CONCEPTS FOR FLEXIBILITY USE – INTERACTION OF MARKET AND GRID ON DSO LEVEL

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ABSTRACT

A variety of many new decentralised active grid users are integrated by distribution girds which offer flexibility options. Different concepts that enable distribution system operators to allocate available flexibility of active grid users in order to comply with local grid-related restrictions on the basis of interaction of market and grid are regarded in this paper. Common mechanism as well as crucial success factors are analysed. A proof-of-concept implementation is described as well as consequential challenges for distribution system operators and necessary adjustments of the regulatory framework that arise are pointed out.

FLEXIBILITY AND USE CONCEPTS

As part of the EU-wide energy transition and the German Energiewende in special a variety of many new decentralised active grid users are integrated by distribution girds. All these active grid users are able to offer flexibility options. Whereas today the flexibility need is manly driven by the fluctuating in-feed, in future higher simultaneity and the expected growth in electrical consumption will lead to an even higher flexibility need, as shown in **figure 1**.

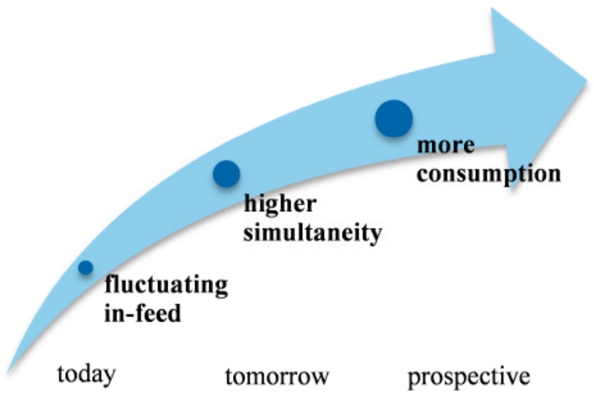

Fig. 1: Main driver for flexibility need and chronology of appearance

Weather- or market-related increased time and regional simultaneity of demand and supply leads to situations where the system operator on the one hand has to ensure the safe operation of the grid, on the other hand often the cost of the increase in grid capacity, only for these rare situations, is in no economically acceptable cost-benefit ratio. Especially in these situations an economically optimized allocation of flexibility between market and grid is efficient. Therefore an concept that allows the interaction of market and grid is needed.

To meet this challenge currently discussed are different concepts that indicate the interaction of market and grid by a so called "flexibility traffic light scheme". These concepts describe how flexibility, that is offered by grid users, is made available for distribution system operators and are thus the basis for the development of smart grids.

Unlike the system state classification of the guideline on transmission system operation [1] and the TSO real-time awareness and alarming system [2] or other only grid related concepts, flexibility traffic light schemes are not limited to the description of the system state or current capacity utilization, but rather describe the status of the interaction of market and grid. The current status of the discussion in Germany on concepts to integrate flexibility on DSO level is reflected by the BDEW smart grid traffic light concept [3], BNE Flexmarkt concept [4], the VDE/ ETG RegioFlex concept [5] as well as BMWi working group "smart grid and meter" [6]. The European view on flexibility use in distribution grids are regarded in contributions of EURELECTRIC [7], EDSO [8] and work by the expert group 3 of the smart grids task force that was set up by the European Commission [9,10]. An overview and a detailed analysis of the differences of these flexibility traffic light concepts can be found in [11].

FLEXIBILITY BETWEEN MARKET, SYSTEM AND GRID ORIENTED ALLOCATION

In general all kind of active grid users – consumer, supplier and storage – are possible flexibility provider and thereby are regarded in the concepts. In general flexibility is provided, when the grid user adapts his generation or consumption behaviour by an external signal [7]. The concepts also have in common, that they differentiate between the use of flexibility in a market-based and in a regulated environment. The use can be divided into three applications, as shown in **figure 2**. Beside the use case also the temporal dimension – from the long-term security of supply until the time of physical delivery of electricity – of flexibility allocation has to be considered [7]. Flexibility can be used market, system and grid oriented [3,6,7] :

- *marked based trading* for portfolio optimization of supply and demand before the settlement date [1]
- *system oriented balancing* on settlement date (not regional restricted)
- *grid oriented use* to avoid local grid congestions (localized) on settlement date

Both system and grid oriented use of flexibility are allocated to the regulated environment.

