Impact Study of Value-Added Functionality on Inverters in Energy Storage Systems

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Motivation
Power conversion systems (PCS) developers are incorporating value-added functions; little is known about the overall PCS reliability.

Objective
Develop electrical models to gain an understanding of the degradation of a PCS and its internal components due to value-added functionality; primarily VAR generation. Investigation and modeling of frequency support applications may be considered as a secondary objective.

Simulated System
The reliability models will then be leveraged to identify areas of improvement such as revised component selection and advanced control methods.

Figure 1: High-Level Diagrams of Experimental Setup
Figure 2: ABB PCS100 ESS Solution
Figure 3: Theoretical PQ-Controlled Voltage-Sourced Converter
Figure 4: PLECS Switching Model with Thermal
Figure 5: PLECS Battery Model
Figure 6: Real and Reactive Power Reference vs. Output
Figure 7: IGBT and Diode Loss from Manufacturer (Fuji)
Figure 8: IGBT and Diode Loss from Simulation
Figure 9: Junction Temperature vs. Converter Power Output
Figure 10: DC-Link Capacitor Ripple in Test Conditions (Fig. 6)

Future Work
- Selection of final converter components/topology
- Improved degradation and reliability analysis
- Assessment of PCS improvement proposals
- Evaluation of the effect of additional value-added functions

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