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LIBERTY NEWS

LIGHTWEIGHT BATTERY SYSTEM
FOR EXTENDED RANGE AT IMPROVED SAFETY

this issue

LIBERTY Newsletter

LIBERTY focusses on the areas of lifetime, increased range, battery safety and sustainability. The project aims to develop a battery pack that will have the same useful life as those of current combustion engines, i.e. up to 20 years or 300,000 km.

The LIBERTY project started in January 2021. This newsletter briefly presents the achievements and main results from the LIBERTY workpackages until now. Furthermore the conferences where LIBERTY project was presented are highlighted in the black box on the left side and news from the COLLABAT cluster as well as LIBERTY's open access publications and the brand new project video can be found in this 3rd Newsletter.

Enjoy reading!

Insight in LIBERTY's technical work

What we aim for:

LIBERTY's overall target is **substantially improving BEV battery performance, safety and lifetime from a lifecycle and sustainability point of view.**

The **key objectives** of LIBERTY are:

- **Objective 1: To achieve a range of 500 km on a fully charged battery pack;**
- **Objective 2: To achieve a short charging time below 20 minutes;**
- **Objective 3: To achieve an ultimately safe battery system;**
- **Objective 4: To achieve a long battery lifetime of 300.000 km;**
- **Objective 5: To achieve sustainability over the battery pack's entire life cycle, reducing its environmental impact by 20 %.**

LIBERTY project develops a complete battery back starting from current innovations at TRL (Technology Readiness Level) 4. The final result of LIBERTY will be a TRL 7 battery system (demonstrator in operational environment).

Please find below a description of the excellent work done in the workpackages to reach these objectives.

Presenting LIBERTY - Maybe you have met us @

LIBERTY project presented @eMobility Expo World Congress

21-23 March 2023, Valencia, Spain

Yolanda Bravo Rodríguez, Leader of Battery System Hardware Component Development at Valeo, presented the LIBERTY Project and the innovations from Valeo at the eMobility Expo World Congress. During her presentation, Yolanda Bravo Rodríguez presented **LIBERTY's successful work on many innovations in the area of improving the performance, safety and lifetime of BEV batteries from a lifecycle and sustainability perspective.**

A focus was on the innovations from Valeo: the Battery Thermal Management System and Battery casing. Some impressions of the well-attended session can be found on the photos.

Maybe you have met us @

LIBERTY project presented @RTR conference

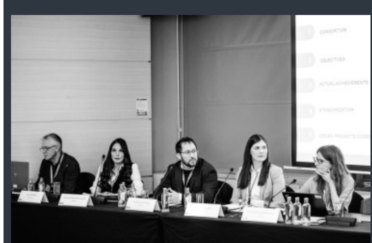
14-16 February 2023, Brussels, Belgium

LIBERTY coordinator Eduardo Miguel presented LIBERTY project and the current state of the LIBERTY innovations developed at the European Conference on Results from Road Transport Research (RTR).

In the session "**Next generation of battery pack for BEV & PHEV**", the three other COLLABAT Cluster projects MARBEL, HELIOS and ALBATROSS were presented**.** The session was moderated by Martha Gialampouki, project adviser from CINEA and also the Project Officer from LIBERTY project and Denise Tapler, Development Engineer Battery at AVL.

Eduardo had interesting discussions with EU personnel and industrial stakeholders, sharing a wide variety of perspectives towards EU project innovations!

The RTR conference brought together around 400 experts in the road transport sector from all over Europe and was organised by the EC in the collaboration with 2Zero, the European Road Transport Research Advisory Council (ERTRAC) and the CCAM Association.



Highlights from the WPs

Requirements, design criteria of the battery system and test plan (MBAG)

Summary of status and achievements

In WP1 the specification for the battery system was worked out. Within the specification, the requirements as well as the design criteria of the battery system were defined and consolidated to ensure the battery system will meet the targets (e.g. range, charging time, charging power, mileage). A test plan was drawn up to develop advanced test procedures for safety and performance tests. The generated test plan allows the validation and evaluation of the implemented battery system.

