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Same but different. Links, conflicts and solutions.

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Redispatch and balancing: Same but different. Links, conflicts and solutions.

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***Abstract*— The authors provide a critical analysis of existing approaches to balancing and congestion management (specifically redispatch) and their effects on the incentives for service providers. This issue is particularly important in the view of the harmonization of ancillary service procurement in Europe, introduction of cross-border balancing markets and cooperation on congestion management. There is no universally established procurement mechanism for either of the two services. Based on case studies of Germany, France and the Netherlands and the introduction of an EU balancing energy platforms, we derive three stylized interaction models and discuss their comparative conflicts, risks and performance. We argue that market-based redispatch procurement can both increase allocative efficiency and resource availability as long as structural congestion is addressed first. Timeframe of procurement and remuneration mechanisms are other crucial factors affecting market efficiency. Combining redispatch with wholesale markets might yield a further improvement while minimizing conflicts between redispatch and balancing.**

***Keywords*— balancing, redispatch, ancillary services, incentives, market design**

I. INTRODUCTION

Balancing and congestion management, two key functions of the transmission system operator (TSO), both require short-term flexibility. The TSO must ensure, on the one hand, a continuous balance of supply and demand and, on the other hand, that energy can be securely transmitted from generation to load. For the former, balancing resources are activated to contain or restore system frequency. For the latter, if the market result cannot be accommodated by the available transmission capacity, generation units or loads can be redispatched, i.e. their dispatch is adjusted downwards upstream and upwards downstream of the congestion point[1]. In this paper we address the question if and how these services and the way they are procured by need to be coordinated.

Both balancing and redispatching involve adjusting the schedule and real-time operation of generators and some loads; so far, only TSOs procure these services[2]. The two services can conflict with each other. For instance, a balancing service cannot be provided by a generator that is redispatched to relieve congestion. Conversely, activation of balancing resources may aggravate congestion, causing higher system costs or reducing the effect of redispatching. Both services need to cope with short-term uncertainty, yet some aspects are more predictable, such as structural congestion and imbalances caused by "discrete trading periods"[2]. The degree of alignment between the two processes depends on a number of factors, such as the technical and regulatory requirements and the reliability of forecasts. Procurement mechanisms, their timeframes and the geographic scope of the two services result in different incentives, opportunities and strategies for the participants.

While market-based balancing service provision is the most common approach in the EU, the approach to redispatch ranges from mandatory cost-based to market-based provision, in some cases integrated with the balancing market [1], [2]. Compared to balancing, the procurement of redispatch has received only limited scientific attention, presumably because of a lack of transparency in the procurement process or limited volumes in some countries. Thus, the main objective of this paper is to analyze approaches to balancing and redispatch as well as relations between them and identify solutions for maximizing their joint economic efficiency. We show that separate procurement of balancing and congestion management resources works best, but that the efficiency depends on the procurement timeframes, the degree of congestion and the remuneration of redispatch.

II. BACKGROUND: RELATIONS AND DIFFERENCES BETWEEN BALANCING AND REDISPATCHING

The main differences between balancing and redispatch are summarized in Table 1. While balancing resources are not geographically bound, the location of a redispatch unit is key to its effectiveness with regard to the congestion point. The activated volume cannot be directly translated into the amount of congestion it can relieve. Consequently, when selecting resources for congestion management, the TSO has to consider not only the cost or the bid of the provider but also its effectiveness. In a meshed European network, there are multiple options, but the ones farther from the congestion point likely have a lower effectiveness, which greatly constrains the options available to the TSO.

While balancing is mostly carried out in real time, redispatch is a continuous process starting with the TSOs' individual and joint planning processes and procured in several steps, from day-ahead to real time [6]. It does not require prior reservation, unlike balancing, which typically relies on the reserved capacity.

In balancing, a distinction should be made between proactive and reactive approaches to system management. A proactive

[1] We focus on control areas in which intra-zonal congestion is handled through redispatching, as is common in Europe. Intra-zonal congestion can also be solved through changes of network topology or, in Scandinavia and Italy, by splitting a control area into several zones in case of congestion.

[2] Congestion management is expected to be conducted on the distribution network level in the future as the number of DER in the power networks increases, however, this aspect is out of the scope of this paper.

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TABLE I. OVERVIEW OF THE MAIN DIFFERENCES BETWEEN BALANCING AND REDISPATCH.

