Electrical & Computer Engineering

D E F E N S E

Louisiana State University

Participation of Battery Energy Storage Systems in Load Frequency Control of Power Systems

a dissertation to be defended by

Zakaria Afsharbakeshloo

Ph.D. Candidate

LSU Division of Electrical & Computer Engineering

Abstract—In this dissertation, functionalities and roles of Battery Energy Storage Systems (BESSs) in power systems are extended beyond primary frequency control (PFC). The BESSs, while participating in PFC, are controlled to first maintain their state-of-charge (SOC) within an acceptable range through a primary charge controller, and to recharge the BESS to its maximum SOC through a secondary charge controller. This forms a hierarchical frequency and SOC control of power grids with BESSs. As an important participation of BESS in frequency control, grid inertia enhancement can be performed through BESS for the inertial response of grid frequency that has been presented in the literature. However, this is contingent upon knowing the accurate knowledge of the equivalent grid inertia, which is variable due to the connection and disconnection of renewable energy resources, calling for inertia estimation to determine the deficit in the grid inertia. Here, adaptive control theory is used to control the grid inertia without the need for accurate information about the equivalent grid inertia. As another role of the BESS in frequency control, the cyber-attack mitigation is performed on the BESS-side to detect and mitigate the adverse effect of a cyber-attack on the communication links used for secondary frequency control. It is proven that BESS-side attack mitigation excels in synchronous generator-side while considering the communication link delay, which always exists in power systems.

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