BALANCING WITH DSO-CONNECTED DEMAND AND GENERATION UNITS - CASE STUDY AUSTRIA

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The content of this paper reflects the opinion of the author and does not represent the position of any organisation.

ABSTRACT

This paper addresses the conditions for using DSO-connected demand and generation units for balancing (load frequency control) and analyses the effects on the balancing market and on imbalance costs in a case study of the Austrian balancing system. Based on an analysis of the previously existing framework measures were taken like improving prequalification rules, introducing a dedicated grid tariff etc. After optimizing the framework the number of market participants (especially 3rd party aggregators which pool units which they do not operate themselves) and the amount of prequalified demand units (including industrial plants, power to heat units etc.) increased substantially. A combination of this new framework with a series of other measures has significantly reduced balancing costs.

INTRODUCTION

In Austria balancing capacity and balancing energy are procured through a fully market-based mechanism by the Austrian TSO (Austrian Power Grid AG), and have been historically supplied by TSO-connected power plants of a few energy companies. With the intensified development of the liberalised balancing markets several factors have been creating a need for facilitating participation of new balancing service providers (BSP) regardless of the connection level of their units (DSO or TSO). One of these factors is the growing amount of DSO-connected generation; another factor is the expected growth in balancing energy needs due to an increase in fluctuating generation resulting from technological development and decreasing technology costs; the political initiatives aim at decreasing greenhouse gas emissions and better linking up demand, including end users, with the energy market. Some elements of the Austrian balancing framework did not take these factors optimally into account or introduced undue barriers in the past.

Before the change BSPs were energy companies with conventional power plants (mainly hydro) with similar cost structures. In automatic Frequency Restoration Reserves (aFRR) there were five market participants, in manual Frequency Restoration Reserves (mFRR) eight, one of them was pivotal supplier in all market segments.

ANALYSIS OF THE FRAMEWORK

To remedy the situation, the entire framework was analysed to detect and, where necessary, provide a sound basis for removing such barriers. The existing framework had been designed for relatively big conventional plants only because at that time there was no need for more general rules. Nevertheless, some aspects had been already taken into account, like pooling and no general exclusion of demand units.

The following aspects were identified and considered especially relevant for DSO connected and demand devices:

- Grid tariff: Additional grid tariff payments in case of higher consumption due to activation of negative reserves can reach or even overcome the incomes from balancing markets and participation might financially not be interesting.
- Prequalification process: not practicable in case a big number of similar units has to run in detail through the whole process or the whole process is required once again if an already prequalified pool is enlarged.
- Monitoring: obligatory online monitoring for every single technical unit causes disproportionate effort.
- Minimal size of unit (e.g. for Frequency Containment Reserve - FCR - two MW!): too high limits would exclude smaller DSO connected units.
- Minimal bid size (e.g. due to technical restrictions for manual activation: has an impact in particular on small BSPs.
- Technical requirements: should be in principle the same for every kind of technology.
- Supplier-independent: it was not supported by framework to use flexibility of units for balancing independent from the supplier of that metering point (3rd party aggregator).

MEASURES

Based on the analysis measures were developed and implemented. The measures taken so far include changes in the technical prequalification conditions (e.g. minimal bid size, pooling concepts), grid tariffs and other areas. The following sections describe in particular DSO and demand related measures. Other already implemented measures like product duration, lowering of minimal bid size, international cooperations etc. are here not listed.

New Prequalification Concepts

In May 2014 APG released a fundamentally revised version of the prequalification conditions. One of the main goals was to establish a framework that allows for entry of new market participants (e.g. aggregators) and new technologies by already considering the new Network Codes - in particular LFC&R (now part of the Guideline on Electricity Transmission System Operation), which at that time had been almost finished.

The new conditions foresee the possibility to aggregate technical entities (TE) by a Balance Service Provider (BSP) who does not operate them himself. Moreover such entities which are part of a pool organised by the BSP need not to belong to only one single Balance Responsible Party (BRP) any more but can be distributed over several BRPs – and over several distribution grids.

Tariff implications - dedicated grid tariff

Especially for demand, which in Austria is mainly connected to DSO grids, the grid tariff is a substantial cost factor. Therefore a new grid tariff dedicated to balancing for consumers was introduced. . In general the tariff for demand is based on the measured maximal capacity. In case of activation of negative reserves the consumption rises and could therefore result in much higher payments. Thus a new grid tariff component was established, which is only applied to the activated negative balancing energy of consumers and corresponds to the tariff for pumped-storage power plants

For the application the DSO first determines the peak demand for every metering point. Then the respective BSP, who activated the reserve unit, has to transmit the activated balancing energy (in 15 min. time series) for every metering point. With this information the DSO is able to calculate the share of “normal” demand. To check the data all DSOs transmit their data to the TSO. The TSO aggregates the transmitted data of the DSOs and checks the sums with originally requested activation data. The whole data transfer is determined in the Market Rules. Through this method the effects on tariffication are minimised, because the tariff is only applied to the energy activated and consumed for balancing.

