Preliminary Hazard Analysis and Functional Safety Concept for a 2nd Life Battery Energy Storage System

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Abstract:

Soon the number of retired batteries from electric vehicles (EV) is expected to increase dramatically. By 2030¹, more than 5 million tons of EV batteries will no longer be suitable for mobility purposes. The capacity loss of the retired EV batteries is estimated to be around 2.3 % per year and the estimated 1st life of the batteries is estimated to be around 5 - 10 years². Thus, at the end of the warranty, the expected nominal capacity of the EV battery varies between 70 - 80 %. This is also the First-Life End-Of-Life (FL-EOL) threshold adopted by most automotive industries. Although such a battery does not fulfil the automotive requirements, its storage capacity can still be exploited for other applications, such as stationary energy storage systems.

In this research, we present the Preliminary Hazard Analysis (PHA) and the Functional Safety Concept (FSC)³ of a 2nd life Battery Energy Storage System (BESS) intended to be used for grid balancing purposes. The 2nd life BESS consists of modules coming from traction applications and its BMS (Battery Management Systems) will include novel technical approaches such as monitoring the state of the BESS with Electrochemical Impedance Spectroscopy and the wireless communication between the Slave board and the Master board. The BMS is the main technical safeguard of the 2nd life BESS as it can help to manage inherent risks associated with the 2nd life batteries and the overall battery system.

Both functional and general safety requirements of the entire system comply with the international standards IEC 63056, IEC 62619, IEC 61427, IEC 62620, and IEC 62933-5. PHA includes potential preliminary hazards about lithium-ion battery, the BMS, other chemicals or hazards and natural hazards (considering the location of the 2nd life BESS).

A functional safety concept for the preliminary system architecture of the BMS is developed and it will be re-evaluated and modified through the development phase of the BMS and the 2nd life BESS prototype in general.

¹Propulsion Quebec. Lithium-ion Battery Sector: Developing a Promising Sector for Quebec's Economy; KPMG for Propulsion Quebec: Montreal, QC, Canada, 2019 ²How Long do Electric Car Batteries Last? What 6,300 EV Batteries Tell Us | Geotab ³ See, K. W., et al (2022), *Critical review and functional safety of a battery management system for large-scale lithium-ion battery pack technologies*, (2022) 9:36, International Journal of Coal Science & Technology.