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**Research Report**

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# Coordinated Balancing of the European Power System

Report on the key elements of debate from a workshop of the Future Power Market Platform,  
held at the Clingendael, Den Haag, April 14th  
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Integration of European electricity markets delivers efficiency savings, increases flexibility and can make markets more competitive. Alignment and integration of balancing is particularly important for system security and impacts development in subsequent markets. With increasing shares of intermittent renewables the benefits of integration increase. The increasing use of intermittent generation assets also creates common demands on all systems and thus reduces the obstacles for further integration. While these benefits are widely accepted in expert groups, they need to be better quantified for a wider community.

In the FPM meeting we reviewed the experience gathered in Europe with the coordination of balancing, starting from two early implementation projects for Coordinated Balancing Areas (CoBAs), the TERRE and EXPLORE project, and the interactions with the European Guidelines on Electricity Balancing that has been evolving in parallel and will be submitted by the European Commission in the coming months for approval by the members states.

We find that all countries are interested to preserve their existing structures of market design. This reflects a wider perception that there is no good or bad market design. To the contrary, national approaches have evolved historically and reflect the (historic) operational challenges and characteristics of each system, as well as preferences of the dominant stakeholders in each country.

This is reflected in the proposed balancing code that has been developed by stakeholders under the coordination of ENTSO-E - following broadly defined framework guidelines provided by the agency for the cooperation of energy regulators (ACER). In the European processes, all parties demonstrate good intent to advance cooperation and found pragmatic compromises.

Alignment of settlement periods to 15 minutes and a move towards marginal pricing represent tangible requirements the new code would imply. For other elements the discussion pointed to unresolved questions, regarding the currently envisaged concepts of standardized products, the linkages across time periods, the interactions between balancing and congestion management procedures, and the pricing of opportunity costs of pre-contracted balancing services. To address these topics, the Network Code defines a process based on proposals by TSOs, consultation, and approval by National Regulatory Agencies (NRAs).

Facing challenges to advance a common European solution, the emphasis has shifted to regional initiatives. Apart from the NOISE platform building on the close cooperation among Scandinavian power systems (Nordpool) two prominent CoBAs exist. First, EXPLORE focuses on re-active design (Austria, Belgium, Germany and the Netherlands) for Frequency Restoration Reserve (FRR) exchange. Second,

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TERRE is based on a pro-active design (France, GB, Greece, Italy, Portugal, Spain, Switzerland and Ireland as an observer) for Replacement Reserve (RR) exchange. Especially EXPLORE reflects countries with similar market designs, including converging gate-closure times, product lengths and reactive balancing methods allowing market participants to do economic optimization close to real time and TSOs only solving real time imbalances.

Early learning from EXPLORE suggests that even with such commonalities, detailed procedures need to be harmonized, for example with respect to congestion management procedures. TERRE countries, exhibiting larger differences in operational paradigms, have developed plans for a central platform to share replacement reserves while providing flexibility for continuation of national procedures. Countries are likely to develop tailored national interfaces and potentially complementing national products to allow for secure system operation.

A further concern is that regional initiatives (CoBAs) may be incompatible among each other. Within CoBAs, TSOs with similar market designs work together. Hence the more fundamental market design differences between re-active/pro-active operational approaches are retained. This could lead to regional markets being developed and at the same time may inhibit progress towards integration of the European power system. Against this background, ENTSO-E proposed to the Balancing Stakeholder Group a new concept of 'organic growth' CoBAs. They focus not on different geographical regions, but first on the development of a common platform at the EU level to then allow TSOs in different regions to plug into the platform. However, the approach re-introduces the challenge of agreeing on a common approach among stakeholders of all EU countries. This emphasizes the need for suitable governance or process and appropriate conceptual frameworks to help align perspectives.

The discussions of the balancing code and CoBAs point to a central challenge for progress of European power market and system integration. The focus has to date been on harmonization of products and time-lines rather than on the design of markets to create appropriate incentives and reliable information to support system operation.

Focusing on products and time-lines was more in line with the approach of the European Commission to foster integration through competition, and may have been to some extent effective for longer-term and day-ahead time-frames. However, with increasing shares of intermittent renewable energy sources the share of transactions in intraday time frames and the importance of balancing increases. In these time frames it is particularly important that products, markets and operational paradigms are aligned.

