Battery energy storage system design for office building

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With their high responsiveness, battery energy storage systems have the possibility to offer different services in the field of power supply. However, each of these operating strategies has a different influence on the ageing of the battery. By considering this degradation process in the initial sizing of the system, the operational life can be extended and the profitability of the project optimized.

Motivation

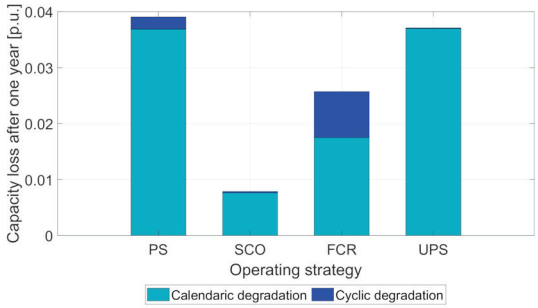
In most system integration projects, the question of the lifetime of battery energy storage systems (BESS) is a central issue in sizing. As ageing is strongly influenced by the operating point (SoC, DoD, C-rate), each operating strategy causes a more or less rapid degradation of the storage capacity. The search for the optimal battery configuration is the key to extending the life of the system and ensuring its long-term profitability.

Methodology

The analysis carried out in this project relates to a real situation: the integration of a BESS in a commercial building equipped with photovoltaic production plant. Different scenarios are generated based on consumption and production profiles calibrated to the characteristics of the reference building and analyzed. Four "primary" operating strategies that can be provided by BESS are selected:

- Peak shaving (PS)
- Self-consumption optimization (SCO)
- Frequency containment reserves (FCR)
- Uninterruptible power supply (UPS).

The sizing of the BESS is performed for each of the scenarios and control strategies. In all cases, the ideal power profile of the battery is simulated and the energy performance as well as degradation of the system are estimated using mathematical models based on several scientific publications on the subject. An economic analysis is finally carried out to determine the BESS configuration that generates the lowest depreciation cost. At the same time, the revenues generated by the operating strategy are evaluated, which allows the profitability of the system to be estimated.



Storage capacity lost after one year of operation for different operating strategies

After dealing with each "primary" strategies individually, the evaluation is repeated by providing several services with a single BESS. The impact of the combination on the sizing, degradation process and economics of the battery is calculated following the same logic and compared to the "primary" configurations.

Results

The ageing analysis of the BESS showed that, for the assumptions made for this project, the optimization of self-consumption has the lowest degradation rate. On the other hand, the reduction of power peaks leads to significant stress that significantly reduces the lifetime of the system.

From an economic point of view, only peak shaving and frequency containment reserves strategies are beneficial under certain conditions. Unfortunately, the current energy market context does not allow to guarantee the necessary profitability for the other services offered by the BESS.

Finally, the combination of services slightly improves the situation but it does not reverse the trends identified during the analysis of "primary" strategies.

More generally, this project has established a calculation method to estimate the degradation of a BESS in a simplified way for the dimensioning process of the system. Thanks to this, a complete technical-and-economic analysis can be carried out, as was the case for this work.

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