

Neuhoff, Karsten; Richstein, Jörn; Piantieri, Carlotta

Report

TSO-DSO-PX Cooperation II. Report on key elements of debate from a workshop of the Future Power Market Platform

Suggested Citation: Neuhoff, Karsten; Richstein, Jörn; Piantieri, Carlotta (2018) : TSO-DSO-PX Cooperation II. Report on key elements of debate from a workshop of the Future Power Market Platform, DIW, Berlin

This Version is available at:

<https://hdl.handle.net/10419/180382>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

TSO-DSO-PX Cooperation II

Report on key elements of debate from a workshop of the Future Power Market Platform,

Milan, 10th Jan 2018

Karsten Neuhoff¹, Jörn Richstein², Carlotta Piantieri²

Introduction

This workshop was used as an extension of the debate on the necessary future coordination between transmission and distribution system operators, which is driven by the changing role and location of resources within transmission and distribution networks (Neuhoff and Richstein, 2017).

This workshop thus focussed on two issues identified as especially relevant during the previous workshop:

1. What are plausible coordination mechanisms between TSOs and DSOs?
2. How can congestion at the distribution grid be dealt with?

Both these question promise to gain importance in the coming years (Neuhoff and Richstein, 2017), as larger parts of the system wide generation and flexibility will reside in the distribution grid. While this report is not focussed on the question of grid investments (which will be necessary), grid constraints will need to be dealt with more frequently, as renewables have low capacity factors (thus more easily being constrained in peak hours), and new demand might be strongly correlated by its own nature (e.g. EV charging after working hours, heating demand in the winter) or via the synchronisation with wholesale electricity prices which disregard grid constraints. This will lead to binding constraints on all grid levels and therefore requires coordination between system coordinators.

Possible interactions between TSO – DSO levels

In the previous workshop three main types of future coordination mechanisms were discussed: full integration of the role of TSOs and DSOs, several options for limited integration/coordination, and vertical market coupling. In the current workshop, the more realistic options of limited integration/coordination between TSOs and DSOs were discussed in more detail. *Case studies* presented in the meeting have shed light on the importance of several architectural elements. The discussed models can be summarized in the following six forms, which follow the definitions of several publications (Gerard et. al., 2018 following the H2020 SmartNet definitions; Ecofys and Fraunhofer IWES, 2017; Energy Networks Association, 2017), and represent an extension of our discussion in the previous FPM workshop report (Neuhoff and Richstein, 2017):

I. Static prequalification (Centralized AS Market Model)

¹ Head of Climate Policy Department at DIW Berlin and Professor for Energy and Climate Policy TU Berlin, kneuhoff@diw.de

² Research Associates, Department of Climate Policy at DIW Berlin, jrichstein@diw.de, cpiantieri@diw.de.

The Centralized AS market model (as defined by Gerard et. al (2018)) is characterized by a single AS market managed by TSOs. Distribution constraints are checked by DSOs through a separate process (with static pre-qualification), after which market participants are free to submit their bids to the single market or to the markets for ancillary services (AS) managed by the TSO. This model is the best in line with the framework currently in place. Nevertheless, the standardization of processes and the optimization of TSO-DSO cooperation is crucial to enhance the efficiency of the scheme. DSO constraints are not necessarily considered close to real-time, thus the potential of local flexibility that can be realized with this approach will be necessarily limited, as DSOs and TSOs will be cautious in their qualification procedures.

II. Cascade market model (Local AS Market Model)

In the Cascade Model (described by Gerard et. al (2018), and by Ecofys und Fraunhofer IWES (2017) as the “Local AS Market Model” and by Energy Networks Association (2017) as the “DSO Coordinates” model), the DSO selects priority flexibility options (and/or checks for feasibility) and passes the remaining bids to the TSO or wholesale level. The DSO coordinates the procurement of flexibility resources available at the D-level that can be used for the balancing and the management of system’s constraints in both D- and T- networks. The TSOs directly procure only the flexibility resources that are not linked to the D-network, and indirectly activate flexibility resources connected to the D-network via the DSO which is usually responsible for their procurement. TSO and DSO operate according to a pre-defined set of DERs services that satisfy TSO and DSO requirements. This might lead to an over-procurement, as the DSO will retain all reserves for his own operation, as long as it is not incentivised to pass them on.