The discussions of the FPM pointed to the importance to acknowledge that there may be large discrepancies between (i) a good design for one country, (ii) harmonization of products to facilitate trading (iii) integration of systems based on physical requirements of all countries (and thus avoiding the need for additional subsequent national platforms) and (iv) integration of markets compatible with the physical requirements of increasing shares of intermittent renewable energy sources. EU power market design should move from the harmonization of products for cross-border trade to the integration of systems to meet future needs.

Further progress towards the integration of European energy markets will need to build on lessons from countries in the periphery of Europe that already face today system operation challenges that require a

closer alignment of markets with system operation. Such constraints are anticipated for future years to also affect centrally located countries. One option to consider is the development of a blue-print for the envisaged power market design that provides a clear picture of how power markets and operational processes can work together in a coordinated way guiding the next steps of market design.

In the remainder of the report we first discuss no-regret elements for progress on further integration, then challenges that need to be considered when advancing other elements of market integration. We conclude with some lessons from the European experience and the implications for further policy development.

## No regret Options

**Imbalance settlement periods** need to be standardized across countries to facilitate international energy trading. Therefore convergence to the largely used 15 min period is supported by most. While sometimes high costs are attributed to the adjustment of imbalance settlement periods, it seems that the majority of such costs are linked to metering of retail customers. However, only customers that want to provide demand response for such short periods require updated meters while standardized load profiles suffice for the remainder of load.

**Clearing of bids** in intraday and balancing markets differs across countries and time-frames between pay-as-bid and clearing based on the price set by the marginal bid. A common approach is necessary for market integration so as to avoid inefficiencies and inconsistencies that may cause gaming with destabilizing market results. Marginal pricing is widely seen to be preferable as it avoids discrimination against smaller players with less information. It also avoids the need for mark-ups of bids to recover opportunity costs in pay as bid formats that results in use of the generation technology with lowest sum of marginal cost and mark-up rather than generation technology with lowest marginal cost. Marginal clearing prices also create incentives for all parties to contribute to a balanced system.

## Challenges

**Standard products** are a key element of the balancing code and of CoBAs. They reflect the philosophy that energy and reserves are traded in standardized products not only within countries but can also be traded between countries. If instead, products differ across countries and between day-ahead, intraday and balancing, this may reduce liquidity and also traders may be quick to spot and arbitrage differences – resulting in gaming of market design rather than improvements of system outcomes.

The experience to date suggests that existing product design (e.g. product length, activation time, requirements on ramps etc) reflect not random national choices that can be easily aligned, but are tailored to physical needs of European countries with different network and generation structures. This implies that multiple standardized products need to be maintained.

Irrespective of the precise definition of standardized products, in their current format they are considered too crude for a secure operation of some of the systems that have limited surplus flexibility either because of inflexible generation assets or island structure of the network. In these cases TSOs will likely acquire additional local resources – undermining the principle philosophy of integrated markets.

A key area of discussion between TSOs is on the differences between the standard product that is exchanged cross-border between TSOs (and for which the Network Code currently envisages ex-ante prescribed parametrization), and what is formulated internally by Balancing Service Providers that may reflect specific parameters of their assets. Any differences between the cross-border product and the product delivered locally ultimately creates additional imbalance for the connecting TSO, which need to be solved with closer to real-time and hence more expensive products.

**Linkages across settlement periods:** An often ignored dimension linked to shorter settlement periods is that many generation assets only have limited flexibility to ramp up or down for example within a 15 min period, while they could ramp over longer periods. To allow for full participation and realization of all flexibility potential a closer characterization of physical capabilities is required to accommodate increasing shares of intermittent resources, as well as inflexibility of must-run units. Countries like UK, Poland, Italy, Greece and Ireland dispatch based on multi-part bids of generation assets

Full reflection of physical capabilities in standardized multi-part bid submitted to balancing mechanisms can also resolve an ongoing debate on whether TSOs should dispatch standardized balancing products according to merit order (in order save costs by first using the cheapest options) or call all accepted bids prop-rate (in order to use more units to accelerate the response). If generators and demand side can reflect the full flexibility of their assets in bids, market clearing leads to the use of the least cost option to provide sufficient response to ensure system rebalancing. Also the TSOs can benefit if they have full sight of the units delivering the energy. They will not have to consider ramping energy as an unwanted by-product but as useful energy that can help to balance the system.

