

# Regulatory challenges of large-scale integration of renewables – governance of flexibility markets

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**Abstract:** The new buzzword in the energy transition is *flexibility*. This paper discusses challenges in market design and governance design associated with flexibility management.

**Keywords:** flexibility, market design, governance

## I. INTRODUCTION

The growth of renewable energy sources (RES), especially solar and wind, is impressive. Yet, the surge of intermittent RES causes unanticipated problems. Hurdles are technological as well as institutional. Adjusting the institutions is an ongoing process and is subject to debate, which is known by “rules & regulations”<sup>2</sup> or alternatively by “roles & responsibilities”. Part of the debate concentrates on the future role and the governance model of the distribution system operators (DSO), which immediately affects the development of smart grids.

The electricity supply industry (ESI) is changing quickly from a top-down, single-firm game to a decentralized bottom-up, multiple-player system, with far-reaching consequences for the governance and regulatory structure. The distribution companies are reshaping their governance structure, following major drivers. First, the emergence of third parties (i.e. non-incumbent parties) onto the electricity sector. The interaction with many different players must be coordinated, whilst securing a non-discriminatory level playing field. Second, (administrative) unbundling rules to promote competition restrict the activities of the network companies beyond network activities; whereas this is good for competition, it tends to impede efficient development of smart grids. As discussed in [1], [2] and [3], these developments have far-reaching consequences for the distribution companies.

This paper steps into a topical development: the organization and governance of *flexibility*-management. Flexibility is system-stabilization with the use of decentralized generation, load and storage facilities; as these facilities are decentralized, the distribution network and thus the DSO are affected by the developments. Two issues stand out: first, what is the borderline between the TSO and the DSO, and second, what is the future role of the DSO? This paper concentrates on selected issues in market design and governance design.

The debate on flexibility has only just started. Ideas are being developed in smart-grid demonstration projects like the SINTEG-projects “enera” and “windnode” in Germany or the initiative “USEF” in the Netherlands,<sup>3</sup> variations can be found in other countries. In sum, views are not settled yet. This paper

follows this by setting out key questions, without attempting to provide answers.

## II. WHAT IS FLEXIBILITY?

“Flexibility is here defined as the ability to adapt and anticipate to uncertain and changing power system conditions, in a swift, secure and cost efficient manner.” [4] (p. 36) Whereas Ecorys & ECN [4] primarily think about the DSO, the same holds for the TSO. With the rise of decentralized RES and the decline of centralized generation, we see that the TSO increasingly will have to manage the transmission system with decentralized resources. [5] (ch. 4) describe the sources of flexibility in much detail. Basically, they distinguish generation, load and hybrid. Under generation, we find CHP (industrial and city-heating) and RES (biogas, biomass, PV and wind). Under load, large (industrial) users, heat-pumps, e-mobility and power-to-gas. Finally, under hybrid, RES-storage facilities, battery storage and power-to-heat. It should be possible to actively manage these resources; [6] (p. 8) calls this “Active Demand and Supply (ADS)”.

### A. Why flexibility?

There is nothing new about flexibility as such; the TSO always needed generation and load to manage the system. The novelty is that the need for and the potential from flexibility is now emerging at the decentralized distribution level. As yet, there are no suitable institutions (ie. rules, regulations and markets) to facilitate this efficiently, which explains the current discussion on institutional design. Why the sudden interest in flexibility?

- The roll-out of smart meters technically allows utilizing the potential of decentralized flexibility.
- The rapid emergence of third parties, especially aggregators, entering the market with new business models; flexibility management is one of these.
- The large-scale integration of decentralized RES, especially wind and pv, with two consequences. First, RES intermittency makes it more difficult for network operators to balance the network and for balancing responsible parties (BRP) to balance their accounts. Second, distributed generation starts to create network congestions, which can be relieved by flexibility.