Highlights / Main results

Initially, all the battery components were identified and design guidelines were set. Based on that, the requirements for the battery system and the Electric and Electronics (EE) architecture have been defined based on inputs regarding the EQC, first life, second life, eco-design and total cost of ownership (TCO). The foundation for all subsequent work packages was laid. Apart from that, the test plan was defined and all the requirements were reviewed after the design of each component was already initiated.

Battery system design (BRING)

Summary of status and achievements

WP2 is pointing at: reduce 20% battery weight while still meeting sound crashworthiness requirements and an optimal total cost of ownership (TCO); allow fast charging up to 350kW considering the battery system voltage level increase from 400 to 800V, includes safety solutions to guarantee high insulation while limiting the potential thermal runaway, and lastly, allow for optimal cell cycle life.

The fully development of this task is 100% achieved and BRING has successfully submitted the deliverable on M21.

Progress towards objectives

- Reduce 20% battery weight while still meeting sound crashworthiness requirements and an optimal TCO (Achieved)
- Allow fast charging up to 350kW considering the battery system voltage level increase from 400 to 800V (Achieved)
- Includes safety solutions to guarantee high insulation while limiting the potential thermal runaway (Achieved)
- Allow for optimal cell cycle life. (on track. Tests are ongoing in WP6)

Highlights / Main results

- MS3 achieved: Conceptual design of battery system and overview of technical progress.
- MS4 achieved: Draft battery system design I.
- MS5 achieved: Draft battery system design II.
- MS6 achieved: Final battery design.

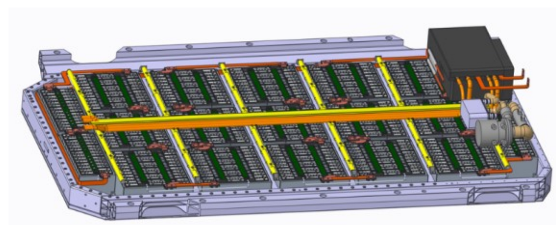


Figure 1: Battery system including electrical and thermal subassemblies

Battery system hardware component development (VAL)

WP3 is dedicated to the hardware production for the assembly of demonstrators and the integration in the final battery pack and vehicle. All the components of the battery pack that are included in this WP3 must cope with the objectives of the overall project with different contributions to weight reduction, fast charging capability, safety, durability and sustainability. Every partner which is responsible for product development has considered both explicit requirements for the performance, but also interaction with other components for the final integration. The partners that are not responsible for product development (MER and BRING) have been of substantial support and help for the definition of the integration.

Summary of status and achievements

The main activity has been focused on the production of the hardware components. The previous period ended with a battery system design that has been definitively frozen during this period, to cope with all the interactions between components and integration for battery pack testing and vehicle assembling. The detailed design for each component has been finalized, so the production of the hardware is fully defined. A relevant number of hardware has been already produced and the battery pack demonstrator is in the assembling phase.

Highlights / Main results

- Battery system design frozen
- Production of components demonstrators: mechanical components for cell fixation and separation, safety system, electrical system, pressure sensor and battery casing already produced.
- In progress: battery main switch and cooling system.

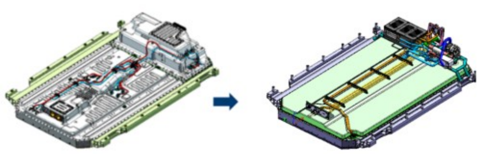


Figure 4 Battery pack evolution from serial application

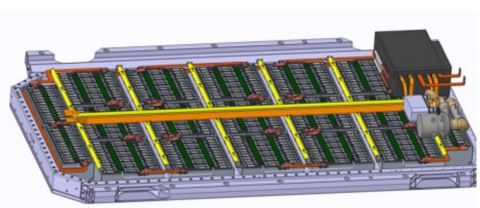


Figure 5 Battery system including electrical and thermal subassemblies with the cell stacks integrated in the battery housing. The battery junction box integrates the battery main switch and the pressure sensor is located in a corner of the battery pack.

