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Report

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Coordinated balancing

Report on the key elements of debate from a workshop of the Future Power Market Platform,
 DIW Berlin, 17th February 2017
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Introduction

The winter package and discussions on harmonizing short-term electricity markets in Europe increasingly focus on the interface between national and cross-border balancing and intraday markets. The FPM workshop and this report discuss the intraday markets as well as replacement and frequency restoration reserves (cf. Figure 1) to explore opportunities for improvement and integration of the national systems.

While at European level, the gate closure time for XBID (the continuous cross-border intraday market) and existing cross-border exchanges is set to one hour before delivery, countries have also pursued different strategies to unlock flexibilities until shortly before delivery. Some countries (e.g. Germany or the Netherlands) established gate closure times for local intraday markets up to 30 (DE) or even 5 (NL) minutes before delivery, other countries rely on the TSOs acquiring replacement reserves which they aim to exchange via the LIBRA algorithm (grown out of the TERRE project).

		Regulation							
		Tertiary		Secondary		Primary			
Day ahead		(XB) Intraday		Replacement Reserve		Frequency Restoration Reserve		Freq. Containment Reserve	Settle
				Local Intraday					
		XBID	Auction	Libra	Continuous	mFRR	aFRR	Legend	
• GC: 12:00 (previous day)		• GC:60 min		• 30m activation • 15m-1h (linked)		• 15 m activation • for 15m		Markets with energy trade positions	
Bid formats	block bids	Simple bid	multi-part	linked block	15min	15min	TSO-procured reserves with energy prices		
Clearing	marginal	Pay-as-bid	marginal	marginal	bid +	.	TSO-procured reserves without energy prices		
Rolling	some	yes	yes	no	yes?	yes?			
T-pricing	yes	no	yes	yes	yes*	yes*			

Figure 1 - Design characteristics of successive European markets and mechanisms. Dotted areas refer to national differences in implemented markets.

Some countries implemented and the Grid Code Electricity Balancing envisages that frequency restoration reserves can be provided by uncontracted bids and that flexibility can be exchanged cross-border on a TSO to TSO basis (EXPLORE project).

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Two central questions specifically have arisen in those debates:

- Do balancing energy and (local) intraday energy markets compete for liquidity or can they be mutually supportive?
- How are interaction between TSO actions and markets structured?

The approach towards addressing these questions reflects two paradigms, which we will call (i) bilateral and thus largely local flexibility exchange and (ii) structured sharing of European flexibility via auction-based platforms.

The underlying reason to distinguish these two paradigms is the hypothesis that bilateral trading in continuous markets does not allow for an effective allocation of transmission capacities, but is limited to a first come first serve allocation. As a result, transmission capacity is not allocated to transactions between pricing zones with big price differences, where it creates most value, but to the trader submitting the first, even if this is between pricing zones with limited price difference. This was the motivation to shift from NTC to flow-based transmission allocation at day ahead stage. A further limitation of the continuous allocation of transmission capacity is that it does constrain adjustments of transmission patterns at (frequent) times when multiple transmission constraints are binding in the European system. In auction-based approaches this is however feasible, and used in flow-based market coupling at day-ahead stage.

The two paradigms thus reflect differences between the priority to (i) retain flexibility on contract, product, and platform design and (ii) the priority on getting efficient pricing and clearing which is inherently easier on a common platform. The discussion to evaluate these different paradigms needs to be grounded both in institutional economics (coordination requirement implies need for governments to design institutions, e.g. markets, and area delineations (Bidding Zones, LFC Blocks, tariffs & grid reinforcement)), and power system engineering (synergies from system wide perspective and consideration of loop flows).

This raises the question what risks for system security, costs for system operation and constraints for further renewable integration result, if we fail to implement European sharing by pursuing different approaches.

Experience with bilateral exchange

In the paradigm of bilateral flexibility exchanges, energy is traded bilaterally (i.e. OTC) or on continuous exchange platforms (XBID before, national platforms after gate closure). This approach was initially developed to facilitate entry for new actors in a system dominated by vertically integrated incumbents. To reduce barriers for entry based on delivery to customers, incumbent utilities were mandated to manage short-term energy balance, network constraints and system stability.

Focus on shorter national gate closure

The focus on shorter gate closure times is driven by the interest of market parties to improve their balance. With most liquidity gathered just prior to gate closure, any reducing of gate closure time is seen to provide opportunities to improve balance and thus reduce the cost incurred for imbalances. Shorter to realization, weather patterns and the resulting renewable energy output become more certain.

