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Report

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Bidding Structures and Trading Arrangements for Flexibility across EU Power Markets

Report from the Future Power Market Workshop 2015, held at Ofgem, London, June 26

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While in recent years the introduction of the target model for the intraday time period was often associated with continuous trading, the flexibility of the target model to also allow for additional intraday auctions has recently been emphasized with the successful introduction of a 15 minute intraday auction in Germany. Intraday auctions are already present in European countries like Italy and Spain.

In a one day workshop of the Future Power Markets Platform with generation companies, power exchanges, TSOs, regulators and academics, it was discussed how intraday auctions can help to address the evolving demands on the power system:

- New and decentralized players (distributed generation and demand response) need to be integrated into the market and therefore be provided with an accessible trading platform.
- Increasing shares of power need to be traded intraday so as to balance generation profiles depending on new weather forecasts and renewable generation.
- Conventional power stations can increase their value to a system with wind and solar and their environmental performance, if the trading arrangement facilitates intraday adjustments to start-up and ramping.
- Increasing importance attributed to integration of markets requires efficient transmission use, for example with the extension of flow-based transmission allocation to intraday time-frames.

Exploring both European and international experience, the different elements of intraday auctions were then discussed including the need for harmonization and coordination. While the introduction of intraday auctions may improve upon the power market design, it was clear that many of the challenges for efficient and secure operation of the power system will not be addressed with such auctions alone, for example relating to congestion management or coordination of short-term trading and system operation for reliable flow forecasts.

1. Why introduce intraday auctions?

Short-term markets are at the core of an efficient electricity market design. They must be designed with the energy system of the future in mind. This creates a set of drivers for the introduction of intraday auctions.

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Extending efficiency gains obtained from existing intraday auctions

Market players, both new and incumbents are trading increasingly in intraday so as to balance their generation profile depending on new weather forecasts and renewable generation and to comply with the requirements to balance demand and supply in shorter intervals. The increasing intraday trading activity has motivated EPEX to introduce a first intraday auction for 15 minute products at the opening of intraday trading. After the implementation of the intraday 15 minute auction, traded intraday volumes have with 10-15 GWh been much higher than with continuous trading alone that cleared rarely more than 5 GWh. To the extent that additional adjustments result from additional participation of new parties and from parties that might otherwise retain positions or optimize to a larger extent within their portfolio, this reflects an increased efficiency of the market outcome.

This experience also is in line with insights from cross-country comparisons. The liquidity of intraday market in Europe is highest in Italy and Spain, the two countries with multiple intraday auctions. It was however noted, that in Spain at least some of the liquidity may have been caused by other incentives, for example for coal power stations to sell intraday linked to coal subsidies or reserve procurement at day ahead market that resulted in infeasible schedules and required adjustments in intraday markets. Furthermore some obligations were mentioned in Spain and Italy to execute transactions on the intraday market.

Integrating new flexibility technologies

New and decentralized players (distributed generation and demand response) need to be integrated into the market and therefore be provided with an accessible trading platform. An intraday auction price applies uniformly to all parties. Thus all market actors receive/pay the same uniform price on their sales/purchases. This allows suppliers to reveal marginal costs and be rewarded at the true system value reflected by the last bid accepted in the auction. Compared to continuous trading that effectively implements pay as bid pricing, a uniform price and standardized trading times are especially beneficial to small players without sophisticated trading departments operating 24/7.

Realizing full flexibility of conventional assets

The variations of output from wind and solar power need to be matched by increased variations of production from conventional fossil power stations or by demand response. In contrast to traditional generation patterns responding to daily repeating on- and off-peak demand patterns, the time profile is also more varied and may be adjusted on short notice, if for example the arrival of a strong wind pattern is delayed.

Thus it will be increasingly valuable for the system and thus also will allow to better reward the value of conventional power stations, if the full capacity to ramp production and the ability to start- and stop power stations is realized. This will require that the temporal dependency of production choices in several adjacent intervals can be submitted in block- or multi-part bids to market clearing algorithms like Euphemia for the day-ahead market. However, in continuous trading matching across multiple bids is inherently limited while liquidity for each of the different types of block-bids is too low to support efficient bilateral matching (given that more than on- and off-peak products are traded). Furthermore, experience with Euphemia has shown that market clearing of block-bids in the day-ahead market requires 10 minutes with a desire of participants to extent this period to improve the quality of the

clearing process. This is far from the suitable interval for matching of continuous traded bids that needs to happen within fractions of a second.

The introduction of intraday auctions therefore can provide the opportunity to clear more and smarter block-bids or multi-part bids so as to realize on the intraday the full flexibility of conventional power stations as much as demand response or storage with inter-temporal linkages.

