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**Research Report**

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# A Blue Print for European Power Market Design

Report on the key elements of debate from a workshop of the Future Power Market Platform,  
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The European electricity market design is in a process of continuous development. To help guide this process with a long-term view, the FPM on Blue Prints for European Market design focused on developing long-term visions for future development.

From the last FPM meeting on balancing market design we derived criteria to evaluate future designs of the European electricity market, based on current, but also future projected challenges. The electricity markets are changing since

1. We will have more renewable energy in the system
2. There is going to be more transmission interconnection
3. More distributed technologies are participating in the system
4. Generation adequacy is increasingly a regional rather than a national objective

In the following the debate surrounding the criteria is discussed, and then the blueprints for the future electricity market design outlined.

## Discussion regarding market design principles

In general, the goals of energy policy can be summarised by the energy triangle of cost-efficiency, sustainability and energy security. However, these three goals are not sufficiently detailed to guide the design of electricity markets. Therefore in the following, several detailed principles are defined that were discussed during the FPM workshop:

### 1. Prices need to reflect the value of energy to the system at any time

This principle states that pricing of energy needs to reflect the value of energy provision to the system. One question that arises is whether pricing energy is enough, or whether additional remuneration, for example for flexibility or to make the market design incentive compatible (e.g. via uplift payments) is needed. If and how to remunerate flexibility or energy is also related to the length of energy products. The shorter the trading period (1h, 15 min, 5 min products) the closer energy products get to approximate flexibility capabilities of generators. Therefore harmonisation of imbalance settlement periods to 15 minutes is a pre-requisite for shorter energy products. In order to ensure depth and liquidity, common clearing platforms and capability based bids (e.g. multi-part bids) might need to go hand in hand with decreased product lengths.

Externalities such as voltage stabilisation or losses might not be easily included in prices and might continue to be delivered for free or remunerated via tariffs. A first step would be to develop correct pricing of such externalities and see if alternative efficient allocation mechanisms for such externalities exist. Finally correct pricing of energy also needs to correctly price scarcity and therefore incentivise long-term investment.

## **2. Prices need to be consistent over time and incentive-compatible**

This principle is underlining the importance of coherence of energy prices over all time horizons (e.g.: pay-as-cleared). In expectation intraday prices should be coherent with balancing prices, and in turn day-ahead prices should be consistent in expectation with intraday prices. This feature becomes more important due to the advent of storage and other new technologies, which can arbitrage between those time frames. It is therefore essential for market parties, including decentralised ones, to have incentives compatible with system operation over several time frames. Robust (auction based) clearing prices then also can provide a consistent reference for longer-term contracting arrangements to support (re-) investment choices.

Currently the European power system is lacking this consistency, starting with the absence of a clear real-time or balancing price, due to design choices such as pay-as-bid auction format, pro-rata activation, difference between imbalance payments and balancing prices as well as limited participation in some countries. It is important to consider that this consistency is not only important from an operational time-frame, but also to set the correct investment incentives.

## **3. All players and technologies can contribute their full capabilities.**

Several new technologies and actors may or already are contributing to the power system. Market design should allow all actors and technologies to bring their full potential efficiently to the system. For small scale technologies this requires frameworks that allow aggregation to realize economies of scale. But in principle the market platform should allow every participant, irrespective of scale or type of portfolio, to offer their full capabilities rather than requiring that for example flexibility provided of different technologies is aggregated to match standardised product as this creates market entry barriers and reduces transparency for secure system operation.

## **4. No discrimination against resources located in other bidding zones if transmission capacity is available.**

This issue is still prevalent for shorter time horizons in intraday and balancing markets. Cross-border transmission allocation in day ahead markets is in most instances implicitly pursued with joint auctions while on some borders it remains based on explicit auctioning of capacity. In continuous intraday markets allocation of transmission is on a first-come-first-serve basis. This potentially discriminates against market parties that could provide flexibility across bidding zone borders under an implicit allocation scheme. This is specifically an issue for decentralised generation and demand response, which may only be capable of reacting to local price signals. Dynamic recalculation of cross-zonal transmission capacity during the intraday time frame –based on unit based schedules as basis for reliable flow forecast– can further avoid discrimination against resources in other bidding zones.

## **5. Minimize congestion within bidding zones**

Especially in the current bilateral paradigm it is import to minimise congestion within bidding zones to limit market interventions of TSOs to strengthen investment incentives and to avoid risks for operation from uncertainty and gaming opportunities.

## **6. Efficient use of all resources by optimizing across space, time and system services**

To optimise across space, time and system services, a co-optimisation approach is necessary at day ahead, intra-day and balancing timeframes to incorporate system operation needs and constraints. This also includes dynamic dimensioning of reserve capacity, as is for example done in France. For

this to be successful the operation of exchanges and TSOs would probably need to be integrated more closely.

## Complementary blueprints

Three complementary blueprints for intraday and real-time markets crystallized during the debate as a step-wise approach: first a continuous bilateral trading approach can be complemented with an approach with intraday auctions with capability bids. This may then provide the basis for the later development of a full co-optimisation approach including multiple constraints such as time, space and reserves.

