An Optimization Framework for Dynamic Hybrid Energy Systems

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A computational framework for the efficient analysis and optimization of dynamic hybrid energy systems (HES) is developed. A microgrid energy system with multiple inputs and multiple outputs (MIMO) is modeled using the Modelica language in the Dymola environment. The optimization loop is implemented in MATLAB, with the FMI Toolbox serving as the interface between the computational platforms. Two characteristic optimization problems are selected to demonstrate the methodology and gain insight into the system performance. The first is an unconstrained optimization problem that optimizes intrinsic properties of the base generation, power cycle, and electrical storage components to minimize variability in the HES. The second problem takes operating and capital costs into consideration by imposing linear and nonlinear constraints on the design variables. Variability in electrical power applied to high temperature steam electrolysis is shown to be reduced by 18% in the unconstrained case and 11% in the constrained case. The preliminary optimization results obtained in this study provide an essential step towards the development of a comprehensive framework for designing HES.