Temperature and Cycling Effect on Microgrid Advanced Li-ion Battery Storage: Efficient Multi-Year Technical Energy Planning- a Case Study-

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Abstract : This study focuses on the optimization of a microgrid solution designed for a real-world location (Adrar), with a specific emphasis on the dynamic changes in the integrated Li-ion battery performances, particularly on time-temperature effects and cycling degradation over the system's lifetime. We meticulously evaluate various scenarios, including different combinations of energy sources such as solar photovoltaics (PV), a diesel engine backup system, and Li-ion battery storage for off-grid applications. The research employs an innovative approach, incorporating a multiyear growth method and conducting indepth technical analyses using the Hybrid Optimization Model for Electric Renewables software to pinpoint the most efficient energy system. The analysis extends across a 20-year, simulating each time step throughout the project's lifespan. These factors are crucial in optimizing the microgrid's long-term sustainability. Although this approach demands additional computational time, it ensures the development of a highly accurate model. Initially, we conducted model runs without multi-year optimization, relying on the Optimizer to identify the optimal system configuration. The outcome reveals an ideal system composed of a Danvest generator with a capacity of 760 kW, 200 kWh of Li-ion storage, and a competitive levelized cost of electricity (COE) at $0.309 per kWh for the one-year model. This integrated microgrid design offers valuable insights into the potential of Li-ion batteries as a crucial component in achieving efficient and sustainable energy solutions for real-world applications.

Keywords : Li-ion, Microgrid, Multi-year planning, Technical optimization, PV, Diesel, Hybrid energy system