Optimal Component Sizing for Peak Shaving in Battery Energy Storage System for Multiple Industrial Clients

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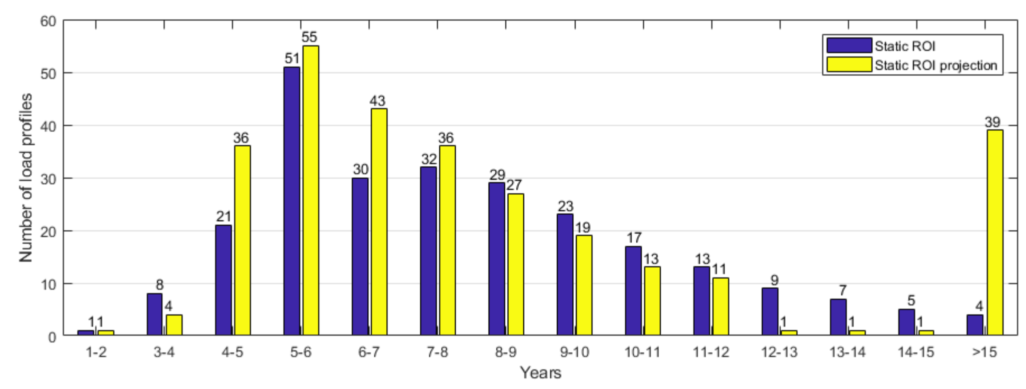
BACKGROUND

Recent attention on industrial peak shaving applications sparked an increased interest in battery energy storage. Among other studies, there have been several reports examining optimal sizing of such storage systems for individual clients which results in the battery energy storage system standing idle most of the time.

A study of nearly 300 industrial load profiles within Germany showed that in 2017 about 10% of all load profiles result in a static return of investment (ROI) of 5 years and below and can be described as interesting for peak shaving. Also, the study shows the perspective of investment reduced by 30% and price per kW raised by 30%.



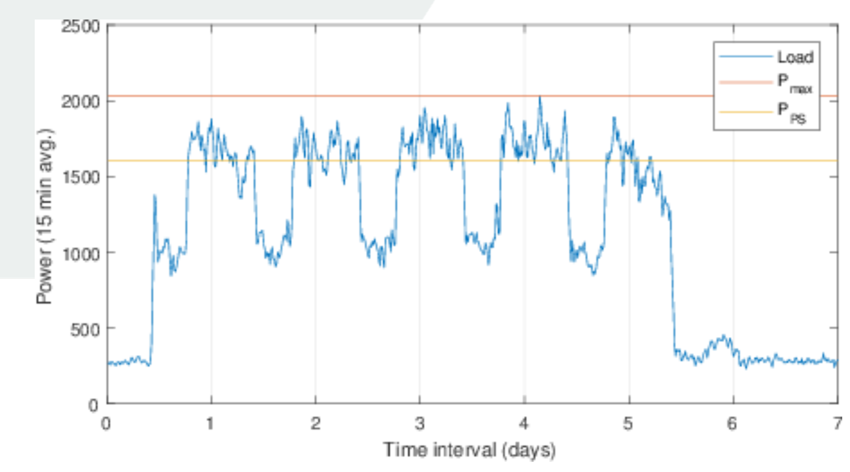
OBJECTIVES

Objective: “Energy storage as a service”

This work proposes a new business model where battery energy storage is offered as a service by a new stakeholder. This new model allows sharing a single battery storage system among multiple clients.

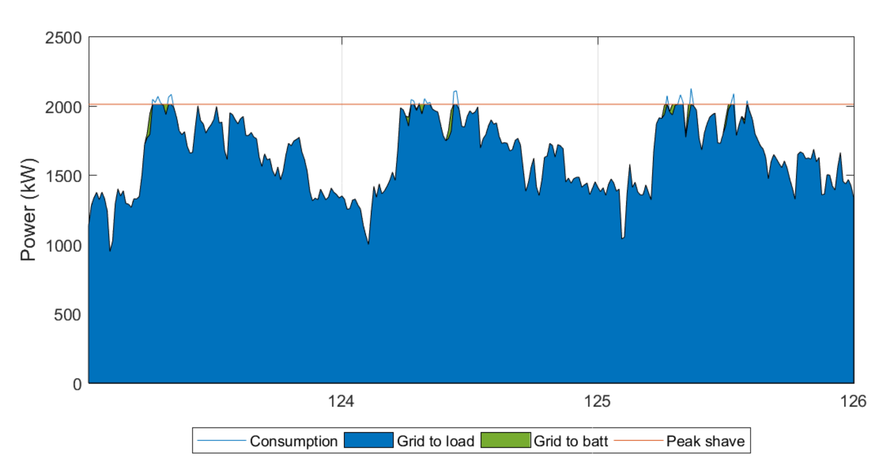
The energy management system proposed in this study is derived from measured and simulated data for an exemplar BESS.

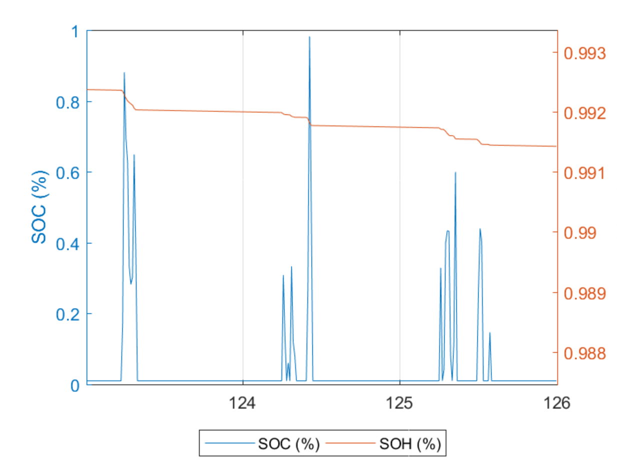
The price components for industrial customers: the total energy consumption $E_{total} = \sum Load_i$, the maximum power peak in the billing period P_{max}, and the maximum power peak after peak shave P_{ps}.



