Energy Storage Systems for Multiple Power System Applications: Technology Selection and Sizing

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Technology selection and sizing of Energy Storage Systems (ESSs) for power system applications are key aspects of the design procedure. Based on the services provided, both the technology and the size of ESSs can vary significantly. In this work, we present a new methodology for optimal sizing and technology selection of ESSs for multiple power system applications, that combines a probabilistic analysis of critical network characteristics such as demand and energy prices, with a nonlinear optimization problem that takes into account operational costs, lifetime, operational and manufacturing constraints of ESSs.

The methodology has been validated for an ESS providing Peak Shaving and Energy Arbitrage services simultaneously. Along with optimal sizes and technologies, results showed that, for the considered case study network, optimal life is limited by aging, rather than cycling lifetime. The effects of different demand and energy price patterns on the operation, lifetime and profitability of the ESS have been studied as well. We showed that optimal operational cost of ESS is determined not only by its characteristics (e.g. CAPEX, efficiency, self-discharge, lifetime) but also by energy price profile, specifically peak price duration (Fig. 1). Also, we showed that optimal sizing of ES assets for the Peak Shaving application primarily follows the power requirement from demand profile, with a significant additional energy capacity deployed (Fig. 2).

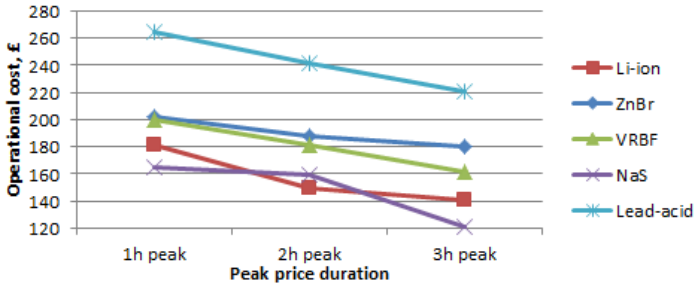
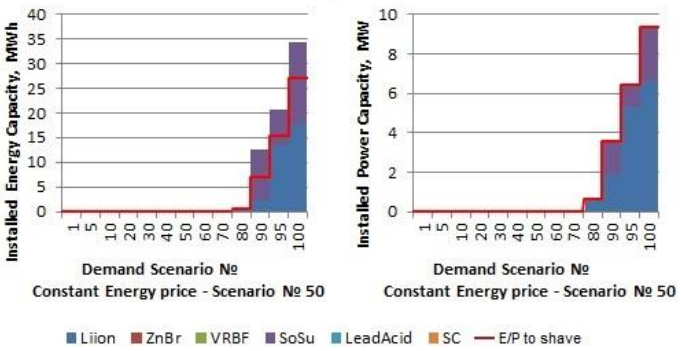


Fig. 1. Operational cost vs peak price duration



a) Energy Capacity b)Power Capacity

Fig. 2. Energy and power capacities of ESS for Peak Shaving