Developments of Day-Ahead Electricity Markets: Insights from Bidding Data

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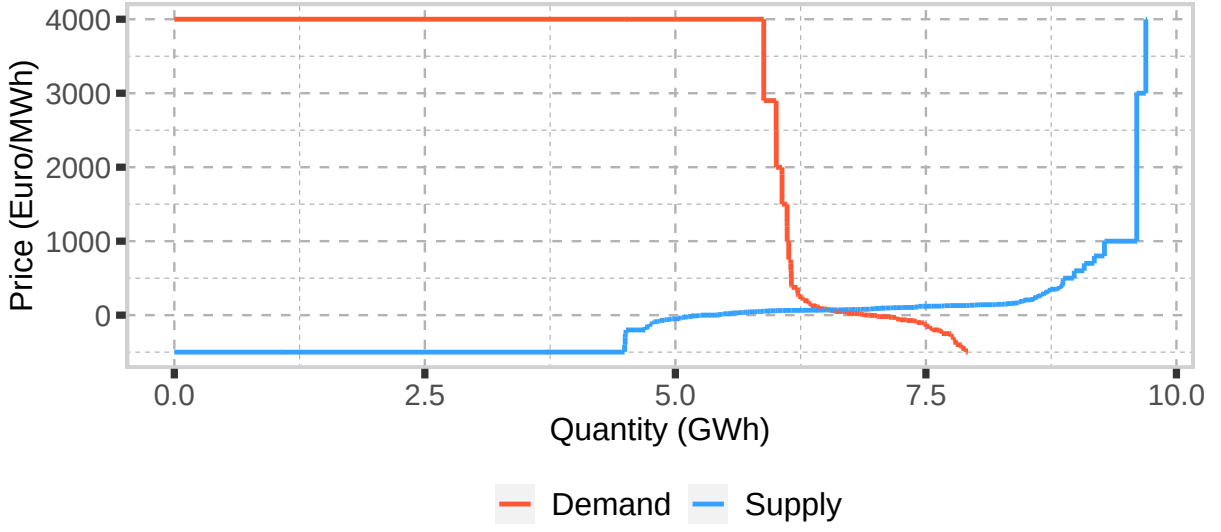
Overview

Since the introduction of European electricity markets in the early 1990s, many aspects of the energy landscape have changed significantly. Key developments, such as the coupling and integration of national and regional markets, the transition from fossil-fueled power plants to more renewable energy sources, and the introduction of real-time markets have transformed how electricity is traded and consumed across Europe. In this study, we aim to investigate how such developments have influenced electricity trade in the day-ahead electricity market.

In the day-ahead market, participants can sell and buy electricity in a pan-European auction for the 24 hours of the next day in (hourly) blocks. They do this by submitting bids, indicating the amount of electricity that is demand or supplied, and for what price. The day-ahead market is cleared daily at 12:00 noon. At this time, so-called supply and demand curves are constructed by ordering the bids based on the bidding price. The intersection of these curves, an example is given in Figure 1, determines the electricity price and volume for each hour. This price is either paid or received by all participants whose bids were successful in the auction. Since the day-ahead market operates shortly before the delivery period and features a uniform clearing price per hour, it is regarded as the best representation of electricity's value at different times of the day. Consequently, the clearing price is often referred to as "*the electricity price*". The price is determined per bidding zone, which in Europe mostly corresponds to the borders of a country (TenneT, 2025).

Figure 1: Dutch day-ahead supply and demand curve between 12:00 and 13:00 on 18.07.2023



Notes: For the supply curve, all bids of market participants that want to sell electricity are ordered from lowest to highest price. For the demand curve, all bids of market participants are ordered from highest to lowest price. The intersection of these curves gives the Market Clearing Price.

In order to investigate developments in the day-ahead electricity market, we use a rich dataset from the European Power Exchange on the bids that have been submitted in the Dutch day-ahead electricity market in the period 2006-2024.

Methods

We analyze the bidding data in different ways.

Individual bids. First, we analyze individual bids submitted in the day-ahead market. By examining the distribution of bidding prices and volumes, we gain insights into market participants' bidding behavior, and how this has evolved over time. This analysis is further contextualized by considering external factors, such as the increasing share of renewable energy in the market and fluctuations in commodity prices, including natural gas and coal.

Demand and supply curves. Then, we use the bids to construct the demand curve and supply curve as given in Figure 1, and analyse these hourly curves. We do this by estimating the price elasticity of demand and the price elasticity of supply, which indicate how the quantity of electricity (demanded and supplied) responds to price fluctuations. The price elasticity is given by:

$$\frac{\partial q/q}{\partial p/p}, \tag{1}$$

where p is the electricity price, and q is the corresponding electricity quantity.

To estimate the price elasticity from the supply and demand curves, we extend the approach of Wan et al. (2022), consisting of the following steps. First, we use a regression analysis to model the relationship between bid prices and quantities. Where Wan et al. (2022) use linear, exponential and cubic functions, we fit monotone splines to the demand and supply curves. Compared to the models used by Wan et al. (2022), spline regression offers a more flexible method to model nonlinear relationships by fitting smooth, piecewise polynomial functions (Perperoglou et al., 2019).

Then, we use the estimated spline regression to calculate the price elasticity as the percentage change in quantity divided by the percentage change in price. From Figure 1, it becomes clear that the price elasticity is not the same for different parts of the curve. For example, for high electricity prices, the demand curve is relatively steep, indicating that the amount of electricity demanded responds strongly to changes in the electricity price. However, at prices around zero, the demand curve becomes flatter. To take into account this variation of the price elasticity, we estimate the price elasticities (of demand and supply) at different points of the demand and supply curves.

We repeat this procedure for all hours in the period 2006-2024, and analyse how the price elasticities of both the supply curve and the demand curve have evolved.

Results (expected)

At the moment of writing, the analysis is not finished. However, by June, we expect to have finalized the analysis and that we can present our results.

Conclusions

In summary, this study investigates the evolution of electricity trade in the day-ahead market by analyzing bidding behavior, supply and demand curves, and price elasticities using a rich dataset from the Dutch market (2006–2024). By applying advanced spline regression techniques, we estimate and examine variations in price elasticity over time and across different price levels. The results will provide valuable insights into how key developments, such as the increasing share of renewables and changing commodity prices, have shaped market dynamics, enhancing our understanding of the day-ahead electricity market's role in Europe's energy transition.

References

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