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How Many Zones Should an Electricity Market Have? A Cross-Country Perspective on Bidding Zone Design

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The electricity markets in Europe are divided into geographical bidding zones, each with a uniform price for electricity. However, the number and size of these zones can significantly affect the efficiency of the electrical system. This paper examines a central question in the current debate on electricity market design: *how many zones should a 'national' electricity market have?* The study explores this issue through a comparative analysis between countries with long-standing zonal systems, such as Italy, Norway and Sweden, and jurisdictions like Texas and California, which adopted zonal pricing in the past but have since shifted to more granular nodal systems. By observing how zonal systems have been designed and adapted over time in different markets, it is possible to identify common aspects of implementation and the different results in terms of efficiency, price convergence and congestion management.

We show that zonal configurations can offer significant advantages in aligning price signals with the physical constraints of transmission networks, while introducing design challenges and trade-offs. However even in countries with several zones, the number of zones remains small (Italy has the most in the EU at 7) and zonal structure characterised by high degrees of inertia. In spite of the intention to review zonal boundaries every three years, the EU is still completing its first review 7 years after it was initiated, with mixed success.

Italy, in particular, presents a compelling case of how zonal markets evolve. Since the launch of the power exchange in 2004 and the transition to a fully zonal consumption regime in 2025, Italy has maintained a stable but adaptable zonal structure to manage persistent North-South imbalances. Over time, the zonal price spread has narrowed, thanks to transmission upgrades and the internalization of new renewable generation dynamics. The creation of the Calabria zone in 2021 and the reallocation of Umbria demonstrate how expert-based revisions grounded on operational knowledge and grid planning can improve the spatial granularity of price signals without compromising liquidity or competition. Finally, the particularity of the hybrid system in Italy opens up a political issue: the single national price on the demand side has been replaced by the zonal price, which has created a further socio-economic debate. In the logic of pricing generation, the cross-over of supply and demand will reward consumers in the more virtuous electricity zones with higher production and more inclined to flexibility.

Norway, on the other hand, has adopted a more dynamic approach, gradually increasing the number of bidding zones between 2008 and 2015 to reflect changing hydrological balances and grid bottlenecks. The zonal structure helps to integrate the vast hydropower resources into the Nordic market and to send location signals during periods of scarcity, particularly in drought years.

However, the presence of internal congestion and strategic supply behaviour in some Elspot areas highlights the limitations of the current zonal resolution. Moreover, the price differences between the various market zones emphasizes Statnett's proposal to split zone NO4, motivated by increasing wind capacity and flow constraints, highlights the need for continuous boundary refinement even in mature zonal systems.

Similar dynamics were observed when Sweden switched from a single-zone market to four-zone markets in 2011. The reform was dictated both by internal congestion management needs and by external pressure from the European Commission, which regarded practices to avoid internal congestion as distortions of competition. Empirical analyses show that the reform was successful in differentiating prices geographically and improving investment signals, particularly for the southern SE4 zone. However, the emergence of persistent price differentials and increased volatility in some areas suggests that complementary policies, in particular network strengthening, are needed to stabilise performance.

Despite the diversity of experiences examined, several general conclusions can be drawn.

First, zonal pricing can improve transparency and operational efficiency by signaling congestion and guiding investment. However, the benefits depend on the appropriate definition and periodic re-evaluation of zone boundaries.

Second, while smaller or more granular zones can internalize constraints more effectively, they may also raise concerns over liquidity, particularly in long-term markets. Yet, as shown in Italy and the Nordic region, institutional mechanisms such as market coupling and coordinated planning can mitigate these effects.

Third, price volatility and welfare impacts vary by context: while zonal markets may introduce short-term price differentiation, they can also reduce redispatch costs and deliver longer-term efficiency gains.

Finally, a persistent gap in literature and policy practice is the lack of empirical evidence on the true welfare effects of bidding zone reconfigurations. Most existing studies are based on simulation models or partial indicators. There remains a need for more systematic and evidence-based assessment of past reforms, including their impact on consumer surpluses, producer behaviour and system-wide efficiency.

In light of the results presented, we support a dynamic and evidence-based approach to zonal area design. Rather than considering the number of zones as fixed, regulators should consider zonal boundaries as a policy tool that evolves with network constraints, market developments and decarbonization targets. Responsive zone design, supported by expert and model-based assessments, can balance efficiency, liquidity and equity in increasingly complex and integrated energy systems.

However, it is equally important to acknowledge that once a zonal structure is implemented, it tends to exhibit institutional and political persistence. As such, zonal design should be approached with a clear understanding that reconfiguration entails both technical and institutional costs, and that the benefits of greater operational precision must be weighed against the systemic value of predictability and continuity.

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