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Holistic view of needs and requirements of multi-market flexibility trading

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Abstract: The key idea of the proposed study is to provide a holistic top-down understanding of flexibility trading in a multi-market environment. The objective of the proposed study is to analyse the needs and requirements of existing and emerging electricity markets for flexibility to work as a bridge between flexibility providers and users. The proposed study focuses on issues like coordination between stakeholders, data exchange, interoperability, liquidity and rules and structures essential for an accessible and viable flexibility trade. More often, flexibility will be located in distribution grids and distribution system operator might require flexibility themselves. The coordination of flexibility trading becomes more complicated when an aggregated prosumer flexibility impacts multiple stakeholders. The particular focus of the proposed study is to describe and analyse the needs and requirements of flexibility in markets and how they could be integrated as a part of the overall electricity market environment.

1 Introduction

Recent changes of the power system, mainly driven by variable and distributed renewable energy sources in the production sector and electrification of transport and heating in the consumption sector, have caused some difficulties for grid operators. As an example, transmission system operators (TSOs) are facing an increase of frequency volatility due to the decrease of total system inertia, which is driven by the conventional synchronous power generating modules replacement with the power electronic interfaced power sources like solar and wind power. The shift to decentralised generation is also affecting distribution system operators (DSOs) and problems such as overloading, overvoltages and overall power quality in distribution systems have become more common. The grid operators can take some traditional actions such as grid reinforcement, production curtailment etc., to eliminate the problems. Although the mentioned alternatives are viable, it is aimed to propose solutions that can take advantage of new technologies integrated into grids and could be based on a market mechanism to complement the conventional choices by facilitating the flexibility markets.

A significant part of flexibility is utilised by market participants internally, e.g. by a balance responsible party (BRP) to meet day-ahead market obligations in the form of self-balancing. However, not all market participants have the necessary amount of flexibility; flexibility might be very expensive for them, or they are not allowed to own such resources, and therefore flexibility trading is needed as well. Several markets have been implemented to enhance energy balancing (intra-day market and frequency response service markets) and to maintain the security of the power system (congestion management, non-frequency ancillary services and capacity markets). Most of these markets are matured and have standardised products, but new services like ramp control, smoothed production, BRP portfolio balancing for frequency response services and operational, short-term and long-term planning for intra-zonal congestion management are emerging to guarantee the availability of production capacity and to foster the usage of available flexibility [1].

The aim of the paper is to provide mechanisms to unlock all the available flexibilities to benefit the involved stakeholders. Specialised markets have their own rules, tools etc. to realise trading, which makes it very difficult for the flexibility provider to participate in all these markets. Markets are also lacking the required flexibility resources because strict rules prevent them to participate. The need for flexibility might be very occasional in local markets, which makes it less interesting for flexibility providers. The paper analyses the overall needs and requirements of market stakeholders to enhance multi-market multi-actor flexibility trading [2]. An idea of 'a single entry' for flexibility trading is also introduced, which will provide a coordination mechanism for information exchange between market stakeholders to meet the requirements of all stakeholders which could be conflicting from time to time.

2 Analysis of needs and requirements

2.1 Coordination

The core need of flexibility coordination is to make sure that the flexibility trading does not create negative effects for other stakeholders. Flexibility procurement of TSOs should not cause a congestion problem for involved DSOs when small-scale aggregated flexibility is traded at, for example, reserve or balancing power markets. Vice versa, an increasing amount of flexibility connected to distribution grids will be needed to fulfil the balancing needs of TSOs, and therefore should not be locked out. Proper coordination schemes should be in place to avoid harmful interactions between TSOs and DSOs. Prequalification processes [3] for the traded products will be part of the coordination process. Product pre-qualification is about checking whether the unit can (technically) deliver the product it wants to deliver. Grid pre-qualification is about whether the unit(s) connected to the grid can realise the product delivery, considering the technical characteristics of the unit and the capabilities of the grid.

With the increasing portion of distributed energy resources, there is a growing need for cooperation between parties located not only on different voltage level but across the whole interconnected power system. Indeed cross-border trade of flexibility is increasing, and new platforms are developed to make it a reality. In particular, TSO-level cooperation in cross-border markets such as cross-border intra-day market and markets for frequency containment reserve (FCR), automated frequency restoration reserve (aFRR) and manual frequency restoration reserve (mFRR) in Europe are good examples of such coordination. Therefore, TSOs do not only need to coordinate with their connecting DSOs but also with their connecting TSOs. From the flexibility providers point of view, the use of assets should be maximised and it should be possible to utilise from local to national and to cross-border level. Therefore, coordination of actors at cross-border, TSO, and DSO levels is needed. Besides, special attention should be given to avoiding too numerous and diverse products, while considering local specificities.

As another example, independent aggregators have potentially conflicting interests with retailers when it comes to a situation when the sold flexibility of an aggregator causes an imbalance to retailers' BRPs. In contrast, the flexibility trade of an aggregator may reduce retailers' imbalances, which opens an opportunity for coordination and internal agreements between them. In this case, the independent aggregators' model should consider all stakeholders' concerns. Regarding market design and regulation set up, the voices of all parties should be taken into account before decision making, irrespective of the parties' share in the market place. This aims at each stakeholder being willing to share information needed for a successful market operation. Stakeholders should be involved in the dialogue for assessing the needs, building relevant products, and setting market rules.

