World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:18, No:10, 2024

Mathematical Modelling and AI-Based Degradation Analysis of the Second-Life Lithium-Ion Battery Packs for Stationary Applications

Authors : Farhad Salek, Shahaboddin Resalati

Abstract : The production of electric vehicles (EVs) featuring lithium-ion battery technology has substantially escalated over the past decade, demonstrating a steady and persistent upward trajectory. The imminent retirement of electric vehicle (EV) batteries after approximately eight years underscores the critical need for their redirection towards recycling, a task complicated by the current inadequacy of recycling infrastructures globally. A potential solution for such concerns involves extending the operational lifespan of electric vehicle (EV) batteries through their utilization in stationary energy storage systems during secondary applications. Such adoptions, however, require addressing the safety concerns associated with batteries' knee points and thermal runaways. This paper develops an accurate mathematical model representative of the second-life battery packs from a cell-to-pack scale using an equivalent circuit model (ECM) methodology. Neural network algorithms are employed to forecast the degradation parameters based on the EV batteries' aging history to develop a degradation model. The degradation model is integrated with the ECM to reflect the impacts of the cycle aging mechanism on battery parameters during operation. The developed model is tested under real-life load profiles to evaluate the life span of the batteries in various operating conditions. The methodology and the algorithms introduced in this paper can be considered the basis for Battery Management System (BMS) design and techno-economic analysis of such technologies.

Keywords : second life battery, electric vehicles, degradation, neural network
Conference Title : ICSCAIA 2024 : International Conference on Soft Computing, Artificial Intelligence and Applications
Conference Location : Tokyo, Japan
Conference Dates : October 03-04, 2024