Technical Implications on DSOs

Whereas the new rules ensure maximum flexibility for BSPs they cause a number of implications to BRPs. For example BRPs, which know their current imbalance rather accurately and do not activate reserves themselves could counteract a reserve activation by an aggregator assuming it was a deviation from schedule.

But not only BRPs have to handle effects resulting from the new framework. There might be also impacts on distribution grids and Distribution Grid Operators (DSOs). In the past control reserves were normally located in conventional power plants with a high percentage connected to the TSO level. With the new concepts more and more reserve entities are expected to be connected to the distribution grid. A major concern of DSOs is possible negative effects on grid operation. Especially in cases where such technical entities might be concentrated in a small region and activated simultaneously impacts on power flow and voltage could occur. So far fortunately none of these effects have occurred in practise since up to now the reserve capacity in DSO-connected small entities is still relatively small but their number is constantly increasing and discussions with DSOs lead to the conclusion that mitigation measures should be taken to be prepared for the future.

DSO involvement

The first important step is the information of a DSO by the BSP about an envisaged provision of control reserves in its grid as part of the prequalification process. Once a BSP plans to apply for prequalification he has to inform the DSOs where their entities are connected to accordingly.

The DSO can then express his concerns or can even specify limitations. It is the duty of the applicant to further inform APG about any possible limitations so that they can be taken into consideration in the evaluation of the application – in particular concerning availability aspects. Thus, this concept allows to express general concerns and potential limitations. Nevertheless the real effects might not be known in advance.

That is why a second step has been introduced. APG, the DSOs and the BSPs elaborated a standardised data exchange with the goal of informing the DSOs in real time about aggregated reserve activation for all concerned technical entities (TE) in their grids. To make this possible, APG aggregates data with a time resolution of one minute coming from the BRPs for every DSO, as shown in Figure 1.

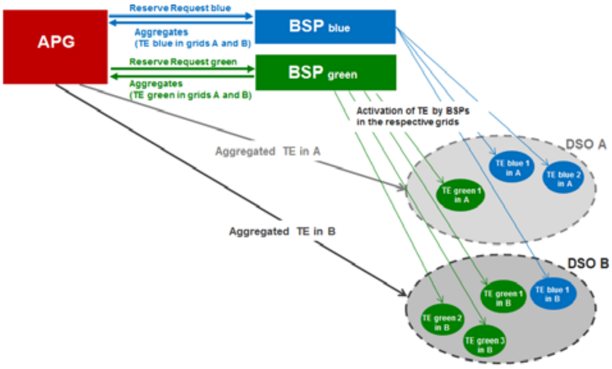

Figure 1: Data Exchange DSO-TSO

The benefit for BSPs lies in the fact that they do not have to establish online data connections to every DSO. Online data connections already exist between TSO and DSO and can be used for the data transfer explained above. With these data the DSOs gets online information about activation of TE in its grid to be able to correlate activation with operational effects in its grid. However, more detailed data could be needed in exceptional cases – this leads to the third step.

Only in case a DSO can verify that a specific TE has a direct impact on grid operation he has the right to request detailed online data for this specific TE. However, this will not be the standard case, since every TE operator/owner must already have a connection contract with the DSO which sets out the usual conditions for the use of the connection.

We consider this fact important when thinking about possible online limitations for the individual TE. There have already been discussions about this aspect. Some DSOs see the necessity to be able to set limits also after tendering is over and bids have already been accepted. In deviation to this line we think that first any (possible) limits of TE in terms of providing control reserves should be clarified during the prequalification process, including also any congestion issues and second possible specified limitations from the operational point of view should be handled before submission of bids. To guarantee that, contracts shown in Figure 2 are necessary.