Common to all blueprints is a vision that longer-term trading will continue to involve bilateral trading to allow fine tuning of contracts and management of counterparty risk.

### Continuous bilateral trading

Continuous bilateral trading is the currently predominant market design in Central-Western Europe. Actors are free to trade electricity on a bilateral basis (but also on exchanges) within bidding zones and bids are not specific for individual units, but are conducted on a portfolio basis. This approach focuses on the opportunity for market participants to adjust their positions within their portfolio and define new product types to trade with other market participants. This allows for participation of a variety of firms that engage in further development of the bilateral-trading system.

The approach requires large bidding-zones to ensure liquidity. TSOs' interventions to ensure operational security (e.g. re-dispatch, balancing reserves) are meant to remain limited and if possible as close as possible to physical delivery (after gate closure time).

In this market design it is relatively evident that strong, clear price signals are necessary to set the correct operational and investment incentives. Ideally this starts with a consistent uniform imbalance price in the balancing market which can be passed through to consistent price signals in the intraday and day-ahead market. Furthermore, constraints within bidding zones need to be minimised for this market design to work well.

With increasing shares of variable renewables the volume of adjustments intraday and close to real time is increasing. Hence, there is an increasing need to unlock flexibility from all potential market actors in generation, supply and network assets. This raises the question whether bilateral trading with self-dispatching of generators already sets sufficient incentives for market actors to offer their entire flexibility due to economic incentives and whether the legal requirement to be in balance as well as penalty terms to use balancing services impedes this. If so, market parties and portfolios may have to hold positions opposite to those the system needs.

### Intraday-auctions with capability bids

A further development of the intraday trading could be based on the addition of intraday auctions based on capability bids. It allows market participants to reflect technical capabilities of their units, for example ramping rates and maximum and minimum generation capacity. Bids could be submitted as standing orders to the auctioning platform (and be flexibly updated by market actors during the day). This would enable generators to offer their full flexibility to the system with relatively little transaction cost, as compared to a 24 hours continuous trading desk needed for continuous trading. Thus, market actors can benefit financially from providing their flexibility to the market, rather than keeping it idle in case they need it to balance their own portfolio.

Given the existing experience in Germany, this would probably increase the liquidity and depth of markets and give a robust uniform price signal to improve contracting. Intraday auctions allow for transparent transmission based on the experience of implicit flow-based transmission allocation from day-ahead markets. Introducing the identical capability product to day-ahead markets and potentially also to balancing mechanisms could lead to a coherent opportunity for market participants to offer their units from day-ahead to balancing time. Providing the TSOs with the auction results, improves reliability since TSOs gain additional information on continuously updated power plant schedules. In the longer run this would also create the preconditions for co-optimising between short-term energy demand and reserves. Furthermore auctions are also better prepared to deal with shorter product length, such as 5 minute resolution of price, since units can implicitly participate in such short time frames.

Since currently trade is for differences of energy, this would need to be considered in the design of the intraday auctions and the capability bids. Market participants submit to the clearing algorithm the currently planned schedule for participating units as well as pre-existing commitments to provision of ancillary services and re-dispatch. To maintain the incentive to adjust for new expectations each auction result would be financially settled. This is the main difference to the current real-time pricing designs.

### Multiple constraint co-optimisation

The third blueprint that was discussed is a full co-optimisation approach. Here generators exclusively bid capability bids into a centralised market platform, which takes multiple constraints such as time, space and reserve requirements into consideration. This is already common practice where systems are running close to technical constraints, for example because of transmission constraints or due to limited availability of flexibility in the system.

The nearly identical clearing system is then run several times before delivery to adjust for changing expectations (mainly demand and renewable in-feed, but also power plant outages). However, from a financial perspectives it is only a 2-settlement system. The results of the day-ahead market are financially firm, and participants are payed for (or receive) the real time price only for differences of production /demand volumes to day ahead clearing. To come to an efficient solution all actors must be able to fully describe their capabilities to the system, including evolving requirements for demand and storage. It is also clear that the basis for efficient system operation would be a clear real-time price signal which has a dispatch duration that is short enough to capture the value of flexibility (reflected in variations in prices between intervals). Transparency can be maintained by relying on fully reproducible results, which can be used for post fault event queries. This is internationally the most common and refined market design.

For the potential European implementation, especially in the context of increasing shares of renewables, a set of design options need to be further assessed: where in the system is aggregation necessary to keep the solution feasible? Can such a co-optimisation algorithm be nested, i.e. at DSO, regional and EU level (and which institutions should be responsible) or is it better to solve for the overall system directly? Should participation be limited to physical units, or could financial entities participate via virtual bids? Is the inclusion of uplift payments a necessity? What level of dynamic definition of constraints (such as reserve requirements and transmission requirements) is desirable and is there a trade-off between theoretical optimality and complexity and transparency of the algorithm?

*Presentations from the workshop, as well as previous FPM reports are published at [www.diw.de/fpm](http://www.diw.de/fpm)*