The philosophy of TSOs with a re-active approach to system balancing differs. They expect market participants to internally balance supply and demand and to adjust their position with bilateral market transactions and on trading platforms. With full information, perfect competition, and very quick trading, a re-active balancing approach will deliver the same outcome as a pro-active approach. To the extent that these assumptions are not satisfied, the efficiency of the outcome may be inferior.

**Pro-active versus Reactive TSOs** European TSOs are often categorized as either pro-active or re-active. Pro-active TSOs, like for example NGT in the UK, forecast potential imbalances and activate replacement reserves. Costs are then allocated to market participants that are in imbalance, creating an incentive to incur reasonable effort to balance positions. Re-active TSO, like in Germany only measure system imbalances and then activate fast response options that are usually more expensive to respond to observed imbalances. To avoid large – and thus risky – imbalances, systems with reactive TSOs like Germany may impose penalty pricing structures and formulate administrative requirements for balanced schedules.

**Congestion management and balancing** TSOs require adjustment bids both to balance the system and to implement re-dispatch measure to resolve transmission constraints within bidding zones. In most countries, market participants bids submitted to the TSO are used to resolve transmission constraints and balance the system preferably without causing additional constraints. In some countries, bids are tagged to identify for which purpose they were used, so as to directly allocate imbalance costs while socializing costs for congestion management. Short-term market designs in countries with significant

transmission constraints are shifting to a sub-zonal (Italy) resolution or co-optimize balancing and congestion management (Poland, UK, Ireland).

A different approach is implemented in Germany for accommodation of the higher levels of internal transmission constraints without the introduction of smaller bidding zones. TSOs are authorized to mandate all generation assets that are not committed to the balancing mechanism to adjust production levels for re-dispatch purposes in exchange for a cost based compensation of incurred costs. While initially implemented close to real time, re-dispatch measures are now often initiated day ahead to accommodate for the large scale of congestion. To limit distortions of balancing markets from the cost-based re-dispatch, balancing bids are called upon without spatial considerations, further increasing the re-dispatch needs. This approach is impossible to replicate in countries with weaker transmission networks or less surplus on flexible generation capacity. It is also not welcome by neighboring TSOs: If a national TSO lacks reliable information on generation patterns at intraday period, it cannot coordinate with neighbors about forthcoming loop-flows.

The use of different approaches to congestion management creates challenges for integration of balancing markets. A common clearing of all balancing bids without consideration of location within pricing zones is possible in countries as long as they have very limited internal congestion like the Netherlands, or in countries like Germany as long as it has sufficient resources to schedule and finance ex-ante re-dispatch. For other countries that will implement joint balancing and re-dispatch measures, like the UK, this is more difficult. Therefore the coordinated balancing approach TERRE is discussing screening of bids for their potential interactions with national congestion management before they are passed to an international clearing algorithm. A more consistent approach would be the consideration of all physical constraints (e.g. also internal transmission constraints) in the integrated clearing algorithm. Countries without relevant transmission constraints could then still continue to operate as a single pricing zone.

**Full remuneration of scarcity value** Investment and re-investment into different generation and flexibility options depend on full remuneration of the value provided to the system. Different mechanisms within and across countries may artificially dampen scarcity prices, for example if security margins are adjusted on an ad-hoc basis to make additional import capacity available for reducing balancing reserves. A pre-defined operational protocol is necessary to ensure that scarcity events result in appropriate scarcity prices to reward participants that contribute to system adequacy and flexibility. This also implies that assets that are dispatched to accommodate for emergency situations need to be remunerated at the value they provide to the system at these times rather than on a cost basis.

We discussed particular moments when TSOs make use of reserves or reduce security margins to balance the system. A clear principle that has been proposed and is applied in Texas is that if the ISO depletes its reserves to meet demand of the market, the energy provided is priced at the opportunity costs in terms of increased risk of load spilling once the reserve is further depleted (Operational Demand Response Curve). A numerical application of the approach to the Belgian context suggests that currently Belgium CCGTs only cover their variable costs, while an ODRC system would also let them recover their long-run investment costs.

A set of questions regarding this proposal were discussed in detail. In particular, implementation requires a common understanding of the Value of Lost Load to be considered in such evaluations, as well as of the assessment of the risk profile (probabilities). Furthermore, it was discussed how the price diffuses across different balancing products as well as to earlier stages of market clearing. This may well differ dependent on the currently different intraday and balancing arrangements across EU member states.

