HOW TO INCENTIVIZE SHORT-TERM FLEXIBILITY RESOURCES IN ELECTRICITY BALANCING GROUPS –

INTERNATIONAL COMPARISON OF IMBALANCE MECHANISMS IN EUROPE

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Overview

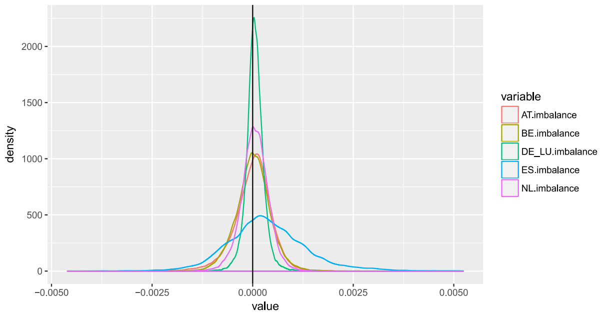
An important issue for minimizing costs of operation of power systems is to minimize imbalance energy, i.e. unplanned generation and demand deviations from the committed program (schedules). In systems with a high share of variable renewable energy sources (vRES), the main deviations result from forecast errors of weather-driven generation [1]. Raising renewable electricity generation might cause significant deviation spikes within a short time period. This can be minimized (e.g. through manual short-term trading optimization), but not completely avoided. The occurring imbalance energy can be compensated with imbalance energy of other balance responsible parties (BRPs) within the control area (imbalance mechanism). The resulting deviation of the control area after compensation is called the delta control area, or the control area imbalance (system imbalance) [2] and it is the sum of all imbalances of all BRPs. If the value is positive, there is too little energy in the system and if the value is negative, there is too much energy in the system. This system imbalance is covered with automatic frequency restoration reserves (aFRR) and manual frequency restoration reserves (mFRR) by the transmission system operator (TSO) via activating balance service providers (BSPs) (balancing market) [3], [4]. The residual imbalances are compensated with unintended exchange of connected control areas [2], [4]. The actual design of imbalance mechanisms differs across European countries. In single-price schemes (implemented e.g. in Austria) BRPs are financially incentivized through the imbalance mechanism to use available short-term flexibility resources to be balanced and also to counterbalance deviations of the overall control area. A big advantage of this approach is that BRPs are also able to use their short-term flexibility capacities, which might for several reasons not be eligible to participate in the centrally organized balancing energy market operated by the TSO, e.g. because it became available after gate-closure-time (GCT) of the balancing market.

Methods

This paper is primarily associated with the research field “Energy Economics” with the sub-discipline of “Electricity Economics”, especially connected to the specific fields of expertise of “Markets & Prices”, “R&D and Emerging Technologies” and “Policy & Regulation” [5]. To analyze the different data sets, appropriate statistical methods are applied using the scientific computing language R [6]. To compare the different imbalance schemes throughout Europe, different control area imbalances and imbalance prices of ENTSO-E Transparency Platform [7] and TSO websites [8] and [9] were analyzed. The control area imbalances of different market balancing areas (MBA) were standardized by dividing them with the corresponding yearly electricity consumption of 2015 according to ENTSO-E [10] (see Figure 1 left). As the implementation of Electricity Balancing Guideline (EB GL) [4] will determine the main changes of imbalance energy mechanism design, different advantages and disadvantages of imbalance energy schemes are discussed, as well as a Merit-Order-List-Model to estimate the theoretical effects of marginal pricing (see Figure 2 right).

Results

EB GL will lead to market integration for balancing and imbalance mechanisms. Inter alia according to literature, future imbalance mechanisms might take into account following elements [11], [12]. Mentioned elements for imbalance mechanisms are not complete, not in order of importance and have to be further discussed: (1) No market barriers for new market entrants, (2) Incentivizing BRPs to reduce their imbalances or reduce system imbalances, (3) Avoid free-riders covering their consumers with imbalance energy, (4) Avoid fusion of balance responsible parties (e.g. subgroups of one BRP), (5) Avoid arbitrage with intra-day markets, (6) Avoid arbitrage of balance service providers (BSP) on balancing activation with imbalances, (7) Avoid congestions within the control area, (8) Imbalances should be published near real-time for BRPs, (9) Imbalance prices or indicative prices should be communicated near real-time to BRPs and (10) Efficient allocation of balancing cost.



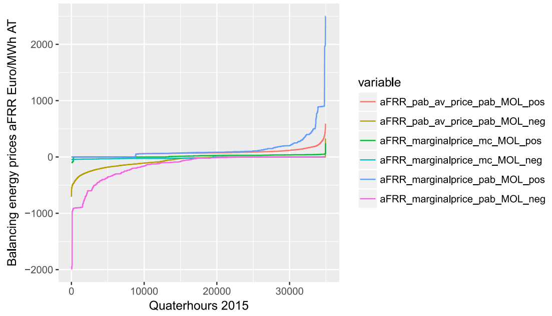


Figure 1 left: Comparison of distribution functions of balancing area imbalances for AT, BE, DE_LU, ES, NL standardized with electricity consumption in 2015. Figure 2 right: Modeled aFRR balancing energy prices with marginal pricing for pay-as-bid Merit-Order-List (hypothetical), marginal costs under perfect competition MOL (theoretical) and real balancing prices in €/MWh for AT in 2015. [6], [7], [10], [13], [8], [9], [14]

Conclusions

From a system operation point of view, it might be better that BRPs stick to their schedules (e.g. to avoid overshooting, congestions etc.). Overshooting also depends on the features of the power plant park of the considered control area. However, there are small control areas in Europe, where the transmission system operator is able to handle nearly real-time trading (e.g. Netherlands). There are arguments for a central allocation of system beneficial flexibility (e.g. an efficient balancing market). However, not all decentralized, short-term, system beneficial flexibility of BRPs can be allocated to the central balancing market in the short-term (e.g. therefore integration via the imbalance mechanism). EB GL will lead to a harmonization for imbalance mechanisms [4]. Price signals might lead to unintended effects and additional incentives for BRPs might have to be implemented on national level to integrate their short-term flexibility in an efficient way. According to EB GL, BRPs have to pay at least the price for activation of balancing energy within the imbalance settlement period for the imbalances depending on the direction of the control area imbalance (imbalance price) [4]. Currently, imbalance mechanisms mostly propose a higher payment for major deviations of control area and financial benefits, if BRPs are decreasing system imbalance. As EB GL force marginal pricing (pay-as-cleared) with common Merit-Order-List (cMOL), high imbalance prices for a few quarter hours might occur (see Figure 2 right). In conclusion, there are a lot of effects and interdependencies, which have to be kept in mind for the future imbalance energy system. The design of imbalance mechanisms is influenced by, and can only be seen in connection with, the relating electricity system of the respective country, or rather control area.

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