Battery management system and state estimator development (FHG)

Summary of status and achievements

Two out of three open tasks were finalized. The development of state estimation algorithms (SOX) has been launched, covering a tailored design of State-of-Charge (SOC), State-of-Health (SOH), State-of-Function (SOF) and State-of-Safety (SOS) algorithms.

Such development has been decoupled into two main approaches: i) an innovative approach and ii) a conventional approach.

The development of the BMS hardware and software based on the definition from task 4.1 (BMS definition) has been finished. The software and hardware of the BMS master and BMS slaves are available.

The task which covers the BMS assembly and actual production of the parts has been started and finished.

The overall holistic BMS architecture developed in WP4 with its data processing layers and communications are illustrated in Figure 3.

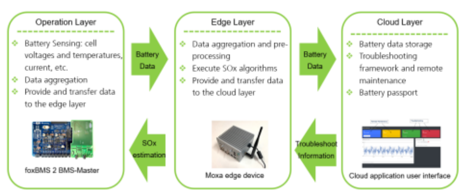


Figure 3 Schematic illustration of the BMS operational, edge and cloud layer

Highlights / Main results

BMS platform, master and slave units are finalized and available for battery system assembly. Preliminary SOC, SOH and SOS algorithm are developed and tested. Two journal papers were published in the reporting period describing the state parameter estimation results achieved within WP4.

Development of advanced test procedures for safety and performance (VIF)

Summary of status and achievements

The test protocols for the accelerated life tests on cell level are defined. Within WP6, the ageing tests (cycling, calendar-life and validation profiles) are in execution. Based on the obtained test results the test protocols are adapted.

- Cell-stack level performance tests:
  - The test protocols are defined
  - The cell stack is designed
  - Manufacturing ongoing
- Battery system level performance tests:
  - A battery system test plan is in development which describes all the required equipment, procedures and test sequences in detail.
  - Testbench preparation initiated
- TR simulator device is built up
- Two TRP-stacks designed, assembled and tested
- Test matrix for mechanical cell stack tests is defined and tested
- BMS testing draft is generated
- SOX unit-testing environment is developed and the inclusion of tests ongoing.
- Collaboration with the COLABATT cluster

Highlights / Main results

- Accelerated life cell test protocols
- Cell-stack level performance test definitions:
- TR simulator device
- TRP-stack testing
- Mechanical cell stack test protocols
- BMS testing draft
- SOX unit-testing environment
- Collaboration with the COLABATT cluster

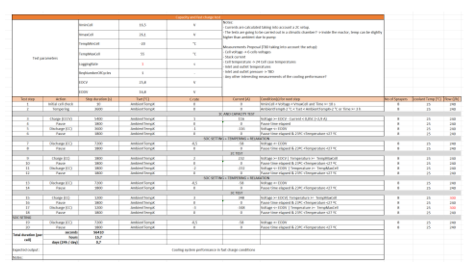


Figure 2 Test protocol for a cycling test on cell-stack level

Integration, testing and concept validation on cell, cell stack, battery system and EV level (FM)

Summary of status and achievements

Work is performed on following tasks:

- Battery system assembly and functional system testing;
- Performance and safety testing on cell and cell-stack level;

- Performance and safety testing on battery system level.

A battery pack assembly procedure is developed consisting of the planning regarding to component deliveries and battery pack assembly. This is done in coordination with WP3. At the same time, a cell-stack assembly procedure is defined whereafter cell-stacks are assembled and integrated in the module housing.

With respect to testing activities at cell and cell-stack level, the BoL (Beginning-of-Life) tests at cell level are finished and documented. After that, the accelerated lifetime tests at cell level (cycling, calendar life and validation profiles) are started and currently in execution. Regarding the cycling tests, the majority of the cells have cycled 840 FECs (Full Equivalent Cycles) which is equivalent to the lifetime target of 300.000 km defined in the LIBERTY project. Next to this, performance tests at cell-stack level are executed to validate the performance of the thermal management system. Safety testing is performed by mechanical and thermal runaway tests at cell and cell-stack level. The cell-stacks are developed within WP5.