The quality of the aggregate forecast of wind output for pricing zones does improve however only marginal within the last hour, with most improvements achieved in the preceding hours (according to practitioners 2.4% relative standard error to 2.2%). This is not to ignore that the performance of forecast for individual turbines in the same time period can improve, however this does not result in a similar improvement at the aggregate level as the errors cancel each other out. Thus, a reduction of gate closer time will indeed result in a shift of the trading activities closer to real time but may result in only very limited impact on system wide balancing needs (reserve and activation).

Lock-in multiple gate closure times

Separate cross-border and national gate closure times increase the complexity in the design of mechanisms. An example are mFRR common platforms, if participation in cross-border platforms is restricted to retain national liquidity or if the platform has to allow for withdrawal of bids post submission deadline. Such additional complexity can jeopardize performance of the European mechanism. The experience with the implementation of the intraday trading platform XBID also point to a further risk: If the regulatory requirements for the design of a platform imply complexity and inconsistency with physical reality rather than clarity and simplicity, then this can create multi-year delays for implementation. This can not only undermine the efficient operation of the system, but also delays further progress in market design while all institutions involved attempt to deliver the XBID platform.

Challenges for local bilateral flexibility approach

Continuous trading platforms face two inherent obstacles for large-scale adjustments of trading positions of market parties, necessary for example in case of unexpected outages of big power stations. First, the format of bids on the platform is simple to facilitate matching. This limits the ability of market participants to offer their full flexibility where this involves for example start-up or ramping requirements across multiple 15-minute segments. Second, because the opportunity costs need to be included in the price at which assets are offered, market participants only gradually offer their flexibility in order to capture the scarcity value that may occur. Because of these effects, market participants use the continuous trading platform primarily for marginal adjustments, while larger adjustments will be negotiated bilaterally typically for multiple consecutive hours to better match needs and capabilities.

Where pricing zones are or will be smaller, market participants have fewer options to identify bilateral trading partners as these typically need to be within the identical pricing zone to ensure the agreed schedule is subsequently also feasible. Cross-border trading platforms may in these situations increase the pool of participants, and thus may improve the performance of continuous trading platforms. This will however again be limited to the hours when there is no binding transmission constraint in the entire system. Otherwise matching will again be locally constrained, as due to loop flows, bilateral transaction between any two pricing zones in the network impact flows on all transmission lines in Europe, including those at their capacity limit. This makes matching via a continuous mechanism as XBID particularly difficult. In contrast, in the clearing on an auction platform, transactions could be combined that contribute as well as resolve a constraint, thus overcoming this challenge and facilitating pooling of the system wide liquidity even in the presence of some binding constraints.

The smaller the countries, or the pricing zone within the country, the bigger will therefore be the value of structured sharing of European flexibility based on auction platforms (i) with bid formats that allow for reflection of the capability of flexibility assets and (ii) and based on (flow based) market coupling to allow for sharing of all cross border flexibility to the extent physically possible.

A further challenge, resulting from limited access to all flexibility in the system as well as from penalizing elements in the balancing prices, is the response of (large) market participants that will hold reserves within their portfolio to limit the exposure to short-term or balancing markets or imbalance. This may result in excess reserve holding.

Structured sharing of European flexibility

In the structured sharing approach, the goal is to realize all flexibility potentials and find prices that reflect value to the system as basis for financing of investments. This can be achieved with three structuring elements:

- (i) flexibility is pooled across all actors, e.g. on a common auction platform,
- (ii) all resources can provide their full flexibility, e.g. allow for capability based bids and
- (iii) flexibility is pooled across different pricing zones with (flow based) market coupling, e.g. through implicit allocation of transmission capacity as part of the clearing of the coupled auction platforms.

A structured sharing of flexibility based on all three elements allows for (i) least cost provision of flexibility based on system wide resource pooling (ii) depth of response also across pricing zones to accommodate also large scale power failures while minimizing part-load operation and must-run. It also (iii) provides reliable information on generation and load patterns for TSOs thus contributing to secure system operation.

While energy only bids restrict the flexibility that individual actors can provide for short time slots (e.g. 15 min), it was discussed to what extent capability based bids (also referred to as multi-part bids comprising for example in the case of fossil power stations ramping rates and prices for start-up and operation) are necessary, or can be approximated with block-bids. While Italy, Spain, Poland and Ireland

already make use of capability-based bids, other countries have developed a variety of increasingly complex block-bids.