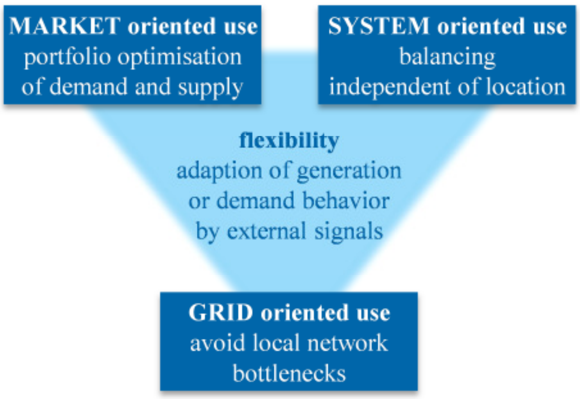

Fig. 2: The three different types of flexibility use

Crucial is also the ranking of flexibility allocation. The grid oriented use is classified before the system oriented balancing use and these ahead to the market oriented use [3]. Generally to principals ensure a secure and reliable grid operation during concurrent flexibility requests:

- local before system wide (location independent) requests
- the directly connecting system operator before other system operators or sales/ aggregators

Common to all flexibility traffic light concepts is, that the need for grid oriented flexibility use is area-specific published/ signaled by the distribution system operator. However, the spatial resolution is different.

FLEXIBILITY AS AN ALTERNATIVE TO GRID EXPANSION AT DSO LEVEL

Flexibility traffic light concepts enable distribution system operators to allocate available flexibility of active grid users in order to comply with local grid-related restrictions. The grid oriented allocation of flexibility can be used for a capacity management in the grid. Thereby flexibility becomes an economical option to defer or even substitute grid expansion. Unlike today, an optimal grid capability in contrast to a maximal grid capability could be striven [12]. That will lead to a grid planning and operation which takes a limited grid usage based on flexibility use into account. By doing this, the macroeconomic cost of the energy transition could be minimised.

Grid expansions always creates enhanced stationary capacities for decades. A basic requirement for a cost efficient use of flexibility, in order to substitute such grid expansions, is a long term availability for a grid oriented use of flexibility. Also Flexibility has to be calculable and predictable, if grid expansion should be reduced [3]. Not all concepts are considering this essential requirement. For how long flexibility can be contracted, is answered differently. Both short-term time periods [7] as well as longer periods (years) [6] are discussed.

THE YELLOW PHASE – INTERACTION BETWEEN MARKET PARTNERS

Eponymous for traffic light concepts is, that three different operating phases can be distinguished. In all concepts flexibility is offered by sales/ aggregators for market- and system oriented portfolio optimisation and for balancing in the green phase. In this phase there are hardly any restrictions for grid users, while - as shown in **figure 3** - the yellow and red light phase reflect increasing restrictions on grid usage. As all concepts distinguish a market-based use of flexibility from a grid-based use they basically differ from each other in their orientation, if rather the interests of distribution system operators or of sales/ aggregators are in focus during the phase of interaction (yellow phase)

