UNIVERSITÄT ZU KÖLN

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Titel:

Grid Connection Sizing of Hybrid PV-Battery Assets: Navigating Market Volatility and Infrastructure Constraints

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Abstract:

The increasing share of intermittent renewable energy generation amplifies power price volatility, increasing the need for storage technologies such as battery energy storage systems (BESS). However, limited transmission infrastructure, particularly constrained grid connections, poses a major barrier to the deployment of both BESS and renewable generation. Co-locating BESS with wind and solar assets can optimize grid connection capacity and reduce project costs. This study examines the effects of grid connection rationing on hybrid PV-BESS assets, accounting for weather-induced power production uncertainty and price fluctuations. Findings indicate that hybrid PV-BESS systems can reduce their grid injection capacity by up to 60% of their nameplate capacity without significantly affecting contribution margins, as peak solar generation coincides with low power prices. In contrast, grid withdrawal constraints substantially reduce contribution margins and increase risk exposure. Furthermore, variable feed-in tariffs, as applied to hybrid PV-BESS systems in Germany, distort price signals, diminishing diversification benefits and encouraging oversized grid connections by inflating the value of generation during low-price periods. These findings highlight the need for policymakers and network operators to design efficient grid connection pricing mechanisms and mitigate distortive interactions with feed-in tariffs.