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A Spread-Limit Product for Storage in Day-Ahead Electricity Markets

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Extended Abstract

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Abstract Summary

This paper proposes a competitive spread-limit product for storage in day-ahead electricity markets that allows the exchange to clear competing storage offers and determine charging and discharging times within a non-discriminatory market framework, rather than through ad hoc operator intervention or centralized battery dispatch. While storage can smooth prices and improve system efficiency, existing market arrangements typically require operators to specify charging and discharging times in advance, exposing them to forecasting risk and potentially leading to privately rational but socially inefficient schedules. Existing products such as the European Loop Block partly address this issue through spread-based bidding, but still require time-specific commitments and are effectively limited to a single cycle.

The paper develops two time-agnostic storage offer types and a clearing rule based on uniform pricing, proportional allocation, and a common normalized dispatch profile. Storage gains are decomposed into storage-side surplus and the combined surplus of non-storage participants, allowing the analysis to distinguish storage profitability from its effect on other market participants. The resulting planning problem admits an exact linear-programming formulation and can be solved globally with standard LP methods. An independent mesh-based dynamic programming benchmark yields closely matching solutions.

Empirically, the design is evaluated using day-ahead aggregated bid-curve data for 2020–2024 from seven European markets. The theoretical results show that total surplus, including storage-side surplus, is non-decreasing over the range of accepted storage quantities, and that the combined surplus of consumers and generators is likewise non-decreasing at each affected hour. The empirical results show that the multi-cycle version consistently outperforms a single-cycle benchmark in both total surplus and non-storage surplus. It reduces intraday price ranges, moderates spikes, supports prices during very

low-price hours, and smooths smaller fluctuations. Overall, the proposed product offers a promising, non-discriminatory way to integrate storage more efficiently into European-style zonal day-ahead electricity markets.

Presenting Author Biography

Takuji Matsumoto is an Associate Professor at the Institute of Science Tokyo, specializing in energy finance. He holds an MS from MIT and a PhD from the University of Tsukuba, and has contributed to energy policy and market analysis in both academia and industry. His experience includes roles at a research institute, a think tank, and government agencies in Japan, as well as a visiting appointment at London Business School. His research focuses on electricity markets, energy finance, and forecasting, and he has published as first author in leading journals such as Energy Economics and IEEE Transactions on Power Systems.