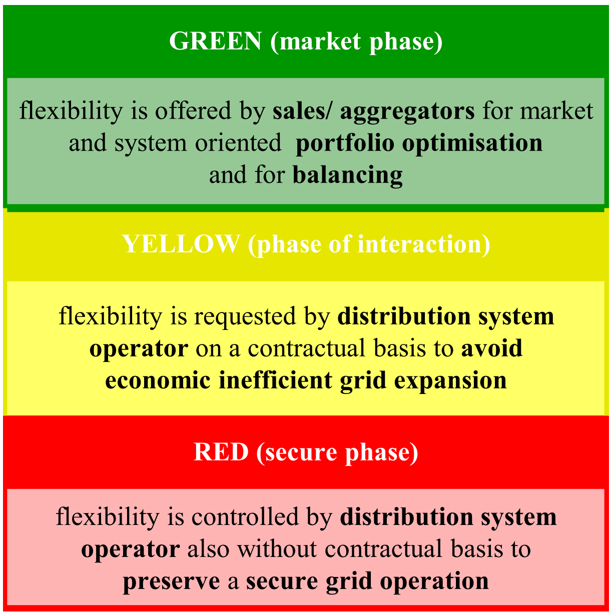

Fig. 3: interaction of market and grid - flexibility use from the DSO perspective

In rather system operator oriented concepts (e.g. [5]) the yellow phase is defined by the grid condition. From the sales oriented point of view (e.g. [4]), this phase is

1 date of the physical delivery of electricity

mainly characterised by the usage of sales offers through system operators. So the main criteria is the relation between distribution system operators and sales/ aggregators during this particularly important phase in all concepts.
Obviously only flexibility traffic light concepts that are actually allowing flexibility to be used in a grid oriented way as well as offering sales and aggregators the chance to optimise flexible grid users within their portfolio seem to have prospects of success.

TECHNICAL PROOF-OF-CONCEPT

An efficient technical implementation requires advancements and interactions of many DSO systems and processes It must be capable to detect future congestions in grids which contain flexible grid users and find possible solutions by using the flexibility in a process close to the market. A major technical challenge is the specification of a congestion and its technical characteristics in a suitable protocol to inform the market about useful contributions of each flexibility and eventually enable the aggregators to support the removal of congestions.
A German research project "Das proaktive Verteilnetz" (transl.: The Proactive Distribution Grid) [13] constructs a technical demonstration of the BDEW traffic light concept [3] and therefore currently develops and verifies an approach for a communication between DSOs and aggregators, which will also be tested in a demonstration in the grid area of Westnetz. As an already available common language, the Meter Point Administration Number is used as identifier for an unerring description of flexibilities. Whereas a aggregator don't has the ability to determine whether a flexibility is affected, the DSO must offer a list of them added up with technical demands and boundary conditions. Depending on the location within the grid and the predicted power flow, the usefulness of possible flexibilities can change. Therefore a congestion-specific sensitivity for each flexibility is determined, to put the aggregators in a position to value each impact and as a result can get offered a considerably larger range of freely selectable flexibilities. The concept behind this opportunity is, that an aggregator may choose little more but less effective flexibility than the technical optimum, while preserving his ability for portfolio optimisation.
A major requirement so that all market players and DSOs easily can participate, is a standardized protocol. At a first set out, the lists could be nearly static and restricted to simplify a participation by accepting a less effective system firstly. This allows a gradually evolving interaction of market and grid towards an economical common use of flexibility.
There are further such demonstrations like the project "USEF" (Universal Smart Energy Framework) [14]. It describes a market model for trading flexible energy use, which includes different operating regimes. From the system operators point of view, these regimes represent a technical concept similar to the German approaches [3,13] and it becomes apparent that not only the economic but also technical approaches are alike.

CHALLENGES AND NECESSARY REGULATORY ADJUSTMENTS

Challenges for distribution system operators arise out of demand to develop a sufficient and standardized communication with the market players and its active grid users as well as adjusting the planning and operation of grids. A future grid-supporting use of flexibility as part of a smart grid, expands the role of distribution system operators and requires an adjustment of the regulatory framework. The role of distribution system operators will be expanded in following fields:

- network planning and operation
- ensuring network security
- support and decentralized coordination of system security in alignment with transmission system operators
- contract and request of flexibility
- data management

When adapting the regulatory framework in particular the technical and regulatory risks associated with new technologies in distribution grids should be duly considered. Moreover, it should be noted that capital costs tend to be substituted by operating costs. Appropriate incentives must compensate for the return on investment for the network operator, to ensure an optimal choice between the alternatives.

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