Three inherent challenges of block-bids at various stages of evolution remain. First, the experience of Euphemia has shown that a bottom-up solution of merging different national preferences of block bids leads to a non-harmonized algorithm with many different product types and inefficient solution times. Second, with block bids, the power profile of generation, and demand within the hourly blocks, remains undefined, and requires thus with increasing renewable penetration either shorter balancing periods (15 min) or increasing TSO balancing action. Third, the import/export levels may jump between discrete trading periods. In contrast, capability bids result in smooth production and demand schedules.

This is illustrated in the UK. Despite the introduction of bilateral trading with NETA; for the balancing mechanism for more than a decade capability type bids are used and cleared on a rolling basis, thus ensuring a secure operation of the island system.

The challenge of market participants to develop a shared perspective on the suitable bid format points to the importance of regulators to guide the convergence process and help define a format for real-time pricing (past cross border intraday gate closure) where a single product, the capability bid, can accommodate for the needs of all market parties.

The discrete nature of production levels (e.g. power stations cannot increase production continuously from zero, but have minimum output requirements for stable operation) naturally implies that market clearing algorithms may not find a solution. Block bids may increase this effect by introducing additional discretion (e.g. blocks can only be accepted entirely or are rejected). Hence, clearing algorithms in Europe allow for the rejection of some bids that, given the market-clearing price, are in the money (so called paradoxically rejected bids). This effect can be avoided for example with minimum up-lift payments. The discussion of bidding formats therefore also should include a debate on whether and how to structure such minimum up-lift payments.

Marginal and non-penalizing balancing prices

Balancing services were previously primarily provided by large-scale generation based on dedicated control technologies. As their share in power production is declining, the participation of smaller scale flexibility providers is of increasing value to the system.

They are however more complex to control directly, and in the case of demand side flexibility, it is also difficult to understand the reference demand in absence of flexibility requests.

This motivates the use of markets to unlock flexibility and facilitate broad participation. In the Netherlands a price signal for imbalances is published each minute with a 2 minute delay. All market participants can thus provide their flexibility to the system, and are remunerated for the difference between their announced schedule (or trade position) and the measured production or demand at this imbalance price. The experience in the Netherlands so far has been very positive: Prices are most of the time close to commodity prices, which means little adjustments on the side of market participants is taking place. Upon the loss of a unit the system accesses a broader set of resources, reducing the imbalance costs and thus the need for market parties to hold private reserves. In consequence, the

approach of marginal and non-penalizing imbalance prices, published close to real time to provide the correct incentive for all market participants to contribute to system balance, saves costs.

As balancing markets are integrated, the transmission constraints need to be considered. The imbalance price needs a local component. This could result, as already envisaged for other balancing products in the LIBRA/TERRE project, in imbalance prices that can deviate across pricing zones. The desired outcome is therefore a geographical structure of imbalance prices that matches the pricing zones.

If the pricing zones remain too big to resolve structural congestion, two basic options exist. Either, the imbalance price signal is more granular than the clearing price in intraday or day-ahead (example Italy). To avoid gaming opportunities from this inconsistency of pricing, dual imbalance prices are calculated. Alternatively, ex-ante re-dispatch measures can be implemented and participating generators precluded from actions that could contribute to subsequent congestion, to reduce transmission load and thus the need for congestion management closer to real time.

The “right” imbalance price signal

One point of ongoing debate for marginal imbalance pricing relates to the allocation of sunk costs, for example of pre-contracted reserve capacity that is called upon to balance the system. Reserves are in principle contracted to accommodate for extreme situations so as to avoid load shedding. Hence, the concept of an operational demand response curve (ODRC) has been developed, that adds the opportunity cost of increased risk of load shedding to the marginal price of contracted reserves. This creates additional revenues towards covering the costs of contracting the reserves.

The consistency of the clearing price in balancing and intraday markets is of increasing importance where small scale actors can respond to – and thus potentially arbitrage – both prices. If price formation is not consistent, then such an arbitrage can destabilize the power system, or disrupt market efficiency by gaming. Therefore, it is important to allow scarcity price signals to propagate from balancing to intraday (and day-ahead and longer-term) markets. Between intraday and day-ahead this is already common as market participants can take open positions on the trading platforms. Virtual bids would allow to make such open positions more explicit, to enhance the visibility to the system operator for security assessments and flow-forecasts.