The last point is important. Network congestion can happen at TSO level and, increasingly so, at DSO level. Moreover, decentralized generation is on the rise, whereas centralized generation is in decline. As a result, we find that both the TSO and the DSO start to rely on decentralized

<sup>1</sup> The author gratefully acknowledges financial support from the research grant ConDyNet 03SF0472D by BMBF, Germany.

<sup>2</sup> Here, regulation means economic regulation, not technical regulation.

<sup>3</sup> URL enera: <http://www.energie-vernetzen.de/>; URL windnode: <http://www.windnode.de/>; URL USEF: <https://www.usef.energy/>.

flexibility; i.e. flexibility in the DSO network. Figure 1 below depicts this situation.

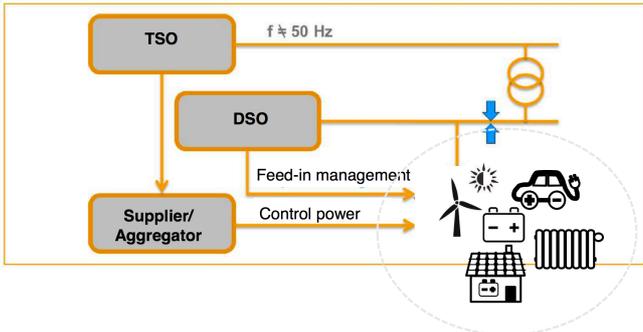


Figure 1: TSO and DSO both rely on decentralized flexibility  
Source: presentation by MVV, Mannheim

This is largely unproblematic if the TSO and DSO are not competing for the same sources and the use of flexibility has no effect on each other's networks. However, increasingly so, cases emerge where network congestion at TSO-level is resolved by flexibility at DSO-level, where at the same time this may conflict with network management at the DSO-level. Here we have a conflict of TSO- and DSO-optimization. This is where market design starts to become important: who has priority or can they optimize jointly? Figure 2 depicts this situation of conflict.

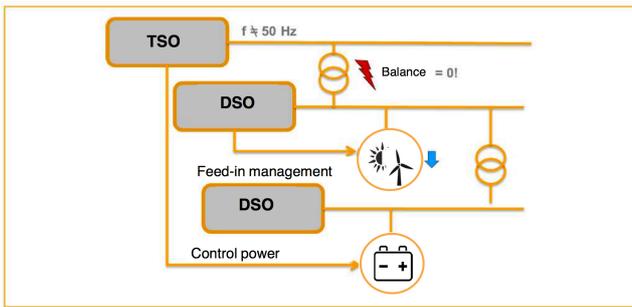


Figure 2: If both the TSO and DSO rely on flexibility, a conflict may arise.  
Source: presentation by MVV, Mannheim

### B. Who uses flexibility?

Figure 3 summarizes the users of flexibility. It distinguishes five groups. First, the prosumers, which represent the suppliers of flexibility, as specified further above. Second, three groups of flexibility demand: the balancing responsible parties (BRP), the DSO and the TSO. Both the latter require flexibility to stabilize the network, the BRP require flexibility irrespective of network congestion. Hence, even if we have an over-dimensioned network without any congestion whatsoever, the BRP would still demand flexibility. Lastly, the aggregators. Their task is to collect supply of different flexibility sources and bring this onto the market; they represent the prosumers. Aggregators can be anyone and can have any size; it is a free-float to be determined by market forces.

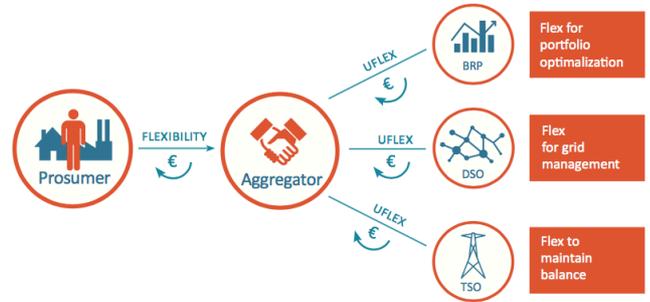


Figure 3: Who uses flexibility markets?  
Source: [6] p. 2.