	Balancing	**Redispatch**
- *Purpose*	Frequency control	Congestion management
- *Procedure*	Mainly curative	Preventive and curative
- *Location*	Irrelevant within control area	Key criterion
- *Decision to award*	Price-based (merit-order)	Based on cost/price & effectiveness
- *Action direction*	One-way (imbalance-dependent)	Symmetric
- *Timeframe*	(Mostly) real time	From day-ahead to real time
- *Duration*	From a few minutes to an hour	From an hour to several hours
- *Approach to procurement*	Market-based/ Mandatory cost-based	Heterogeneous
- *Capacity reservation*	Yes	No[3]
- *Standardized prequalification*	Yes	No

TSO depends less on the scheduling of market actors and intervenes earlier utilizing slower but cheaper resources. Conversely, a reactive TSO approach uses a more decentralized approach in which BRPs are expected to minimize imbalances. In case of congestion, however, participants in zonal markets have no incentive to solve congestion within a bidding zone, unless they are activated for redispatch, which is why redispatching is to a large extent preventive in nature, i.e. it is the goal of the TSO to avoid market intervention as much as possible instead of resolving congestion [12]. Besides, the TSO's preference for using redispatch instead of other measures such as grid expansion depends on their own regulatory incentives [12].

Product requirements for redispatching have thus far not been standardized in most European countries. In general terms, however, redispatch measures can be subdivided into preventive (transmission constraints are considered *ex ante*) and curative (so-called *ex post* redispatch) [7]. The former takes place prior to the day-ahead (DA) market coupling whereas the latter close to real time. Due to a high interconnection level among the European countries, power flows in one country have significant effects on the grid situation in the neighboring countries, e.g. causing a congestion elsewhere or limiting cross-border capacities at a different border due to loop flows. For this reason, preventive measures, among others, involve TSO coordination to reduce congestion. Curative redispatch is used to solve system security issues arising from infeasible market outcomes.

The differences in procurement mechanisms, remuneration and timeframes create opportunity costs for market actors. Currently, balancing is a more attractive option for providers because the service is procured competitively and the selected providers are likely to make a net profit, as compared to redispatch service that is often settled at cost. Consequently, redispatching creates local opportunities different from the zonal incentives in the balancing and/or DA markets. The location-bound nature of redispatch implies that the pool of possible providers is more limited leading to a greater likelihood of market power. Inc-dec gaming[4] is a commonly cited concern, in particular in areas with frequent and predictable congestion [9], [10], [11].

III. METHODOLOGY

Based on the fundamental relations and differences between balancing and redispatch services described in Sections I and II, we illustrate different procurement approaches of the TSOs in Germany, France and the Netherlands (Section IV). Guided by the country studies and the current EU regulation, we derive three possible interaction models between the two services. We then analyze each model with respect to potential conflicts and effects on the participants' incentives (Section V). Finally, the efficiency of the three models is assessed with the help of evaluation criteria, such as allocative efficiency and susceptibility to gaming, and recommendations for improving efficiency and coordination of the two services are derived (Section VI).

As the procurement method of balancing energy is expected to be harmonized in the following few years through European balancing platforms [3]–[5], the focus is on discussing the different approaches to redispatch and their interrelations with the balancing market in the context of current regulatory developments.

IV. REGULATORY PERSPECTIVE

The relations and differences between redispatch and balancing stem not only from the technical requirements but also from the applicable regulation. EU regulation should be considered in view of the recent internal market harmonization rules, including the harmonization of ancillary service procurement. In this section, it is compared to the current approach to redispatch in Germany, France and the Netherlands in order to derive the core properties of each.

A. EU perspective and future developments

According to the European Balancing Guideline (EBGL), balancing energy shall be procured through a TSO-TSO platform that uses a common merit order with a single cross-border marginal price [3], [4]. The use of the European platform is obligatory for all TSOs using standard balancing products[5]. The gate closure time for the standard balancing energy product is set at 25 minutes before real time. Finally,

[3] Some TSOs do have complimentary mechanisms to contract additional capacity that can be activated for redispatch and is remunerated for capacity reservation. This is normally applicable to avoid early decommissioning of power plants, e.g. [8].