III. Shared balancing responsibility models

The model of shared responsibility foresees (as described by Gerard et. al., 2018) a centralized market operated by TSOs and a local market managed by DSOs, coordinated through pre-defined TSO-DSO schedules and managed separately at real-time. This leads to more AS being procured than necessary in the other schemes (and more than what is economically efficient), as DSO and TSO procure and manage their reserves separately, and the TSO does not have access to D-level resources. This coordination scheme stands in stark contrast to the current practice and established regulation (as well goals) at the EU and national levels, which see balancing as the sole domain of TSOs, as frequency is a system wide property.

IV. Vertical market coupling (Common TSO-DSO AS market model)

A coordinated common flexibility market allows both DSOs and TSOs to procure and activate the flexibility services offered by DERs in a common market. If distributed flexibility resources access the common market via the DSO as an intermediary³, this is similar to the vertical market coupling model described by Neuhoﬀ and Richstein (2017). Both TSOs and DSOs manage the secure scheduling of services. Here, the T-level and the D-level constantly coordinate in order to guarantee that T- and D-

³ Another alternative is a system where the TSO is extending its balancing markets to include a local component and give access to the DSOs (termed “reserve market plus” by Ecofys und Fraunhofer IWES (2017)).

network requirements are met through the activation of flexibility resources. As a result of TSO-DSO cooperation, the procurement and use of flexibility is minimized (as counter-activation is avoided) and system costs are minimized. Nonetheless cost allocation between SOs would need to be addressed, as DSOs may otherwise face higher costs if they are cost-responsible for all reserves located at the distribution level.

V. Procurement (Joint or Decentralized) Coordinated by a Third Independent Party

In this model, a third independent party manages a common flexibility market, where TSO and DSO bid for flexibility resources in competition with other private market parties (for example balancing responsible group manager). The market model “IntradayPlus” described by Gerard et. al. (2018) falls into this category, where SOs are in competition with other market participants on the normal intraday market, the bids of which are enriched by locational and other information. As it is a continuous market, the flexibility option is acquired by the first / highest bidder, but might subsequently be resold on the market. It is thus not suitable for acquiring reserves that are available on demand, and could thus fail in situations of scarcity conditions.

VI. Fully integrated market clearing

In a fully integrated market clearing model (Neuhoff and Richstein, 2017), transmission and distribution constraints are integrally considered in the market clearing algorithm. Thus reserve and congestion management requirements by TSOs and DSOs, as well as the energy demand are co-optimised and in simultaneous competition to each other. In practice, this would be computationally expensive; however, it could be approximated via decomposition techniques, and vertical market coupling, or distributed algorithms, as outlined by Caramanis et al. (2016).

Comparison of the coordination options

Figure 1 depicts on the two axis the availability and co-optimisation level of reserves to the DSOs as well as TSOs from not available at all, to available in real-time with a full co-optimisation. As can be seen, the options I and III do not make full use of the resources, as either the DSO only do a static pre-qualification, without any short-term access to flexibility resources (in I), or the DSO have exclusive access to all local flexibility resources (in III). While this figure cannot capture all distinctions between the different coordination schemes, especially in the upper right corner of the figure, in principle a closer real-time coordination between DSOs and TSOs is desirable to: 1) ensure system stability, 2) have a higher efficiency and utilization of distributed flexibility options.