Providing reference price for contracts that reflect value of flexibility

Currently, the future contracts at the EEX are linked and referenced to the day-ahead price. This does however not allow for the reflection of the flexibility value in contracts. The volatility of the power price increases closer to real time, as the number of market participants that can respond and the scale at which they can increase production or demand declines. Thus the real time power price provides the best reference point to value flexibility. Given various distortions to real-time (balancing) prices, intraday prices close to real time can serve as a proxy. Option contracts on these power prices closer to real time can reward the value of flexibility provided by generation and load. However, the continuous intraday market does not provide a well-defined reference price for contracts, and results from continuous trades therefore have to be averaged muting part of the volatility that reflects the value of flexibility. Thus, for hedging and ultimately for providing clear price signals to attract investment in flexibility a liquid and transparent intraday price emerging from an auction would be beneficial.

Realizing full potential of transmission capacity

On the intraday-trading, transmission capacity is allocated on a first come first serve basis for free between OTC (explicit) and exchanges (implicit). This is also the principle envisaged for the shared order book to be implemented by 2017. Thus the potential scarcity value of transmission capacity is captured by the first mover reserving the capacity explicitly or by the best offer on the exchange screen. This first come first serve rule on the explicit allocation is favoring rapid traders instead of efficient ones. Market coupling at day-ahead stage has demonstrated the benefit of coordinated auctions, as thus also transmission capacity is implicitly auctioned thus that the scarcity value can be captured and used, either to reduce transmission tariffs or fund new transmission investment.

Electricity is not worth the same at every point in time and every place where it is produced and consumed. To reflect geographical scarcity the pricing of transmission capacity is essential. Transmission capacity in the European transmission network can in principle be flexibly used for a variety of commercial transactions. If for example an interface near the German-Dutch border is constrained, then this limits German exports both to Netherlands and France. Depending on the scarcity of power in these two countries, the capacity on the constrained interface could be used primarily for transfers from Germany to the Netherlands or from Germany to France. This is the principle of flow-based transmission allocation that is now used in CWE at the day-ahead stage. The auction clearing algorithm simultaneously allocates transmission capacity between pricing zones so as to maximize the system value. Continuous trading requires an ex-ante allocation of transmission capacity and thus cannot realize the flexibility from transmission allocation necessary to make use of the full potential of available transmission capacity. Furthermore, the free allocation of transmission capacity under a first come first serve approach creates incentives for hoarding transmission capacity, thus further restricting any option to use capacity on scarce interfaces to serve needs in pricing zones with high prices.

Tackling the risks from trading robots for security of continuous trading

Increasingly companies trading on the intraday power market are using automated trading machines, so called robots, to execute trades. This replicates developments in financial markets and results in thousands of orders flooding into the order books. Similar to financial markets, the race for speed is seen as merely competition about who is capturing margins between bid-ask spreads or is the first to reserve transmission capacity made available by the TSO. It does not increase the efficiency of the final outcome. Being faster than human traders, the robots are capturing increasing shares of bid-ask spreads and scarcity value of transmission capacity in the market and thus have reduced the enthusiasm of traders for continuous intraday trading.

The escalating volume of bids and offers is challenging for a secure operation of the market and coincides with increasing numbers of interruptions to the operation of the continuous intraday trading platform. Thus it may pose ultimately a risk for the reliability of power system operation that depends on functioning intraday markets.

The increasing volume and speed of transactions is creating further challenges for the implementation of an envisaged joint market clearing in integrated continuous markets based on a common order book. It is currently difficult to understand, how the clearing algorithm for the joint order book can be sufficiently fast to accommodate all trades, especially as complexity is increasing with the number of participants using differing national formats such as quarterly, half-hourly or hourly products, with different types of combinations for the block bids.

2. Implementation details

Intraday auctions show large potential to increase intraday market efficiency. However, questions on their detailed implementation may in fact pose more challenging questions to regulators. What requirements need to be met for the auction rules? What are the products traded? What frequencies are optimal for holding intraday auctions?

How frequent to execute intraday auctions?

Intraday auctions as implemented in Spain, Italy and now also started in Germany, allow for trading of energy products for each of the remaining time-slots in the intraday period. Therefore, the higher the frequency for auctions the earlier adjustment to new wind forecasts are possible and the closer to real time will be the final auction for a time-slot, thus enhancing the ability of market participants to adjust their position in response to new information on generation availability and wind and demand forecasts. Italy currently operates five intraday auctions and Spain six intraday auctions. The discussion evolved around the assumption of hourly intraday auctions.

