Battery storage systems: An economic model-based analysis of parallel revenue streams and general implications for industry

This paper evaluates the economic potential of energy flexibility in 50 different German small and medium sized enterprises (SMEs) through the installation of a battery storage system (BSS). The central innovation lies in the possibility of pursuing multiple revenue streams simultaneously: peak shaving, provision of primary control reserve (PCR) and energy-arbitrage-trading through intraday and day-ahead markets. The energy system of an industrial manufacturing plant is modelled as a linear program (LP) with a 15-min resolution. The model offers the option to invest in BSSs with different capacities, with the objective of minimizing the overall cost and identifying the optimal size of the BSS. The results show that none of these three revenue streams individually is economically attractive, but when combined, all three together can achieve profitability for some companies, whereby the majority of the cash flow comes from peak shaving and PCR. With a fixed BSS capacity of 500kWh, the Net Present Value (NPV) varies from a minimum of −350,000€ for just arbitrage up to about 200,000€ for all three use cases in parallel. In the case of a variable BSS capacity, the capacity varies up to 1200kWh and the Profitability Index (the ratio of investment to NPV) varies from 0.06 to 0.31. Under current German market conditions, arbitrage trading contributes only marginally to the profitability, as the price spreads are too small to justify stronger battery degradation. The paper also identifies various load indicators from the analysis of the demand profile that support the evaluation of a BSS in industry. A stepwise linear regression reveals a moderate dependency of the BSS profitability on two newly developed load indicators. Future work should focus on a more detailed depiction of the battery’s technical behaviour and increasing the sample size to improve the statistical significance of the results.