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NEXT-generation physics and data-based Battery Management Systems for optimised battery utilisation

NEXTBMS

NEXTBMS - Deliverable report

D2.2 – Advanced state estimation, prediction & control functions

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Project summary

NEXTBMS will develop an advanced battery management systems (BMS) built on fundamental knowledge and experience with the physicochemical processes of lithium-ion batteries, which will enable the significant enhancement of current modelling approaches, including the readiness for upcoming lithium (Li) battery material developments. These modelling approaches will be further improved by optimising sensors and measurement techniques to meet modelling needs (and optimising models based on physical sensor data) and the physical cell configurations to form a framework that supports improving the battery state prediction and -control. By solving these challenges, NEXTBMS will ensure that the next generation of BMSs will enable higher performance, safety, and longer lifetime of the battery cells for an overall optimal utilisation of the battery system.

Publishable summary

The goal of the NEXTBMS project is to enhance the performance of battery electric applications. A major contributor to their performance and a key factor in maintaining performance and safety over the lifetime of the battery, is the battery management system (BMS).

The NEXTBMS project aims to surpass contemporary BMS limitations by introducing physics-based and data-driven models and algorithms to the BMS itself. It incorporates physical modelling in BMS control algorithms with improved accuracy.

The advanced model with physicochemical consistency together with the advanced sensors and measurement protocols allow the BMS to diagnose chemical processes and the current internal structure of the battery in real-time. This, in turn, facilitates to dynamically update the battery usage limitations and adapt the battery operating range according to the current operating conditions.

The physics-based model of a cell will be integrated with the battery state estimations. This approach is the enabler for higher integral state estimation precisions and related predictions, provided the higher precisions from Physics-Based Models (PBM) and data-driven models. The accuracy of the estimation strictly relies on the accuracy of the model. The document provides the overview of the state estimators developed which will accompany to both the embedded physics-based model and the cloud physics-based model that can output main and extended states of the cell and the integral battery pack. (e.g., State of Charge (SOC), State of Health (SOH), State of Safety (SOS) and State of Function (SOF)).

The advanced functionalities will be realised by optimised interaction between on-board and off-board computational capabilities, distributing the computational workload between the local BMS and the cloud as well as including AI supported triggering and support of SOX observation in the cloud. These innovations help tackle the challenge relating to transferring BMS from isolated systems into connected systems with increased computational capabilities.