With auction models, which do not consider transmission constraints in their pricing (market solving) algorithms, transmission operators require time between the nomination of generation and load patterns resulting from the final auction and real time so as to resolve transmission constraints within pricing zones through re-dispatch. This is typically referred to as gate-closure time, and would imply that time-slots that are within the gate-closure time cannot be auctioned.

The outcome of each intraday auction may result in updates to generation and load patterns, and should thus be used by TSOs to also update flow-estimates and transmission capacity made available for trade between pricing zones. The level of coordination between TSOs and power exchanges will determine the required time between auctions. In the longer-term, an integration of intraday trading platform and system operation could allow for recalculations on 15 minute basis (experience from US ISOs).

If intraday auctions are structured such that market participants have to determine and submit bids and offers to each auction, then sufficient time is necessary between auctions, and liquidity and depth will likely decline with higher frequency. Therefore it was suggested allow for standing bids that are good until canceled or executed. Thus market participants do not have to re-submit or adjust bids for each auction, and an increase of frequency will not undermine the depth of the auction.

How long should time slots be?

Current formats differ among EU power systems between 15 min, 30 min and hourly products. Also within EPEX, intraday products entail the delivery of power for a 15 minutes time slot. Thus intraday, the market clears on a higher granularity than the hourly day-head market. In general, a shorter time slot – even when harmonized across EU countries – would on first sight not entail significant additional costs. Actors, like for example hourly metered households, would continue to only measure net-demand in hourly time slots, and would only see and respond to average prices across the hour. This is already common practice in many member states and therefore it would not be necessary to adjust smart meters to the higher granularity. However, as price variations within hours might increase, time slots for metering may be increased so as to allow for the provision of flexibility.

What bidding format to use?

Power exchanges and TSOs can allow for different bid formats. **Simple** bids work well if demand and renewable profiles are well anticipated by the market players and there are limited network constraints and sufficient flexibility of plants. With increasing volatility a sole reliance on energy-only bids however becomes challenging and it becomes increasingly important to allow generation and flexible load to indicate intertemporal dependencies with their bids. This is reflected in the Spanish experience – as the share of wind and solar power increased over the years, so did the role of complex bids. Two basic bidding formats of complex bids exist to reflecting inter-temporal dependencies:

Block bids allow market participants to condition the exercise of one energy-only bid on the acceptance of one or several other bids. Thus they allow inflexible conventional plants to express for example the need to operate for several consecutive hours. The power exchange can only call upon a block-bid if it is executed as a whole, and only if the revenue from the market clearing price in the relevant hours suffices to cover the total value of the block-bid. This can result in situations of paradoxically rejected bids: A block bid may be rejected, even so the resulting energy prices in the absence of the block bid would suffice to cover costs of the block bid. But if the block bid were executed, the prices would drop and not cover the costs.

Currently there are varying designs of block bids across Europe with no tendency of convergence. Block bids that differ in their definition are extremely challenging to include into the auction clearing algorithm Euphemia. The algorithm has to find the cheapest combination of energy only and various block-bids to

meet demand at a given price level considering several consecutive hours linked through the block-bids. The combinatorial challenge of finding a suitable combination of energy only and block bids implies that the Euphemia currently requires 10 minute calculation time to clear the day-ahead market and arguable could find significantly more efficient solutions for the system operation, if more time would be available to find solutions.

The limits to potential complexity that can be handled by computational algorithms to solve the combinatorial challenge limits the ability of power exchanges to offer tailored block bids to meet the needs of different generation technologies, storage, and demand flexibility.

Multi-part bids comprise both technical and financial parameters so as to fully reflect the flexibility options of power stations. Thus they comprise variable costs and start-up costs, but also ramping rates and minimum load requirements. In contrast to block-bids, the reflection of technical characteristics – instead of combinatorial questions – is more suitable for computation of market clearing. Solution algorithms converge quickly. Even with a detailed representation of transmission networks the ISOs in the USA solve the full intertemporal optimization within a minute.

The most difficult part concerning the use of multi-part bids relates to the method start-up costs are reflected in the generators' bids. Similar to the situation of paradoxically rejected bids in the context of block-bids, in the case of multi-part bids it may occur that a power station is called to produce power even so the margin between market clearing price and variable generation costs does not suffice to cover start-up costs. This has to date largely been addressed with difficult to estimate side payments to respective power stations, and was at the time designed as a way of limiting wholesale price levels. However, with increasing emphasis in the US and Europe on full cost recovery from wholesale prices and incentives for flexibility, it seem more suitable to reflect the start-up costs in the market clearing price.

How to facilitate participation of flexible demand?