For the system level testing, a battery system test plan is in development which describes in detail among others all the test procedures including the acceptance criteria, required equipment and procedures for troubleshooting. In the same task, a simulation-based assessment will be performed with respect to safety and mechanical abuse. This task is initiated and will use an upscale approach based on the results that are obtained during the safety tests on cell and cell-stack level.

Highlights / Main results

- A procedure and planning for the battery system assembly is developed.
- The cell-stacks for the battery system are manufactured according to the developed procedures.
- Cell ageing tests (cycling, calendar-life and validation profiles) are in execution and the current results are documented.
- Safety tests at cell and cell-stack level (mechanical and thermal runaway) are executed and the results are documented.
- The thermal management system is tested by cycling tests at cell-stack level.
- The definition of the battery system test plan is started and ongoing.

Figure 7 Manufactured cell-stack assembly.

Overall techno-economic assessment, recycling and LCA (ACC)

Summary of status and achievements

ACC has analysed the components used in LIBERTY battery pack and assess the possibility of reuse. The discharge procedure has been finalized and the automatic dismantling/sorting has been designed. MON has created the module for the life cycle analysis and used benchmark data for the LCA analysis.

Highlights / Main results

As for Task T7.1 Development of procedures for battery system dismantling and recycling, assessment of reuse, following main results are achieved:

- Discharging procedure has been finalized.
- Cooling liquid extraction procedure has been designed.
- Automatic dismantling process has been investigated.
- The possibility of reuse components has been investigated.

As for Tasks T7.2 Life Cycle Assessment of the battery system, following main results are achieved:

- Literature review of the state of the art of LCA studies on BEV batteries
- The Circular Economy Indicator has been defined.
- Benchmark data from EQC 2019 has been collected and analysed.
- Simplified LCA data for LIBERTY project has been collected.

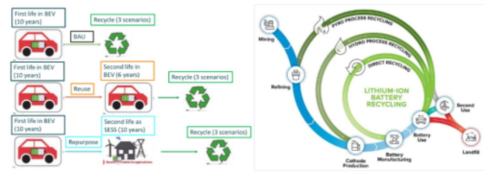


Figure 6 Possible life cycle management scenarios for BEV batteries

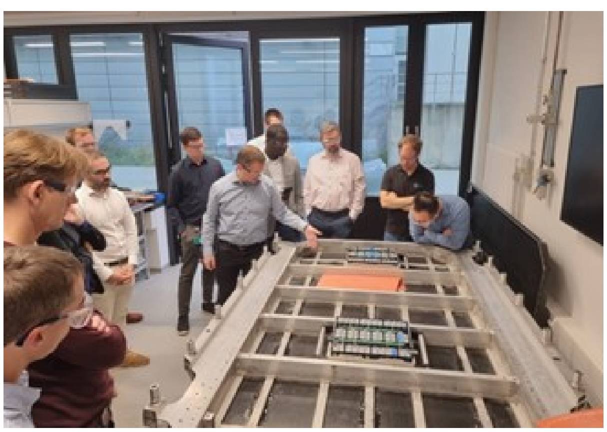
LIBERTY Consortium Meeting, Brussels, 13-14 June 2023

The LIBERTY consortium met in Brussels, Belgium. 25 representatives from many European countries from industry and research institutes attended personally and many others joined online – a real pleasure to work together on the LIBERTY innovations. The focus of this meeting was on the technical work in the workpackages. The first results and outcomes have been shown and we are looking forward to presenting them at the upcoming review meeting. We kindly want to thank our hosts from BRING and CLEPA for inviting us to Brussels and hosting the consortium meeting. The stay was completed by a very interesting introduction to BEPA and the Batt4EU Partnership, fruitful discussions and a nice dinner in the evening. Thank you very much! We are definitely looking forward to continuing the good collaboration within this fantastic project.

LIBERTY Consortium Meeting, November 2023, Erlangen, Germany

Fraunhofer IISB in Erlangen hosted the LIBERTY consortium meeting and its General Assembly after 3-year project runtime, with a lot of interesting points on the agenda.

After lunch the status on the battery demonstrator was shown during another lab tour.



