NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

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Project Title.
An Intelligent Adaptive Modular Battery Energy Storage System for the Built Environment

Abstract.
As battery technology advances and battery system capacity expands, its penetration in buildings enables residential and commercial consumers to be energy prosumers, interact with the grid to provide services, and facilitate grid-interactive efficient buildings (GEB). As such, these Battery Energy Storage Systems (BESS) are expected to operate for a prolonged time without significant degradation, be efficient and reliable, meet the changing needs of the building and grid's requirements, and be fault tolerant. These traits and many more novel features can be met with the application of Reconfigurable Battery Systems (RBS) technology. Reconfigurability transforms static inflexibilities in current BESS systems into highly modular, adaptive, robust systems capable of providing on-demand dispatchable resources and overcoming many fixed-topology shortcomings while reducing operational expenses and improving efficiency. RBS has been proposed and demonstrated for various applications, including BESS. Research and development of RBS integration with the built environment is limited, and this research project proposes to address the existing challenges through the development of an Intelligent Adaptive Modular BESS (I-AM-BESS) for the built environment. I-AM-BESS is highly modular, scalable, and reconfigurable. This novel I-AM-BESS solution requires additional research into the features that it offers, including (i) advanced RBS system design (ii) enhanced micro-electromechanical systems (MEMS) sensor array technology for state of charge (SOC), state of health (SOH), and state of life (SoL) determination, and (iii) an intelligent operation scheme for integrated RBS systems in grid-interactive efficient buildings, using reinforced learning to optimize both building and battery performance. A 2.8 kWh, I-AM-BESS prototype system will be installed at one of UNL's facilities to validate and analyze the proposed project's features.