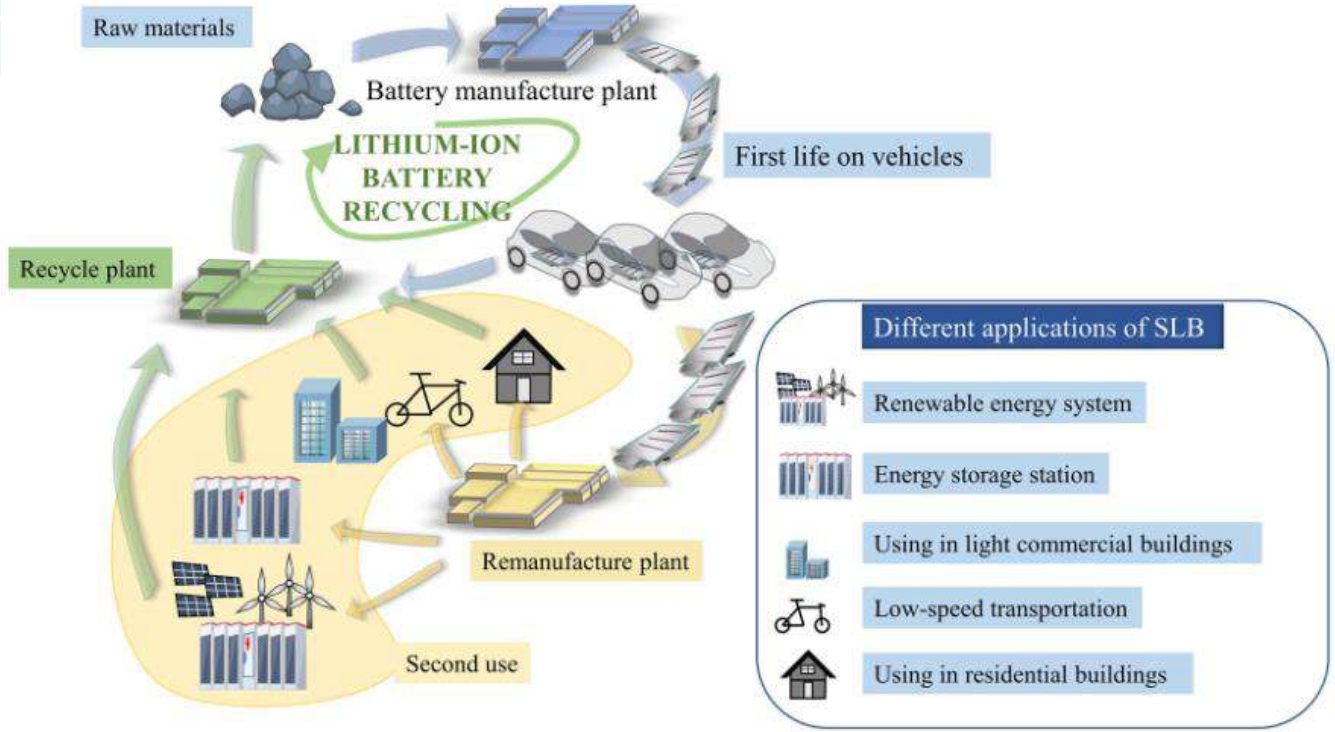
Increase of electric vehicle number and by extension the battery amount produced

- Post-1st life EV battery capacity is projected to reach 185.5 GWh/year by 2025 and 1000 GWh by 2030, providing significant storage for 2nd life applications,
- In addition the battery capacity from 2nd life battery will be increased from other types of vehicles and industrial motive machinery

Environmental and economic benefits due to actually reusing before recycling used batteries



Source: Li, J., He, S., Yang, Q., Wei, Z., Li, Y., & He, H. (2022). A Comprehensive Review of Second Life Batteries Toward Sustainable Mechanisms: Potential, Challenges, and Future Prospects. *IEEE Transactions on Transportation Electrification*, *9*(4), 4824-4845.

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Objectives

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1. Enable the safe and efficient reconfiguration of the BS for 2nd life use.