The consortium took the chance to engage on sound technical discussions and evaluate the great achievements. The next steps for the upcoming months have been coordinated and key decisions for a successful completion of the project have been made. It's great to meet and talk in person! Thanks a lot to our partner Fraunhofer IISB for hosting the meeting. The project is evolving quickly, stay tuned for upcoming news, events and publications!

COLLABAT Cluster

H2020 Battery projects joining forces towards sustainable future battery packs

Four EU H2020 projects – ALBATROSS, HELIOS, LIBERTY, MARBEL – joined forces to form the COLLABAT cluster, to bring state-of-the-art research for complex transport industry challenges towards transport decarbonisation and energy transition, in line with EC climate neutrality goals. The cluster takes up the challenges associated with the future of the electric vehicles sector that fundamentally depends on its technological capacity to **develop** more **cost-efficient** and **long-lasting battery packs** - in terms of **lifetime and range** - based on a **sustainable approach** to ensure the deployment of electric vehicles in the mass market.

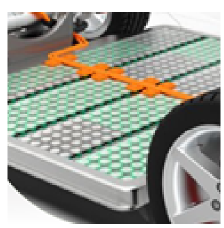
Find out about the highlights from the subclusters in the recoridngs from the sublicster webinars:

COLLABAT Horizon 2020 Cluster

The recordings and slides of the mini-series on the future of battery packs for electromobility are now online

Thank you for your interest in the mini-series of three webinars on the future of battery packs for electromobility.

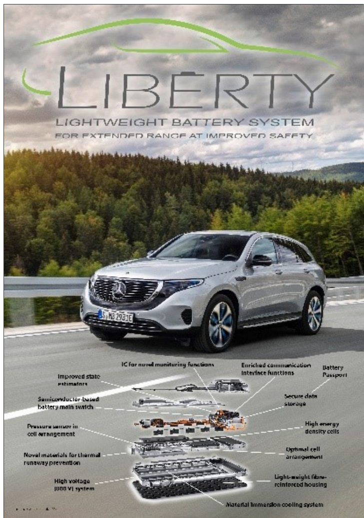
If you were not able to join, or you'd like to share the content with your network, we are happy to share with you the links to the recordings of the webinar.



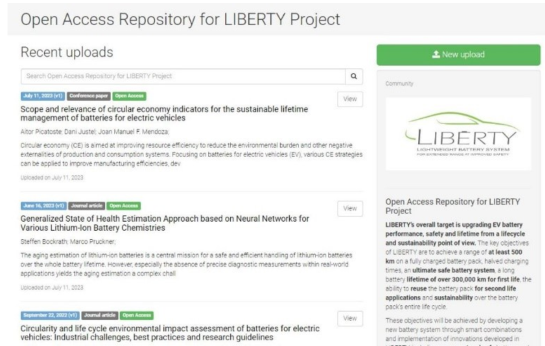
Access recordings and slides

- Battery Management Systems (BMS): New Developments for Next-Gen EV Batteries
- Methodologies for testing and validation of Electric Vehicles' batteries
- The Priceless Value of LCA in the Circular Economy and its Influence in the Battery Industry

We hope you enjoy watching the recordings. If you have any questions or feedback, please do not hesitate to contact us.



LIBERTY Open Access Repository on Zenodo



LIBERTY project supports the concept of **FAIR** (**F**indability, **A**ccessibility, **I**nteroperability, and **R**euse) data works toward making research data FAIR.

Peer-reviewed publications of LIBERTY project will be open access as soon as the research/publication has been completed and published.

Looking for something to read for the weekend? Interested in specialist literature on batteries for electric vehicles? Then we have the right thing! All publications that have been published within the framework of LIBERTY are **publicly available on our** website on our Zenodo repository. Enjoy reading!

How to find out more about LIBERTY project:

The project is evolving quickly. Stay tuned for upcoming news, events, and publications.

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LIBERTY Leaflet

LIBERTY Poster

Articles about LIBERTY published online

LIBERTY publications

LIBERTY presentation

PROJECT FACTS

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Start: 01 January 2021

Duration: 42 Months

Total investment: 10.8 M€

Participating organisations: 16

Number of countries: 7

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