It was discussed whether intraday trading arrangements need to facilitate the participation of different types of flexible demand. In principle aggregation companies could be expected to pool individual flexibility options so as to provide a product that matches requirements of the power market design. This would however imply that new aggregators could only enter the market if they can contract a sufficient scale of diverse flexibility options. Hence it seems desirable to accommodate for the different technical characteristics of different flexibility in the bidding format. To date there is no evidence that this constitutes a computational challenge in the case of multi-part bidding.

What are transparency implications?

Arguably market participants may be concerned about the increased transparency of unit based multi-part bidding, and thus the ability of competition authorities to monitor market behavior. However, it needs to be noted, that even absent of unit-based bidding most generation companies have to submit technical information on power stations to TSOs, and often pursue cost based re-dispatch actions that are negotiated with TSOs or regulators. Furthermore, commercially available data already provide information on many of the technical parameters of conventional power stations, so that information provided for example reflected in multi-part bids is not to be expected to result in revelation of

commercially sensitive information or at least not extending sharing of such information beyond the level of sharing already necessary with TSOs.

How to enhance predictability of flow-patterns for TSO?

Countries like Germany that have implemented balancing at portfolio level have found that utilities with a large portfolio and other aggregators do not provide reliable information during the intraday time period on envisaged dispatch patterns at the unit level. As a result the TSO cannot update flow forecasts and fails to provide early notification to neighboring TSOs on loop flows in GW scale, as well as have difficulties to take effective countermeasures to optimize/improve power flows within their control zones and with neighboring countries. Currently the response strategy by neighbors is the implementation of face shifters to help protect neighboring systems from unanticipated loop flows. Compared to the alternative of providing reliable information and jointly managing loop flows, separating systems forgoes benefits of system integration including efficiency, system security and capacity to integrate larger shares of intermittent renewables.

As for interconnection capacity to and from the UK, for example the FR-UK interconnector can yield up to 6 GW swings in either flow direction. This leads to price movements that would see generators to re-dispatch themselves in line with expected price changes. There currently is a discussion by TSOs on restrictions using whatever measure they can that may facilitate the market in order to respond, however yet no satisfactory conclusions has been made. NGT observes swings only 60-90 minutes ahead of time and can only react with 1300 MW of reserve.

This raises the question how TSOs can obtain early and reliable information on flow patterns and timely updates. In France the system operator requires market participants to provide early notification and updates on envisaged generation at unit level and load patterns at nodal level, and according to these reviews obtains information with 95% accuracy that supports effective system operation. Despite the formal requirement for such nominations in Germany, TSOs have reported that non or only insufficiently accurate information is being provided. In Spain day-ahead nominations at the generating unit level and their intraday updates area also mandatory. The SO uses this information to estimate the reserve needs and network congestions (particularly relevant in the Day Ahead horizon, since right after some reserves are procured). However some RES-E technologies have not offered in the past their best forecast in the day-ahead market, so the question on whether the SO should rely on these nominations is arguable.

This raises the question, whether the format of intraday bidding may influence the ability of market participants to provide early and reliable nominations. In particular, with multi-part bidding, aggregators and utilities would obtain from each auction round a precise and least cost generation pattern that could be directly nominated to the TSO and thus should enhance the quality and reliability of information available for efficient and secure system operation.

In contrast, energy only and block-bidding requires aggregators and utilities to aggregate the flexibility of their portfolio to be reflected in block-bids which does not entail the need for an early decision on the unit specific generation pattern. The discrete choices inherent in accepting or rejecting block-bids furthermore can correspond to significant changes in the resulting unit specific generation pattern. Thus

energy only and block-bidding does not lend itself easily for the provision of early and reliable unit specific generation patterns.

How to combine auctions with continuous trading?

A continuous auction – e.g. every 5 minute – can also be a possible solution in line with the framework guidelines and/or the network codes. However, as discussed above these would need to be responsive to new transmission capacity available on an ad-hoc base. Also with hourly auctions, it may be considered that continuous trading could still run in parallel and be used by traders or market actors that wish to lock-in trades according to their own willingness to pay for whatever reason.

What administrative effort is required?

For continuous intraday trading the XBID project attempts to create a shared order book across participating EU countries including the first come first serve allocation of transmission capacity. This is currently perceived to be a very challenging project of high complexity for example linked to IT requirements to allow for time-critical matching of large number of deals on a continuously basis.

In contrast, the introduction of intraday auctions could largely be based on the technology and commercial protocols already established for day-ahead market coupling.

The different level of complexity of continuous trade and auction based trading is reflected in the significantly lower fees for participants trading at EPEX intraday auctions than for continuous trading.

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