## What can we learn from our experience

**Move from harmonizing transactions to aligning operation:** EU power market integration has been focused on transactions like allocation of transmission capacity and harmonization of standard products. This reflects the idea that competition can advance integration – however, this may have ignored that effective integration is a requirement for functioning competition, at least on shorter time scales. Hence there was less emphasis on how markets can create appropriate incentives and reliable information for efficient and secure system operation.

**Do not ignore lessons from countries in periphery:** Countries in the periphery of Europe improve their national power market designs to accommodate for evolving needs linked to changing generation patterns. They need to align their power market design better with the physical reality of networks and capabilities of generation assets. As a result, Ireland, Poland, and Italy are moving with their power market design towards a similar direction. The UK and France also use multi-part bids for balancing mechanisms.

However, these countries did only form a joint CoBA on Replacement Reserves (excluding Poland as it does not share common border) and were not involved in CoBAs for example on manual Frequency Restoration Reserve. Hence they did not advance their common philosophy in EU processes, probably both because of their geographical separation (and relatively low interconnection between neighbors) and the focus of regulatory and TSO resources on national processes. The current proposed code now includes special provisions for Central Dispatch TSOs (Italy, Poland, and Ireland) but not for other proactive TSOs like UK and France. More clarity is required how the different approaches can ultimately be integrated.

## Implications

**Markets need to create appropriate incentives and reliable information to support system operation** rather than have markets just on top of system operation. This will require more clarity on aspects of operational paradigms, for example in terms of co-optimization of services, starting at day ahead as basis for updates in the intra-day algorithms. With increasing shares of intermittent renewables, decentralized generation and flexible load, the risk of operating the system without aligning markets and operational paradigms is increasing, triggering an increase of security margins with economic and environmental costs. Therefore progress on power market design is time critical.

**Avoid lock-in:** This raises the question, whether approval of the currently discussed balancing codes will help to advance European power market design. The discussion of codes in this and the previous FPM meeting end of 2015 ([www.diw.de/fpm](http://www.diw.de/fpm)) revealed that rather than offering strong guidance they offer most countries the flexibility to continue with current practices. However, special provisions to



accommodate requirements of some of the countries will need to be approved by all TSOs (with qualified majority voting). The Network Code prescribes time frames of 2-4 years for implementation. The result could be the evolution of a market design as a result of a series of piecemeal compromises. Rather than focusing on how to structure exemptions it will be important to converge to a well thought out holistic market and operational design that can meet the challenges of the future.

**Define sufficiently detailed principles:** Very generic requirements have in the past provided insufficient guidance for selecting market design options that are compatible with the current and emerging needs of all EU member states. Hence it may be necessary to define more detailed principles that ensure that market signals support secure and efficient system operation. They may involve:

1. Prices need to reflect the value of energy to the system at any time (to allow markets to support system security) and be consistent through timeframes.
2. All players and technologies can compete with their full capabilities.
3. No discrimination against resources located in other bidding zones if transmission capacity is available.
4. Minimize congestion within bidding zones by transmission investment and appropriate sizing, to avoid gaming and create appropriate locational incentives for (re-) investment.
5. Efficient use of all resources by optimizing across space, time and system services (including re-dispatch). Market algorithms at day ahead, intra-day and balancing timeframes to incorporate system operation needs and constraints.
6. Define clear methods for system operation and market clearing.

**Create a blue-print:** The experience of three EU energy packages and the scaled up effort of all actors in recent years shows that learning step by step takes a lot of time. With evolving needs and technologies, retaining space for learning will remain important. However, the experience of recent years shows that system operation and markets are integrated not only geographically but also across long-term, day-ahead, intraday and balancing time-frames. Solutions that are found to harmonize products within one of these geographical or temporal defined ‘silos’ can create complications in other ‘silos’.

A blue print can provide a consistent picture of a future power market design and operation. It needs to focus on the bigger picture to gain acceptance, to allow for political understanding and sign up, and to retain space for further learning. It should be based on experience gathered to date and compatible with physical and economic realities. Such a blue-print could then be the basis for assessments of individual steps of market design – to test whether they constitute progress, ensure that they contribute to overall consistency, and to avoid lock-in situations with unsatisfactory overall outcome.

*Presentations from the workshop including more detailed characterizations of the experiences from Terre and Explore, as well as previous FPM reports are published at [www.diw.de/fpm](http://www.diw.de/fpm)*