Figure 4 sets out in more detail the (possible) products that may be traded as flexibility. We should note that this list is by no means universally agreed upon, but gives a good impression. Moreover, some of these markets (eg. reserve energy or intraday optimization) already exist for "centralized flexibility", whereas other (eg. DSO congestion management) are new.



Figure 4: What are the products to be traded at a flexibility market?  
Source: [6] p. 19.

## III. KEY QUESTIONS IN INSTITUTIONAL DESIGN OF FLEXIBILITY MARKETS

### A. Market design

Figure 5 (adapted from [5], p. 47) puts flexibility management in the wider context of other electricity markets. We can distinguish between balancing services for system stability at TSO level and for balancing of the BRP on the one hand and flexibility to manage (local) network congestion on the other hand. The first aspect, balancing, is not something new: flexibility creates new balancing products which can be included in already existing balancing or intraday markets. Without network congestion, we would expect such markets to be on a large (say national) scale. Importantly, the new flexibility products provide commercial value for the sellers (which may be households) and buyers (BRP) and trigger new business models for aggregators; all these parties do have the fundamental right to trade flexibility and thus markets to facilitate this will arise. These markets should secure equal, non-discriminatory access to all eligible parties. The second aspect is inspired by local congestion management. This is new: TSO and DSO start to require decentralized flexibility to actively manage the networks.

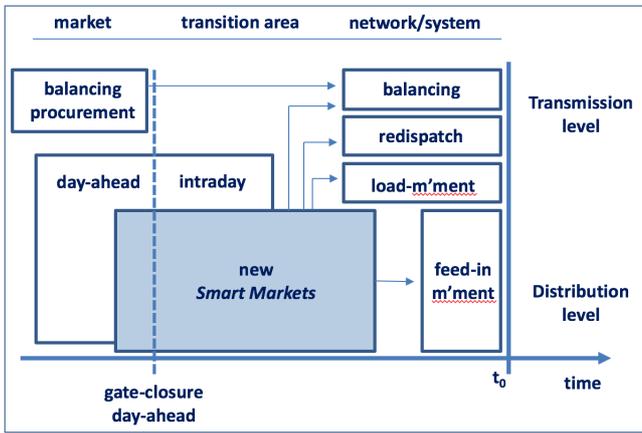


Figure 5: Flexibility in relation to other markets.  
Source: Adapted from [5] (p. 47); translation by author GB.

The question is how to do this: do we need market places for this and how do such markets relate to the other markets? These are fundamental questions of *market design*. The discussion below is in no way comprehensive. Moreover, this paper focuses on the questions, without providing answers.

First, how should the flexibility market be organized? We can distinguish three options:

- Centralized market(s), like an auction platform. This is what the debate seems to be heading for. A platform is desirable if there is a lot of trading on a large scale and with homogenous products. Problems arise with local platforms on a relatively small scale, where localized market power may exist for individual suppliers of flexibility behind a network constraint.
- Decentralized bilateral contracts. This is mostly what happens currently. The TSO or DSO make bilateral contracts with suppliers of flexibility to curtail feed-in or interrupt demand if so required. This will work well if intervention is exception rather than rule and if the products are heterogeneous. It is a relatively flexible way for the DSO to manage the network (cf. [7]). The problem is the lack of transparency, which makes both competitive trading and optimization difficult.
- Administrative rules. If markets fail, the TSO and the DSO will need to have a mandate by law to interfere to stabilize the network. The law would have to specify compensation rules. Of course, such rules already exist, the question is more whether the existing rules are applicable for efficient flexibility management more generally.