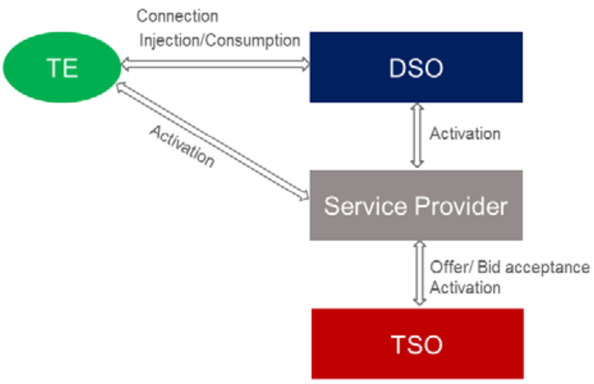

Figure 2: Contracts for service provision/activation

The demonstrated contracts reflect the necessary agreements between:

- DSO and TE (Operator of the TE): connection contract, which determines the conditions for injection and/or consumption; this contract is in any case needed for a connection to the distribution grid and governs e.g. maximum power infeed/consumption; nevertheless it could include – if reasoned that necessary - specific additional rules for provision/activation of grid services.

- DSO and Service Provider: contract that determines e.g. data exchange (offline, online) or possible limitations for service activation; this contract will be also needed for prequalification in case the DSO permits reserve activation only under certain conditions;

- Service Provider and TE (Operator of the TE): in case the Service Provider offers services by means of an aggregation of TEs which he does not operate himself ("Aggregator") a contract will be needed to govern the legal, economical and operational responsibilities, duties and rights of the involved parties.

- Service Provider and TSO: this contract determines the conditions for procurement and for provision/activation of services by the Service Provider (typically based on prequalified properties).

In case operation of the distribution grid requires limitations in service provision/activation these limitations have to be handled on the level of DSO, TE and SP before the tendering based on their respective contracts to allow the SP to consider the limitations and adjust his offers accordingly.

Once the tendering has been over and the bids have already been accepted further limitations through the DSO cannot been accepted by the TSO, but of course the BSP should take care to have enough available TE to handle that inside the pool. The only possible exceptions are unforeseen events – like power line outages. In such a case the SP would not be obliged to deliver (disturbed operation, force majeure).

This approach allows the TSO to ensure the appropriate organisation of services in line with the network codes in undisturbed operation. Otherwise the TSO could never be sure that the services he procured can be activated (which – by the way – would also contradict the idea of capacity procurement).

OBSERVATIONS

Since introduction of the new concepts the number of market participants has increased significantly:

- Automatic Frequency Restoration Reserves (aFRR): End of 2016 there are thirteen market participants (almost tripled from five in beginning of 2014)
- Manual Frequency Restoration Reserves (mFRR):

End of 2016 there are sixteen market participants (doubled from eight in beginning of 2014)

This includes new players from other branches like telecommunication or industry, and also suppliers and independent aggregators (from suppliers). New kinds of demand units have been introduced for reserve purposes such as power to heat units, industrial units or emergency power diesel aggregates. In addition also DSO connected generators (e.g. small hydro and windparks) were prequalified. Also the already existing players have extended their pools with new DSO-connected technical units, not owned and operated by them directly.

Regarding activated energy there is currently data from 2015 available. A rough estimation shows that at least 15%[1] of activated negative Balancing Energy was coming from DSO-connected demand units.

As the market has become more liquid, the costs for reserves have sunk substantially, profiting not only from the mentioned measures but also from purely market based adaptations including changed procurement conditions (e.g. daily aFRR auctions etc.) and also from international cooperation projects. The overall balancing costs in Austria went from more than 200 Mio EUR (2014) to under 90 Mio EUR (2016).

CONCLUSION AND OUTLOOK

The participation of DSO connected units is possible, but has some implications. In the Austrian system this was an important step. Due to the growing share of DSO-connected generation the importance is expected to grow. The tasks and responsibilities of the DSOs need to be carefully considered, and in some cases measures needs to be taken to avoid negative effects.

First experiences with the changed framework have already shown a significant increase in the number of market participants (e.g. 3rd party aggregators with pool units which they do not operate themselves) and the amount of prequalified demand units (including industrial plants, power to heat units etc.). A combination of this new framework with a series of other measures has significantly reduced balancing costs in Austria. All in all there is a clear benefit for the electricity system.

Planned next steps include an optimisation of (real time) data exchange between DSO, TSO and other market participants, especially to on one hand support pooling of units from 3rd party aggregation and on the other hand cover the needs of DSOs and BRPs. The relevant system data are monitored regularly to ensure optimised further development. Possibilities and conditions for further use of flexibility (used for balancing and new potentials) are currently being analysed, both for other markets and for the grid, so that they can be ideally combined and used flexibly to achieve maximum benefit.

1 This number only includes demand units with dedicated grid tariff, no generators.