2. Design & develop an open cloud-based BMS, adaptable to battery technologies & communication protocols for 1st or 2nd life storage applications

3. Embed smart monitoring and control functionalities in the BMS to ensure safety and reliability in 2nd life operation

4. Develop AI-based tools for the reliable and efficient assessment, sorting & recombination of modules according to their suitability and needs for 2nd life applications

5. Demonstrate and assess the efficiency and the impact of the B2L solutions in domestic and utility-scale storage applications towards

6. Propose sustainable business plans to boost the competitiveness of the European battery industry

7. Disseminate and communicate the project results, liaise and exchange know how with relevant stakeholders and other research activities and promote the project findings to standardisation bodies

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Innovations

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- **Open and adaptable BMS for safe use in different applications**
  - Exploring wireless communication within the BMS to reduce weight, cost, and improve reliability, while simplifying disassembly and incident handling
  - Development of an open BMS system adaptable via firmware for diverse 2nd life applications, with cloud connectivity for real-time data and seamless integration of new technologies
- **Smart reliability and safety functionalities embedded in the BMS**
  - Enhance 2nd life reliability and safety with new SoX indicators, real-time algorithms, active cell balancing, and pressure sensors
- **BMS with embedded EIS**
- **Improved system shift from 1st to 2nd life use**
  - Develop an improved system design using a circular economy approach, focusing on easy electromechanical reconfiguration and best practices for reusing systems

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Innovations

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- **Advanced diagnostic tool for 2nd life batteries**
  - Lifespan prediction, Remaining Useful Life updates, and failure detection in 2nd life applications
- **Generalised sizing tool for 2nd life use**
  - Custom tool for optimal capacity, module count, and configuration, assessing techno-economic viability for different chemistries and applications

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Challenges and Solutions

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Lack of Flexible and Standardised Packaging	• Battery2Life employs a **modular and adaptable packaging approach**. The development of an open, modular BMS makes it easier to integrate batteries with different physical and technical specifications, reducing the effort needed to reuse and repurpose them.
Lack of standardised, reliable and efficient means to monitor status, assess suitability and appropriately match used modules for 2nd life applications.	• It will be developed **advanced AI tools** and **smart monitoring capabilities** that provide consistent and reliable metrics such as SoX indicators (e.g., SoC, SoH).
Transferring a BMS design from 1st to 2nd life use is a challenging task, as system, functional and safety requirements are not the same.	• Development of an **open and cloud-based BMS** to make the transition between first-life and second-life easier by allowing for firmware adaptability and integration with different applications. • Innovate battery design from the first life to consider second-life requirements, ensuring smoother adaptation and enhanced efficiency in reuse.

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Demonstration Sites

- **Pillar 1: Industrial Use Case**
  - **Focus**: Integration of second-life batteries into grid applications, particularly for load levelling and supporting weak grid scenarios such as islands.
  - **Location**: Public Power Company (PPC) Innovation Hub, Kantza, Athens, **Greece**
  - The Innovation Hub EV charging microgrid is equipped:
    - Ev chargers (2 DC chargers (of 50 DC and 60 DC respectively fo vehicles with a total capacity of >100 KW)
    - PV park of 40KWp installed power
    - Grid connection
  - SLG will provide the batteries

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Demonstration Sites

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- **Pillar 2: Residential Use Case**
  - **Focus**: Application of second-life batteries for residential energy storage.
  - **Location:** FRONIUS INTERNATIONAL GMBH (FRONIUS), Home system testbed, **Austria**
  - Home system testbed with PV system, supporting AC power of up to 10kW
  - MIBA will provide the 2nd life batteries

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Market Applications

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- Industrial Load Levelling:
  - Grid-scale storage to support EV charging infrastructure.
  - Applications in weak grid systems, especially islands.
  - Synergy with Renewable Energy Sources.

- Domestic Energy Storage:
  - Addressing residential energy demands with PV integration.
  - Growing demand driven by self-consumption benefits and rising electricity costs.

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Expected Impacts

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- Environmental:
  - >25% reduction in carbon footprint for the complete battery life cycle
- Economic:
  - Reduction of 30% of repurposing/refurbishment cost for adapting EV batteries to stationary applications in 2nd life
  - 10% - 75% (depending on the market) gain of the new market demand for 2nd life batteries ESS
- Technological:
  - 25% less time needed to manufacture the 2nd life batteries ESS
  - The 1st and 2nd life of the battery is extended by 10%
  - Early detection of thermal runaway
  - EV battery assessment time is reduced by 25%
  - 20% improvement in reliability of EV battery state assessment .
- Social
  - Creation of new highly skilled scientific jobs in the battery industry
  - Increased public awareness and acceptance about the 2nd life use of batteries

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Project Update (Month 11)

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Achieved:

- ✓ Requirements and specifications have been defined for both demonstration sites and the BMS.
- ✓ Finalized BMS specifications for adapting second-life applications.
- ✓ Established functional safety protocols for BMS software and hardware design.
- ✓ Ensured compatibility between the original BMS and the new BMS for second-life use.
- ✓ Defined E/E topologies for seamless integration.

By the end of the year:

- Aiming for completion of BMS open cloud platform and BMS software architecture.

On Progress

- Designing BMS hardware for enhanced battery systems.
- Developing advanced BMS algorithms and smart embedded functionalities.
- Establishing a methodology for efficient module recombination.

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Thank you! Any questions?

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