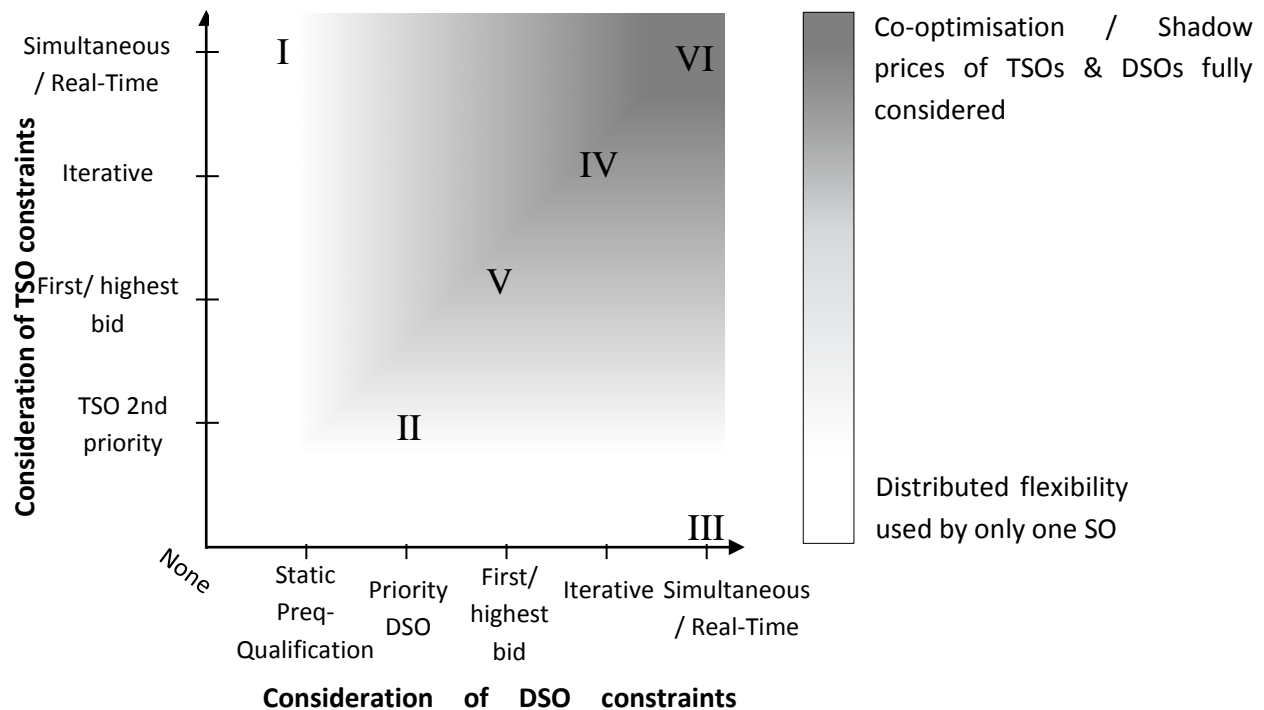


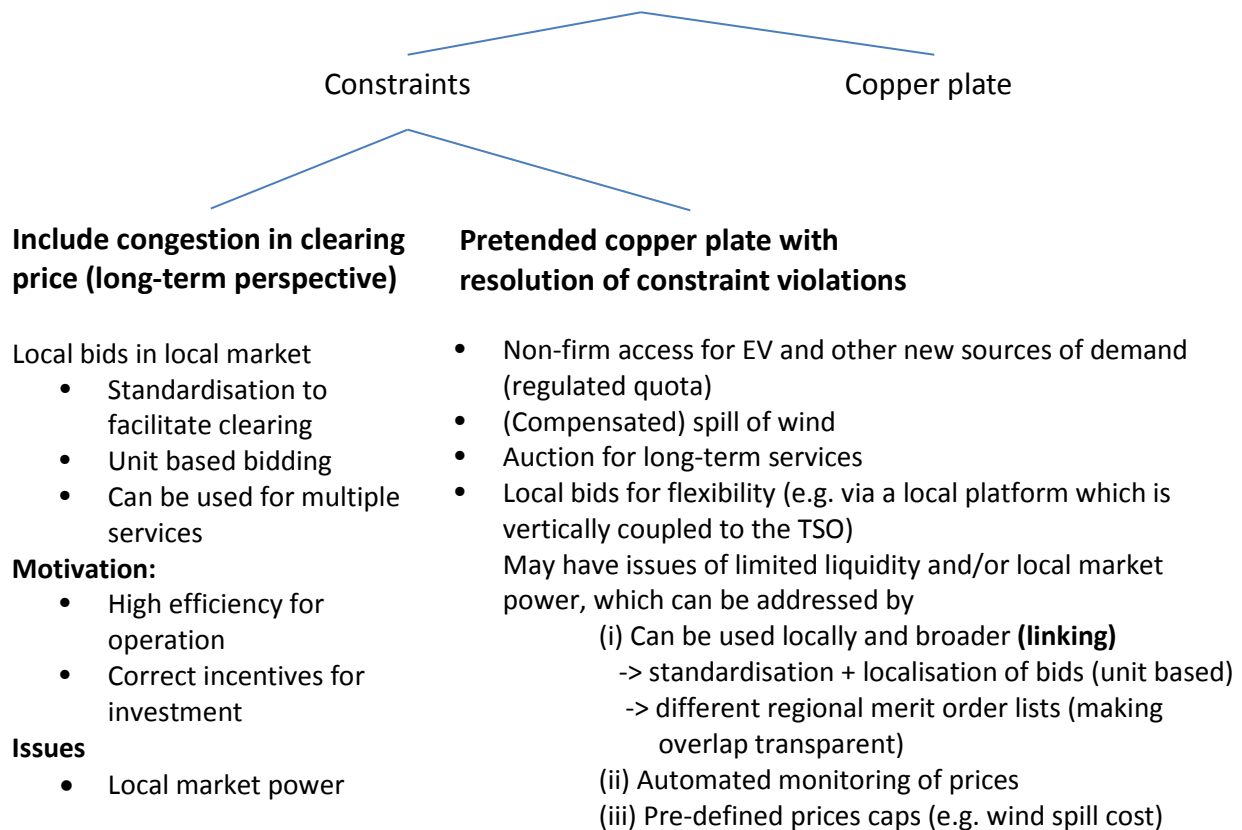
Figure 1 Comparison of coordination options for distributed flexibility resources

Dealing with congestion – options for unlocking flexibility at DSO level

During the workshop the issue of congestion at the DSO level was discussed extensively. In the current situation, the approximation of the grid as a copper plate at the distribution grid is often correct in Europe. However, with the increased shares of distributed energy resources, and especially renewable electricity, as well as new sources/patterns of demand, such as electric vehicles and more flexible industrial demand, distribution grids will see congestion as well. Hence, the occurrence of binding constraints needs to be dealt with at the DSO level.

A long-term vision could be the introduction of locational price signals in distribution grids (while integration with the transmission grid is assured via one of the previously discussed coordination frameworks). While more complicated to interpret than in the transmission grid, several approaches exist to interpret locational price signals (Papavasiliou, 2017). For the distribution grid bidding formats should be standardised to include technical constraints, such as voltage, as well as losses and be unit-based. Using such bidding formats one bid could be used for multiple services. However, due to the small number of active market participants in distribution grids and accompanying market power concerns, such a fundamental shift in market structure may not be desirable nor realistic in the coming years.

Physical situation at DSO level



Therefore, in the first instance of market clearing, the distribution grid will continue to be treated as a copper plate, and actions would be taken either before or after market clearing to resolve the (expected) violation of physical constraints. Options to resolve the constraints could be: (1) Non-firm access for electric vehicles, and other flexible new resources; (2) regulated (and compensated) spill of wind (3); auctions for long-term provision of flexibility service; and (4) local bids for flexibility (thus not exposing all market participants to fluctuating local price signals). Local bids could be realised via either unit- and capability- based bids (which include locational information) or a linking of regional merit order lists (through either a coupling or splitting of lists). Both options would already demand significant changes in the way power exchanges operate. The linking of merit order lists is, however, probably more suited for DSO-to-TSO constraints, as the granularity of the merit order lists would probably take form at a regional, not sub-DSO level.