With decent coordination of grid operators and flexibility providers, flexibility can be utilised where it can generate the highest value, and no double activation of flexibility is realised. For instance, flexibility needs in balancing are less location dependent than in congestion management and therefore, flexibility with suitable location should be allocated to congestion management instead of balancing. Similarly, the flexibility suitable for DSO-level congestion management should be allocated there instead of TSO level, which has more options to choose flexibility from a different geographical location where another DSO is operating, but naturally, this should not lead to increased security risks of power system stability. In this way, by proper coordination of grid operators, flexibility is used once effectively, and a second trade is not needed later to compensate for the negative impacts of the initial trade.

Harmonised and efficient calculation and allocation methods of transmission capacity are needed to develop for all markets as well in addition to day-ahead and intraday markets. Harmonised practices and methodologies lead to maximum utilisation of the grid capacity in markets. The fluctuating power flows may change the location of transmission bottlenecks which might be solved by increased counter-trading, splitting bidding zones for smaller regional zones, in extreme going to completely nodal system.

2.2 Data exchange

TSOs and DSOs have to coordinate with all markets actors to operate the electricity system in the most cost-efficient way and ensure the proper support to upcoming EU Green Deal aims. The transparency in data exchange is considered a necessity and has been addressed in respective EU regulations (i.e. Regulation No 1227/2011 on wholesale energy market integrity and transparency, Regulation No 543/2013 on submission and publication of data in electricity markets etc.). The minimal requirements for data exchange are addressed in EU Network Codes.

System operators' observability on their mutual grids should be enhanced to better perform their mission, including as market facilitator. This would allow better coordination, including close to real time. Besides, if any limitation is decided on the trade of a product, it should be justified and made transparent to the market. For example, balancing trades done by a TSO can cause congestion for some DSOs, and as a result, affected DSOs should be informed about the relevant trades in the balancing market and their approval or justified rejection could be requested before activation. As another example, trade for congestion relief of a DSO's feeder should not contribute to congestion in the network of another involved DSO due to counter trading. Therefore, at least all the affected parties of an ongoing trade should be informed before trade finalisation.

The transparency of short-term markets could be enhanced by reducing the delay of the publication of the balancing market prices. This would increase the temporal resolution of flexibility providers and enable them to participate more effectively. Fingrid in November 2016 launched a pilot to publish the real-time prices of the balancing market in scarcity situations when <150 MW balancing bids are available in the balancing list in Finland. Even though the impacts of that pilot have not been analysed, accessing real-time prices is considered favourable for market participants as they regularly request Fingrid to publish the real-time prices for increased transparency. It can be speculated that self-balancing is improved by the availability of real-time prices in the balancing market.

2.3 Interoperability

Interoperability is an important aspect influencing the participation of flexibility into markets. Interoperable platforms facilitate market participation and speed up the communication process by using similar and standard data models, protocols, and communication technologies for information exchange. Interoperability will become more critical where stakeholders and market platforms need to exchange a massive amount of data because multiple market platforms, data hubs, DSOs, TSOs, flexibility providers etc. need to talk together continuously. Besides, the need to have interoperable interfaces will increasingly rise because the dynamics of the power system and markets will be higher and therefore, a real-time (minute resolution or shorter) data exchange is required if market parties aim to gain benefit in a competitive market environment.

There are already some projects and platform in operation referring to interoperability at a system level. For example, ENTSO-E has developed the ENTSO-E Communication and Connectivity Service Platform (ECCo SP), which is a value-added platform enabling communications between business applications. Another example of interoperability is the common grid model which is a pan-European grid model, with which, TSOs need to share their grid models with the other TSOs and the regional security coordinators. Coordinators are responsible for merging the different grid models of the TSOs and issue common grid models, which are then shared with the TSOs for operational planning with this new regional information. A similar kind of process can be used in the future for TSO-DSO and DSO-DSO coordination in case of frequent DSO level congestions. In less frequent congestion a simplified process is needed to encourage DSOs to utilise flexibility for congestion relief, e.g. due to the outage of a single primary transformer.

2.4 Liquidity

A high enough level of market liquidity is the interest of all involved stakeholders. Flexibility provider prefers to trade on markets that enable quick selling of flexibility without causing a drastic change in the price and have small transaction costs. The users of flexibility prefer purchasing from a liquid market to ensure the availability of flexibility at a predictable price. A liquid market is a mechanism to unlock all the available flexibilities to benefit all involved stakeholders. In order to enhance a liquid marketplace, some reflections are proposed:

