Popular Science Summary of Master Thesis

Battery Energy Storage System Size Optimization for Energy Shifting and Constant Power Delivery - the Benefits of the System Integration with Solar Farms in Sweden

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This master's thesis project was carried out in cooperation with Comsys AB to investigate the optimum size of a battery energy storage system (BESS) coupled with a 10 MW solar farm in Sweden. The current transition to renewable energy sources, such as solar, poses new challenges to the power grid. For example, how do we meet the morning and evening high energy demand when the sun shines during the day? This set of opposite patterns creates an imbalance that could have a negative effect on power quality and availability to customers. Battery energy storage system is regarded as one of the best solutions to this problem due to its ability to provide a range of critical services (Stecca *et al.*, 2020). Two of these services were studied in this work, namely energy shifting and constant power supply. The BESS used for energy shifting allows for storing solar energy during low prices and discharging the energy during high price periods (Asian Development Bank, 2018). The low-price periods typically occur at night and around noon when people are at work (low-demand periods). On the other hand, high price periods occur at times when people get ready for work in the morning and when they come home in the evening (*Nord Pool | Day-ahead prices*). These spot price fluctuations allow shifting energy to the hours when it is the most financially profitable, thus making the system more attractive for investors. At the same time, it allows energy to be stored when there is not as much need for it and discharged when we need it. This helps the system to meet the peak demand and avoid the employment of fossil fuel technologies (Borkowski, Oramus and Brzezinka, 2023). The second studied service - constant power supply- is highly relevant for the future with high solar energy penetration and limited "firm power" supply (e.g., nuclear and fossil fuels). The purpose of BESS in this case is to provide this secure power by storing and discharging the energy in the battery to keep injecting power at a constant level (Tejero-Gómez, 2023). The results for the energy shifting service show that the ideal storage capacity was 20 MWh, thus resulting in the optimum ratio of 2 MWh/MW. For northern regions, the system was not profitable. The energy shifting service was also evaluated for a high solar energy penetration price profile and demonstrated interesting results. The ideal size storage capacity decreased to 15 MWh in northern regions and 5 MWh in southern regions. A significant finding was that northern regions showed increased profitability by 40%, demonstrating that in the future, the BESS system can become attractive for investors even in this part of Sweden. As for the constant power service, the simulations showed a storage capacity of 40 MWh (4 MWh/MW) to be optimal across the whole of Sweden.

References

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