Combined hybrid forms of all three options seem rather likely. For instance, the DSO may be trading on auction platforms, but also support its flexibility demand with long-term contracts. [5] distinguish different drivers for network congestion (wind-dominated versus pv-dominated) and argue that optimal flexibility market design will differ depending the driver. Consequently, it might be useful to have different market designs within one country or even combined hybrid forms with one network area.

As shown in figure 2, a challenge is the potential conflict between TSO and DSO relying on the same flexibility sources. The key question now is: does a (well-designed) auction platform fully internalize any externalities between TSO and DSO? An example: suppose a network situation, which can be solved by either the DSO or the TSO, but it is costly for both; will they free-ride on each other and bid below true opportunity cost? Another example: suppose that the TSO can

resolve a problem at TSO-level with decentralized flexibility, but by doing so causes additional network problems for the DSO. The DSO in turn can address this problem with the use of flexibility, but by doing so increases the problem of the TSO. Does self-interested optimization lead to overbidding as compared to system-wide optimization?

Second, where should the platform be? There are different ideas. One variation is to have these markets at a high (say, national) level. Balancing services for BRPs, for instance, if there is no network congestion, should be traded at a high aggregation level; thus the national intraday market seems to be a natural candidate for these services. Things differ for (local) congestion management. A DSO requiring flexibility to resolve local congestion, does not need a national market, but only local flexibility qualifies. In that case, a localized market organized around the DSO, as system operator, would be better. Should such markets (national and local) be separated or integrated? If separated, does this work if we are dealing with the same sources of flexibility? If integrated, how do we do this and where should this market be placed?

Third, at which level should optimization take place? The SmartNet-project [8] analyzes different ways of optimization. One way is system-wide simultaneous optimization; i.e. the flexibility markets are jointly optimized for the TSOs and (all) the DSOs at the same time. This will result in the overall optimum, but the calculatory requirements, especially regarding real-time markets, is highly challenging. Another way is sequential optimization; first, one network level is optimized and after the subsequent information is passed through the next network level is optimized. A question is: who goes first, the TSO or the DSO? Sequential optimization will typically result in sub-optimal outcomes, but seems to be manageable. More importantly, sequential, sub-system optimization conforms to current institutions: DSO and TSO would be responsible for their own network area.

### B. Governance design: Roles & Responsibilities

Governance of the value chain dictates the roles and responsibilities of various stages in the value chain. Importantly, the value chain in the ESI includes monopolistic and competitive parts. The competitive parts require access to the monopoly parts. To facilitate an equal-access level-playing-field the monopoly part is subject to heavy rules and regulations, which together determine much of the governance structure.

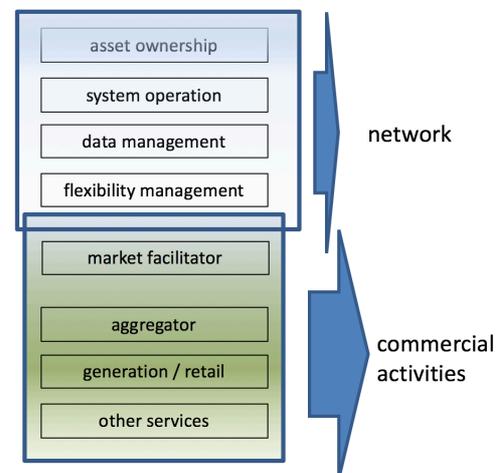


Figure 6: The electricity distribution value chain.  
Source: own source.

Until recently, the network department was usefully described by two parts: asset ownership and system operation. We can see this distinction nicely at TSO level, which is a combination of transmission owner (TO) and system operation (SO); in principle, the same holds for DSO. In recent times, a more differentiated picture has emerged. At the latest after the smart-meter roll-out, data management has become important. And now, being the focus of this paper, we may include flexibility management as an additional stage of the distribution network department.

