**Cloud-Based Battery Management System for Energy Storage Applications: Enabling Second-Life Batteries for Smart Mobility and Smart Homes**

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**Abstract**— The accelerated proliferation of electric vehicles (EVs) raises concerns about battery end-of-life management and sustainability. Second-life batteries (SLBs) present a costeffective and eco-friendly solution by repurposing used EV batteries for energy storage applications. This paper presents a cloud-based Battery Management System (BMS) designed within the Battery2Life project to optimize SLB performance in domestic and EV charging microgrid (grid-scale) use cases. The proposed hybrid architecture integrates real-time monitoring at the battery level BMS, with AI-driven analytics and predictive diagnostics in the cloud. Key functionalities include advanced state-of-battery estimations, electrochemical impedance spectroscopy, a cyber-secure by-design architecture, and support for the digital battery passport concept. The system ensures interoperability, scalability and secures data management, paving the way for sustainable energy storage, enhanced grid resilience, and circular battery value chains.