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Optimal Portfolio of Multi-service Provision based on Stochastic Model Predictive Control

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Abstract : As the proliferation of decentralized energy systems, the UK power system allows small-scale entities such as microgrids (MGs) to tender multiple energy services including energy arbitrage and frequency responses (FRs). However, its operation requires the balance between the uncertain renewable generations and loads in real-time and has to fulfill their provision requirements of contract services continuously during the time window agreed, otherwise it will be penalized for the under-delivered provision. To hedge against risks due to uncertainties and maximize the economic benefits, we propose a stochastic model predictive control (SMPC) framework to optimize its operation for the multi-service provision. Distinguished from previous works, we include a detailed economic-degradation model of the lithium-ion battery to quantify the costs of different service provisions, as well as accurately describe the changing dynamics of the battery. Considering a branch of load and generation scenarios and the battery aging, we formulate a risk-averse cost function using conditional value at risk (CVaR). It aims to achieve the maximum expected net revenue and avoids severe losses. The framework will be performed on a case study of a PV-battery grid-tied microgrid in the UK with real-life data. To highlight its performance, the framework will be compared with the case without the degradation model and the deterministic formulation.

Keywords : model predictive control (MPC), battery degradation, frequency response, microgrids
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