RESULTS

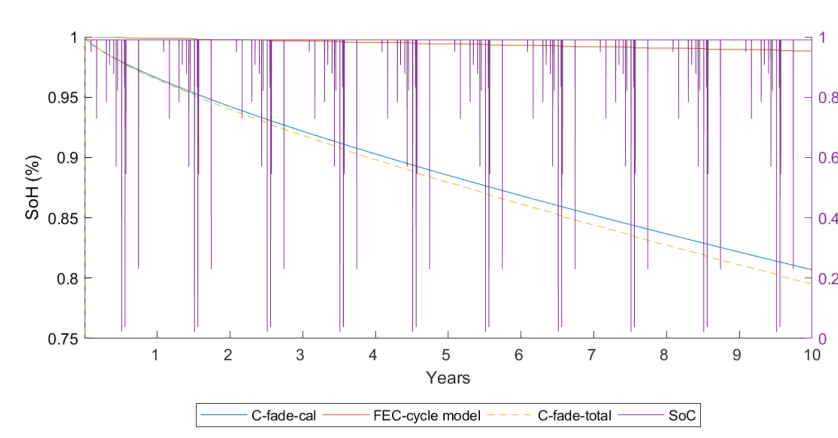
The results show that sharing batteries in peak shaving applications for multiple clients shortens the payback period. The payback for clients with individual BESS installation is 5 years on average and the system shaves around 9% of the peak load. Considering multiple clients with only one storage system providing peak shaving, the payback period decreases to 2 years and the system can cover 21% of the peak load.

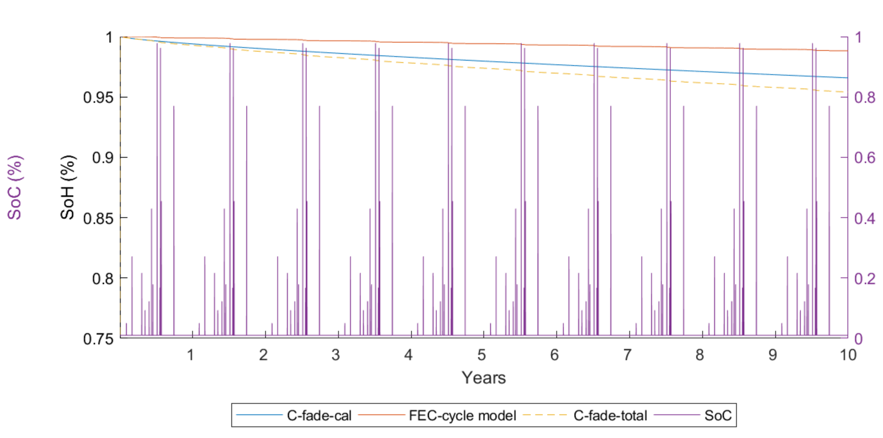




Power flow analysis for a three-day period: load and power flows within the system (left); time correlated evolution of battery state of charge (SOC) and resulting state of health (SOH) decline (right).

The results also show that batteries used in peak shaving applications are more sensitive to calendric aging than cyclic aging. Two battery usage strategies are considered to better understand the impacts of calendric and cycling degradation. The first strategy is naive and assumes that the BESS is always at full SoC capacity, drained only to provide enough power to peak shave, and then fully charged again staying idle until the next peak of load. The second strategy is based in the optimal solution which is achieved using a linear programming (LP) algorithm.





Time correlated evolution of battery state of charge (SoC) and resulting state of health (SoH) decline for the naive strategy (left) and optimal strategy (right).

FUTURE DIRECTIONS

A case study conducted using real world industrial profiles shows the applicability of the approach as well as the strong battery energy storage system dispatch and resulting return on investment dependence with respect to the industry load profile. This underlines the need for general mathematical optimization approaches to effectively tackle the challenge of peak shaving using energy storage systems.

The study highlighted an alternative to maximize the usage of battery energy storage system for peak shaving application and reduce the idle time of such systems. Future research should consider industrial load profiles from Canada, as well as the local energy and power price schemes.

The model reveals the potential of an SOC-aware charge control strategy for peak shaving applications with adequate forecasting, the battery storage system lifetime could be significantly prolonged. Forecasting algorithms ensure that the storage system will be able to charge and discharge energy when needed will be developed in future work.

PARTNERS

smart POWER

Early research on peak shaving was conducted with Smart Power GmbH & Co KG, a company from Munich, Germany, that deals with the design, construction and turnkey commissioning of complete storage systems on an industrial scale.

ATCO Electric

Sample data for simulation studies presented in this poster were provided by ATCO Electric.

FES PROJECT OVERVIEW

Project T06-P02: Modern energy systems provide plethora of data (including data on generation, loads, weather and market conditions) that can be harnessed for the design, monitoring, and control of electric power grids. Under the smart grid framework, this data and information is gathered and processed using information and communication technologies (ICT) and can be used to enhance the reliability, efficiency, flexibility, and resilience of power systems. In future energy systems, an additional degree of complexity will be brought by mass introduction of renewable energy sources (RES) and storage devices. This integrated research program will address the major challenges expected within the future grids through data-driven methods, and develop principles for building grids capable of adaptation to changes not yet anticipated in the future.

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