- Flexibility providers should be allowed to be active in multiple markets; however, the resource should only be sold/activated once.
- Market membership and cancellation fees, trading and exchange costs must be reasonable in such a level that small stakeholders are empowered to participate as well. Competition, as well as cooperation and interoperability between market places, should be encouraged.
- Lowering or adjusting the technical requirements for the participation of flexibility products in the markets. Validation and verification process should be developed for aggregated small-scale DERs.
- Flexibility product should allow for aggregation as much as technically feasible; minimum bid size should be kept low to enhance small actor's participation.
- Facilitating the participation of flexibility in all markets. This is not only a technical question but also includes proper market and product design in order to simplify the trading and allocation of flexibility in a multi-market environment. Consecutive markets should also be designed in such a way that trading is possible in real-time markets without losing opportunities in markets closing earlier.
- Flexibility services can be traded in different markets, and a user-friendly mechanism should be set up to enhance flexibility services. A single-entry point to different market processes could be a concept to pursue, although interoperability and coordination functions would be a more realistic and pragmatic solution.
- Enablers to facilitate flexibility should be put in place, such as the establishment of adequate incentives in balancing and intraday markets as well as the smart meters roll-out to provide the technical feasibility for measuring and reimbursing flexibility resources stemming from the end-users.
- The development of regulation that promotes innovation (e.g. as a flexibility resource) and promotes various respective business models. Storages should be recognised in regulation.

3 Design of the flexibility markets

The overall design of the market environment where flexibility may participate in several markets is very challenging. An optimal solution that works everywhere probably does not exist. Therefore, the following chapters describe some design considerations of the overall system based on [4].

3.1 Market place considerations

The coordination between market places is very important so that flexibility has full potential to realise trading efficiently on all of them. This may for example be realised by coordinating gate opening and closing times properly in consecutive markets or even by combining markets in order to reduce the burden in flexibility allocation for a different market. Examples of combined markets are the balancing power market (mFRR) of Nordic TSOs which is utilised for TSO congestion management, and the intraday market of ETPA which is utilised for local congestion management as well.

The flexibility allocation to markets where it has the most value may be enhanced by publishing open market data (e.g. capacity requests, real-time prices, locational needs etc.) to avoid flexibility scarcity in a market. Also, automated trading mechanisms together with a single IT interface for multiple flexibility markets would enhance the optimal flexibility allocation. In such a complex environment the requirement for information exchange between stakeholders for impact analysis of flexibility trading becomes much more essential and complex than ever before.

To achieve the highest benefit out of available flexibilities with respect to the system needs, flexibility should be stacked and represented in the most optimum way considering the factors such as max/min bid size, direction of deviation (up/down regulation), divisible or 'all or none' bid, the definition of congestion area, mode of activation (manual, automatic), rebound time, rebound condition and availability level of flexibility [3]. That information help buyers to improve their purchase decisions by having a better vision of the offer's characteristics.

3.2 Grid considerations

In addition to traditional issues of transmission capacity calculation and allocation of the enhanced flexibility trading may create new demands for market places. For example, the balancing trades of TSO may create congestion for affected DSOs and therefore, coordination and pre-qualification processes are needed. Similarly, other flexibility trades or self-balancing may create bottlenecks in the grids. It should also make sure that DSO's or TSO's trade for congestion is not counter-traded by BRPs before operation time. Activated bids must be 'firm' at the specific location. Coordination principles should be designed to protect stakeholders from intentional and unintentional actions of each other. Proper counter-trade or compensation mechanism is also needed in congestion management to rebalance BRPs.

The rules of allocating TSO and DSO grid capacities, and rejecting or prioritising trades due to grid capacity problem must be clear. For example, if the traffic light concept is applied, the distinction between green, yellow and red lights must be clear and a grid operator may not move to red light (prioritised and mandatory grid controls) every time when congestion occurs, but a yellow light (purchase of flexibility) should be utilised for congestion relief. The green light indicates that a simplified process of information exchange is viable because there exists enough grid capacity for all likely flexibility trades. The prior analysis of grid state would benefit from a national flexibility register of flexibility contracts, capabilities, location and other characteristics. In comparison to unknown-location flexibility bids, location-tagged flexibilities have more value for the power system.

4 Conclusion

The state-of-the-art analysis of markets for flexibility shows very clearly that there are several needs to develop flexibility markets and products, utilisation and trading of those markets, coordination between markets and between stakeholders, transparency of market information, liquidity of flexibility, rules, technical topics, and regulation as well. Flexibility will be increasingly needed in the future by market and power system stakeholders, and therefore, solutions aiming for the overall benefit of all stakeholders needs to be seriously looked for. All flexibility should be available for unrestricted trading, and market and product design for flexibility should support that aim. Objectives to maximise flexibility volumes on one specific market are not benefitting the overall system, instead, flexibility should be provided to markets where it is most needed and has the most value. Coordination mechanisms and prioritisation rules are essentially important to build a practical and operational platform in addition to technical capabilities and market fundamentals. The liquidity of flexibility in different markets may be increased by proper design of markets and products together. Also, consideration of requirements for flexibility, validation and verification processes, and necessary metadata of resources might be developed to increase liquidity.

The Interoperable pan-European Grid Services Architecture (IEGSA) should simplify the flexibility trading at a different market to increase liquidity and allocation of flexibility to markets where it is needed [5]. It should also enable the coordination and prioritisation tasks to avoid or solve the conflict-of-interests between markets and stakeholders, and to provide transparent information for flexibility in trading and utilisation.

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