ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Case Study On The Behaviour Of Battery Energy Storage Systems During Network Demand Peaks

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There has been a significant increase in the number of distributed battery energy storage system (BESS) installations on the electricity network in the recent years. A higher penetration of BESS on the electricity network brings both opportunities and challenges for the network operators. For example, a BESS can reduce the amount of electricity purchased by the networks' customers but an ideally sized and placed BESS can also provide many grid services such as peak demand support, renewable energy smoothing, and voltage and reactive power support (Divya and Østergaard, 2009, Dunn et al., 2011). Therefore, there has been a considerable growth in the interest of orchestrating these BESS to capture the values of these potential grid services. Many studies model the value of BESS to consumers (Beck et al., 2016, Leadbetter and Swan, 2012) and their potential impacts on the network (Lu et al., 2014, Yang et al., 2014, Denholm and Margolis, 2018), however there are few studies reporting the field performance of these systems (AEMO, 2018, Public Service of New Mexico, 2012, Koller et al., 2015, Ueda et al., 2006, Uddin et al., 2017). The main focus of this study is to assess the behaviour and performance of residential BESS during network peaks and zone substation peaks. In theory, the BESS' ability to reduce household demand at any time is dependent on whether it is sized appropriately to meet demand and whether it can react correctly to changes in demand. During times when the BESS is active, has available energy and demand is lower than the BESS' rated power, the BESS should be able to reduce household demand to zero.

This study analysed BESS behaviour from 1-minute interval data of 15 residential BESS that were operating in load-following mode (meaning they would charge from solar export and discharge to offset a positive net demand). This study reports that during the days of network and zone substation peak demand, only about half these residential BESS demonstrate load-following behaviour, with many demonstrating a greater than 10% deviation between net demand and BESS output. Some BESS demonstrate unorthodox behaviour such as charging during times of positive net demand, either sporadically or at a constant rate. This suggests the BESS models in the literature do not accurately represent how they are operating in the real-world, and so further monitoring should be conducted to assess the correlation between real and modelled BESS. This paper also reports that the residential BESS that were load following discharged at on average 30% to 70% of their rated power during the network peak events. Although the results show that there are opportunities for orchestration to increase the demand reductions from the BESS, it raises a question on the need for orchestration of BESS into Virtual Power Plants if their independent operation results in significant demand reductions during peak events.

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