Efficient use of transmission capacity for sharing European flexibility

The main challenge of a structured sharing of European flexibility resources remains a lack of full internalization of transmission constraints into the market outcome, and therefore the need for additional national or cross-border TSO action to resolve constraints that result from market outcomes. This may involve

- locally defined imbalance prices (like in Italy) combined with dual imbalance prices to avoid gaming of pricing zones that are not consistent between day-ahead and balancing time frames.
- pre-screening of bids for cross-border auction platform by TSOs, to withhold bids that contribute to internal constraints (discussed in TERRE).
- longer-term contractual arrangements between TSOs and generation in (temporary) load pockets (UK)

- mandated re-dispatch measures, implemented in case of significant constraints at early stages (e.g. to facilitate start-up of units) or only on short notice after gate closure, but in all cases in cost basis) (Germany).

The corrective measures at national and in some cases cross-border level to resolve transmission constraints that are not internalized in the market mechanisms create significant challenges.

First, for the implementation of corrective measures to resolve transmission constraints, a time slot has to be reserved to (i) allow TSOs for an assessment of the needs and decide on re-dispatch and then for (ii) market participants to adjust production and demand decisions. This may be the main limitation for moving cross-border gate closure closer to real-time.

Second, corrective measures to resolve transmission constraints can create inconsistencies between market outcomes in day-ahead, intraday and balancing mechanisms. The more complex the market arrangements, the bigger the risk that such inconsistencies result in misaligned incentives that could encourage behavior with negative implications for secure system operation.

Third, national specific strategies to resolve transmission constraints contribute to discrepancies in paradigms – e.g. only because of the opportunity for TSOs to implement large-scale re-dispatch measures prior to gate closure (and often day-ahead) is it possible to retain a short gate closure time in Germany. Countries that avoid ex-ante re-dispatch require longer gate closure time if significant re-dispatch is to be implemented (and production decisions of power stations adjusted) after gate closure time.

All these challenges will be resolved, once pricing zone structures avoid the need for corrective measures. In the meantime, it will be important to avoid lock-ins, e.g. increasing complexity of the design of corrective measures that undermines the further development of the system and instead leads to a sub-optimization at the national level.

Conclusion

The system of bilateral flexibility exchange has evolved at the day-ahead stage in five steps. Cross border transmission allocation shifted from (i) a grandfathering approach to (ii) first come first serve allocation (iii) day ahead auctions for cross-border transmission capacity and (iv) implicit auctions using NTC values and (v) are now at day-ahead stage largely based on implicit auctions using the flows based approach. This enhances the efficiency and flexibility of the use of scarce network resources and increases the level of competition.

At the intraday stage, bilateral exchange on XBID remain on a first come first serve allocation of public resources to private actors (stage ii of day ahead developments). ENTSO-E has been tasked to investigate market-based allocation of intraday transmission capacity and has consulted on the use of implicit auction(s) at intraday stage. This may signal a shift from bilateral flexibility exchange towards a more system-oriented use of central clearing platforms, for flexible, secure and efficient system operation.

A second theme relates to pricing. Article 5 of the proposed new regulation on the internal electricity market envisages that "Marginal pricing shall be used for the settlement of balancing energy." This offers opportunities to better align and eventually converge procedures pre- and post-gate closures and better integrate system operation and markets. Consistency of prices across time-frames and geographies is important to align the incentives of market participants and the overall system and to avoid opportunities of gaming the system.

At the FPM meeting, we have explored many dimensions that need to be considered - and the summary illustrated the value that can be achieved with the design of common clearing platforms both for intraday and balancing arrangements, including single marginal pricing, a common bid format with capability based bids and market coupling that respects transmission reality.

The increasing needs and opportunities for provision of short-term flexibility (and reserves) from decentralized resources can be addressed allowing wide participation in balancing markets, including by frequent publication (in Netherlands e.g. every 2 min) of information on the imbalance price. The participation of distributed resources responding to such prices also requires a better alignment of bid formats and clearing at day-ahead, intraday and balancing level, as well as a locational component. This gives further motivation for the use of a common auction clearing format. The current penalizing elements in balancing and the focus on administrative procedures excludes decentralized resources from flexibility provision and could be lifted once transmission constraints are reflected in market price signals

From the perspective of national power market design, the Winter Package has too often been only assessed from the perspective of bidding zone design. All the more important to consider the opportunities linked to marginal pricing and real-time bids to balancing markets.