Beyond the monopoly network part, we find the roles market facilitator, aggregator, generation & retail and other services (eg. BRP, IT-services). These are commercial activities where competition should prevail. Any party can be involved in these commercial services. The DSO itself may or may not participate in commercial activities; this depends on unbundling provisions. The regulatory authorities are worried that the monopoly part of the company may and can abuse its monopoly power to distort competition in the commercial activities at the advantage of its own commercial services and at the expense of third-party competitors. This is the reason why the regulatory authorities tend to unbundle the monopoly part from the commercial activities. Implementation models of unbundling range from administrative unbundling to ownership unbundling. In the former, monopoly and commercial activities within one and the same company are allowed, but these should be separated by a set of administrative restrictions, including so-called information firewalls. In contrast, under ownership unbundling, the monopoly part is simply not allowed to undertake commercial activities.

In many countries, at TSO-level, ownership unbundling has been implemented, whereas on DSO-level, some variation of administrative unbundling (sometimes with very loose rules) seems to be the most popular choice. Following the emerging flexibility markets and the subsequent reliance on decentralized commercial services, this is now under renewed debate. On the one hand, the DSO may have increased discriminatory potential to advantage own flexibility suppliers at the expense of competitors. This can be short run, by manipulating system operation, or long run, by strategic network investment. On the other hand, unbundling rules may be too restrictive; flexibility management (for instance network-storage-facilities) are commercial activities, but are strictly needed for network management: the line is blurred.

Now what are the options? At this stage of the debate, we may distinguish three models. It is beyond the scope of this paper to discuss pros and cons. Moreover, at this stage, this is only a short-list of options; I do not mean to recommend one or the other model.

- First, administrative unbundling plus data monitoring. This is more or less business as usual, but would require an external institution (possibly the regulator) to monitor the data. Having all relevant data, this institution would be able to investigate abuse of market power upon request. The DSO would still have its data, but there would be an exact "copy" of the data for the external monitoring institution.
- Second, an "iDSO", meaning "independent distribution system operator". This is a relatively novel approach, which relies on the ISO- or ITO-model at TSO level. In this approach, system operation, data management and flexibility management would no longer be under control of the distribution company, but would be run by an

independent entity: the iDSO. Or entities (plural), as they may be separate activities. In return, the distribution company, being the asset owner, can remain to be active in the commercial services. The question then emerges, who would be iDSO and what would be the optimal scale and scope of an iDSO?

- Third, ownership unbundling. In this variation, the entire monopoly part, comprising the four stages set out above, would be split in ownership from the commercial activities. On the one hand, this implies that the asset owner could not engage in commercial activities. On the other hand, and in contrast to an iDSO, the asset-owner can also be system operator, data manager and flexibility manager.

These basic models are further-developed follow-ups of well-known models, which have been implemented already. They all have their pros and cons. The basic trade-off is that stronger unbundling improves competition but loses on coordination (cf. [9]); it is difficult to get the balance right. The challenge is to step away from these standard models and think of new models. Elsewhere and in a different context, together with colleagues, the author developed the concept of a common information platform (CIP), which is a membership-based collective, rule-setting entity to find a good balance between competition and coordination [3]. Perhaps a variation of this might apply here as well, but this is an issue for further research.

#### IV. CONCLUDING REMARKS

This paper explores selected key questions surrounding the emerging debate around the market design and governance of flexibility management, which may be defined as system-stabilization with the use of decentralized generation, load and storage facilities. Decentralized flexibility affects the distribution network and thus the DSO and its future role. The paper concentrates on two institutional topics: market design and governance.

In market design, the prominent question is whether we need centralized auction platforms to facilitate flexibility trading. This raises follow-up questions. What will be the scale and scope of such a platform and who will run this platform? How can we optimally combine a national market for flexibility with flexibility demand for local congestion management?

Regarding governance, the main question is how to make sure that the DSO can also effectively use flexibility to manage the network, while at the same time, flexibility markets are non-discriminatory, such that equal-access competition can develop.

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