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Threshold Based Control Policy for Energy Storage Operations with Demand Response and Renewable Energy

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Abstract

In recent years, as climate change caused by CO2 emission followed by a surge in energy consumption becomes growing serious environmental concerns, there has been a significant effort by industrial sectors to reform existing systems operations to improve energy efficiency and sustainability tied to the wide-spread of demand response program and the high penetration of renewable generations. Followed by these efforts, many studies have been conducted to improve energy efficiency and sustainability in a wide range of industrial systems operations. Given this, the co-location of renewable generation integrated with battery energy storage has been considered as a promising solution that enables many industries to realize energy-efficient and sustainable operations. Considering co-located renewable generations, e.g., solar PV panels, integrated with battery energy storage, this study intends to develop a proper control policy for energy storage operations to minimize electricity cost while meeting time-varying electricity demand load in response to intermittent renewable generation and time-of-use electricity prices. Specifically, this study proposes a threshold-based control policy by determining static time-varying thresholds on the state of charge level using two-stage stochastic programming based on historical data. The proposed threshold-based control policy can be applied to energy storage operations by adjusting charging and discharging energy storage to ensure the threshold has the minimum state of charge level of energy storage.

Keywords
Energy Storage, Demand Response, Renewable Energy, Two-Stage Stochastic Programming.

Biographies

Awnalisa Walker is a PhD student in the Systems Science and Industrial Engineering Department at Binghamton University, State University of New York (SUNY). She is conducting research in the Smart Energy (Senergy) Lab under advisor Dr. Soongeol Kwon. She earned her B.S. in Mechanical Engineering from Northeastern University in Boston. Massachusetts and M.S. in Industrial and Systems Engineering from Binghamton University. She was awarded the National Science Foundation SUNY LSAMP Bridge to the Doctorate Fellowship.

Soongeol Kwon is an assistant professor with the Department of Systems Science and Industrial Engineering, Binghamton University, SUNY, Binghamton, NY. He received B.S. and M.S. degrees in Industrial Engineering from Yonsei University, Seoul, South Korea, in 2005 and 2007, respectively, and received a Ph.D. degree in Industrial and Systems Engineering at Texas A\&M University, College Station, Texas, in 2017. The primary focus of his research has been on developing decision-making model using mathematical optimization and machine learning to improve efficiency and sustainability of energy systems. In terms of application, his research interests include but are not limited to smart grid, demand response, renewable energy, energy storage, building energy management, energy-aware manufacturing, and data centers.