

Frequent Auctions for Intraday Electricity Markets

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Electricity markets are typically organized as a sequence of forward markets that trade products with ever shorter maturity and temporal resolution. Most market designs feature a day-ahead market that allows to trade electricity one day ahead of delivery and a market that gives firms the possibility to adjust their positions until shortly before physical delivery. The latter markets—organized either as real-time or intraday markets—are of increasing importance because of the growing short-term uncertainty in production from renewable energy sources.

There are currently two prevailing designs for intraday electricity trading: continuous markets and repeated auctions. Both designs have their strengths and weaknesses: Auction based markets impose low entry barriers for participating firms and facilitate relatively high liquidity by pooling demand and supply. However, existing auction markets suffer from long lead-times making it difficult to trade the production of renewable energy sources and to quickly react to new information, mostly because there are only a handful of auctions with the last one closing several hours before delivery.

In contrast, continuous trading ensures a high level of immediacy as traders can instantaneously act on new information. The main downsides of continuous trading are the higher complexity of trading, the lower liquidity, which leads to low quality price signals that are often dominated by noise, and the incompatibility of order-book based trading with the physical realities of the electrical grid. Despite these downsides the recent trend in European electricity markets is to discontinue auction-based designs in favor of continuous trading.

The contribution of this paper is the investigation of an electricity market design, which represents a compromise between the extremes of continuous trading and *infrequent* auctions and is well suited to deal with the idiosyncrasies of electricity markets. In particular, we propose that orders should be batched in *frequent* auctions which are repeatedly conducted for every traded product until shortly before physical delivery of electricity starts.

To get an idea how frequent auctions could impact market outcomes, we conduct a case study for the German market by creating a counter-factual for auction outcomes based on detailed order-book level data submitted to the EPEX continuous intraday market for the German market zone in the years 2017 and 2018. To this end, we construct hypothetical auction outcomes for a single auction per product as well as auctions which are repeated every 60 minutes, 15 minutes, 5 minutes, and every minute.

Our results show that the distribution of volume weighted prices remains virtually identical when switching to any of the proposed auction formats. When examining traded volume, we are able to show theoretically that under certain conditions auctions clear less orders and therefore lead to lower traded volumes than continuous trading. This theoretical result is largely confirmed in our numerical experiments. Despite the results on traded quantities, liquidity costs, measured as costs of round-trip trades, are lower for auction-based trading than for continuous trading. Based on these

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results, we argue that even though auctions tend to clear less volume, they are preferable in terms of liquidity cost.

Finally, we use a kernel regression-based approach to investigate the signal to noise ratio of the price signals generated by the two market designs. We find that prices generated by frequent auctions are significantly less noisy than the prices resulting from continuous trading and are therefore expected to produce more reliable price signals that are more closely tied to changes in the fundamental value of the traded product.

Furthermore, we critically discuss the suitability of continuous trading in the presence of network constraints and technical restrictions of conventional units. Taken together these findings suggest that in sparsely traded intraday markets, pooling orders in frequent auctions may be beneficial.