While the former options (1) and (2) are basically quotas (compensated or not), as defined by Ecofys and Fraunhofer IWES (2017), the latter two options are obtained and paid for by the system operators. Not all of these options are suitable for all distribution grid situations and are compatible with all coordination schemes discussed in the previous section.

For example, due to the limited number of market participants, issues of market power may arise in the case of local flexibility bids, which in turn can be addressed by several measures.

- Locational bids could be built on the capability, unit-based bidding format, which would be used not only for congestion management, but also other services. By linking several markets, such as in coordination schemes IV and VI, market power issues would be somewhat mitigated, as producers have an incentive to stay competitive in several markets, using the same bid.
- Automated market monitoring schemes could ensure that market participants bid as in a competitive environment. This requires multi-part bidding formats to allow benchmarking the bid components rather than second guessing mark-ups.
- Thirdly, regulated price caps could be introduced in local markets (e.g. defined by wind spill costs). This could create a regulated price for flexibility, while keeping the market entry open to other market participants.
- Finally, local bids could be combined with long-term auctions for flexibility provision. This could be another way to address the limit liquidity and market power, as a competition for a market is introduced, rather than having competition within a market which might be rather small.

Conclusions

The current institutional arrangement of coordination between TSOs, DSOs and market exchanges will prove inadequate, as more generation is moving to the distribution level, existing electricity demand becomes more flexible and responsive to wholesale market prices, and new flexible demand types such as electric vehicles and space heating become widespread and will increase the electricity demand.

On the one hand, even after reinforcements, grids will more often be constrained both on the distribution and transmission level and, on the other hand, system services currently provided by large conventional power plants will need to be provided by distributed energy resources as well as flexible demand.

At the FPM meeting several coordination approaches between TSOs and DSOs, as well as their advantages and drawbacks, were discussed. Summarising, it can be said that the more a co-optimisation between the TSO and DSO is taking place at real-time, the higher will system efficiency and security be.

Congestion management options at the DSO level were discussed, with locational pricing at the DSO level identified as a long-term solution. Also options for more short-term implementation exist, which keep treating the distribution grid as a copper-plate with the DSO relieving constraints either via out-of-market, or more integrated market mechanisms (e.g. local bids for flexibility). Here the question of misaligned market incentives (resulting in reduced accuracy of schedules and gaming of the system), what resources cause a congestion as well as local market power and how to control it, become relevant for the choice of the mechanism.

References

- Caramanis, M., Ntakou, E., Hogan, W. W., Chakraborty, A., & Schoene, J. (2016). Co-optimization of power and reserves in dynamic T&D power markets with nondispatchable renewable generation and distributed energy resources. *Proceedings of the IEEE*, 104(4), 807-836.
- Ecofys und Fraunhofer IWES (2017): Smart-Market-Design in deutschen Verteilnetzen. Studie im Auftrag von Agora Energiewende
- Energy Networks Association (2017), Open Networks Project Opening Markets for Network Flexibility 2017 Achievements and Future Direction,
http://www.energynetworks.org/assets/files/electricity/futures/Open_Networks/14574_ENA_Open%20Networks%20Report_AW_v9_Web.pdf
- Gerard, H; Rivero Puente, I.E.; Daan Six (2018), Coordination between transmission and distribution system operators in the electricity sector: A conceptual framework, *Utilities Policy*, Volume 50, Pages 40-48
- Neuhoff, Karsten; Jörn Richstein (2017), TSO-DSO-PX Cooperation. Report on the key elements of debate from a workshop of the Future Power Market Platform, <http://hdl.handle.net/10419/167313>
- Papavasiliou, A. (2017). Analysis of distribution locational marginal prices. *IEEE Transactions on Smart Grid*.