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Drawing the Right Lines: Identifying Optimal Bidding Zones for the European Electricity Market

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Extended Abstract

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Abstract Summary

Europe's electricity market is divided into bidding zones, geographic areas where electricity trades at a uniform price. These boundaries largely follow national borders rather than transmission congestion patterns, leading to notable economic inefficiencies. This paper evaluates the economic performance of Europe's current zonal configuration and applies economically motivated clustering techniques to identify and assess more efficient alternatives.

We propose a simple empirical framework to measure how well bidding zones reflect underlying grid conditions. Our key metric, the spatial R-squared, ranges from 0% to 100%. A score of 100% means zonal prices fully reflect local conditions, with no efficiency loss from aggregation. A score of 0% means zonal prices are no better than charging a single European-wide price.

We apply our framework to the rich dataset of the ENTSO-E Bidding Zone Review, which provides simulated nodal prices for over 20,000 nodes across 29 countries in Europe. Our results indicate that the current zonal configuration achieves a spatial R-squared of 91.9%, suggesting that most congestion occurs at cross-border interconnectors. The largest efficiency gain comes from optimally splitting Germany into two zones, which captures 40.9% of the remaining unexplained local price variation, followed by splitting France, which accounts for approximately 9.1%. Furthermore, the multiple sub-zones of Italy and Sweden explain only around 14% of their internal price variation each, while optimally drawn zones can raise their internal spatial R-squared to 85% and 95% for Italy and Sweden, respectively. Finally, we demonstrate our methodology by clustering all continental European nodes freely. This exercise reveals that just seven optimally placed zones can match the efficiency of the existing 34-zone configuration. Our findings complement the recently published ENTSO-E Bidding Zone Review and suggest that the key issue is not the number of bidding zones, but rather where their lines are drawn.

Presenting Author Biography

Jonas Boeschemeier is a PhD candidate in Energy Economics at the Technical University of Munich and a visiting PhD student at MIT's Center for Energy and Environmental Policy Research (CEEPR). He holds an MPhil in Economics, Econometrics, and Finance from the Tinbergen Institute in Amsterdam and a BSc in Economics from Maastricht University. His research examines the role of electricity market design in the energy transition with particular focus on locational and real-time pricing.