Cell lifetime diagnostics and system behavior of stationary LFP/graphite lithium-ion batteries

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Batteries are increasingly being integrated into residential photovoltaic systems in order to increase self-consumption and self-sufficiency. Unfortunately, the lifetime of state-of-the-art battery systems is considered still too low to make energy storage commercially viable. Ageing on the cell level is a complex process depending strongly on operating conditions [1]. On the battery level, additional ageing drivers can result from unbalanced cells or cells with different capacity.

In the present study we investigate the aging behavior of stationary lithium-ion battery cells on both the cell and the system level. A total of 28 commercial 180 Ah high-energy LFP/graphite prismatic cells are characterized on the cell level (capacity, electrochemical impedance, internal resistance) both as supplied and in regular check-up intervals during operation. The cells are assembled and operated within two 8 kWh commercial residential battery storage systems that have two different cell configurations (serial/parallel). The battery systems are embedded in a regenerative power micro-grid that that consists of regenerative energy sources (photovoltaic and wind) and loads (electric car charger, load simulator, offices) [2]. The study thus spans the complete range from cell level over battery pack level to microgrid system level.

Cell-level aging is quantified and related to the acquired data during operation within the micro-grid (cycling depth, temperature, etc.). The performance of the two battery system configurations is compared. The study thus allows to distinguish between cell-level and pack-level ageing drivers. With that, cell aging indicators in favor of extending the lifetime of stationary battery systems are developed.

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