[4] Inc-dec gaming refers to a situation caused by differences between the zonal electricity market price and the local value of a redispatch action. If the value is expected to be higher than the zonal price, a market actor will have an incentive to reduce their offer on the day-ahead market in order to increase it for redispatch and secure higher profits (cf. e.g.[9]).

[5] Automatic frequency restoration reserve (aFRR), manual frequency restoration reserve (mFRR) and replacement reserve (RR). Frequency containment reserve is out of the scope of this regulation and of this study as only balancing capacity is usually procured for this product.

voluntary bids, i.e. bids that were not contracted in the balancing capacity market, will be allowed to provide balancing energy [13].

Cross-border congestion management and cooperation regarding redispatch in addressed in the CACM Regulation (Capacity Allocation and Congestion Management) [14]. Specifically redispatching shall be conducted according to the following principles, as stipulated in the EU Electricity Market Regulation (Art.13 [15]):

1. Redispatch should be procured in a market-based way.
2. The redispatch market is explicitly open to all types of generation, loads and storage (Art. 13 (1)).
3. Redispatch service providers must be financially compensated.
4. *"Balancing bids used for redispatching shall not set the balancing energy price"* (Art. 13(2)).
5. Derogations from principle 1 are allowed if the bidding zone contains structural congestion and is thus likely to be prone to strategic behavior; or if there is a low and uncompetitive volume of generation, demand response or storage; or if the TSO exhausted "all available market-based resources" (Art. 13(3)).
6. The approach to redispatch should give *"efficient economic signals to the market participants and TSOs involved"* (Art 16(1)).

Concerning the use of balancing bids to handle system constraints, including for redispatching, *cross-border* congestion shall be priced into market prices by reflecting the current state of cross-border capacities at the time of the balancing auction. In contrast, the EBGL does not allow balancing bids activated to solve an *internal* congestion to set the balancing energy price. Besides, the bids submitted to the European balancing platforms will not contain internal network locational information [3].

B. Germany

Balancing services are jointly procured by the *Netzverbund* of the four German TSOs using common auctions. The German TSOs use a reactive approach to system management: market actors are expected to minimize their own imbalances whereas the TSOs handle the remaining deviations using balancing reserves.

Redispatch services are procured independently from balancing services. All generation or storage facilities that are obliged by a TSO to adjust their active power for redispatch are remunerated based on reported costs. The TSOs may send redispatch instructions after receiving generation and load schedules at 14:30 day-ahead and later make adjustments continuously as they obtain more information [2].

Currently, redispatch is only provided by large conventional power plants. The Act on the Acceleration of the Expansion of the Energy Transmission Grid [16] adopted in 2019 foresees all conventional and renewable generators above 100 kW to be integrated in the redispatch process starting October 2021. However, the market-based approach for congestion management was decided against due the concerns about the risk of market power and manipulation [9].

C. France

Both balancing, mFRR and RR (see footnote 5), and redispatch are procured through auctions within a so-called 'balancing mechanism'. The French TSO, RTE, has a proactive system management approach and carries out balancing activations prior to the actual imbalance up to one hour before real time, which enables the TSO to use slower reserves. Due to the start-up times of some generation technologies, RTE may instruct some power plants to start ahead of market gate closure if it expects network constraints. Instructions for redispatch are issued prior to balancing instructions. Joint procurement of mFRR and redispatch implies that mFRR bids used for redispatch get remunerated for capacity reservation besides energy activation regardless of the activation purpose.

D. The Netherlands

The Dutch TSO, TenneT, uses a reactive system management strategy. Its main peculiarity is that market participants are allowed and encouraged to use so-called 'passive balancing' (cf. [17]), intentional schedule deviations to minimize not own but system imbalances in response to real-time imbalance signals. TenneT then solves residual imbalances. Another feature of this approach is that availability of balancing resources is increased through allowing voluntary aFRR energy bids.

Redispatch service is auctioned as a specific product, 'reserve other purposes'[12]. A unit might be provided for both redispatch and balancing but, if committed for either, it must be removed from the other merit order. A daily continuous auction for "reserve other purposes" takes place between 15:00 D-1 and 45 minutes before real time. Awarded bids receive energy prices pay-as-bid. The TSO monitors the congestion situation continuously and may prevent intraday trades if they create or aggravate congestion [2]. TenneT can call for additional bids in a specific location if insufficient volume to relieve congestion was provided.

TABLE II. NATIONAL DIFFERENCES CONCERNING REDISPATCH SERVICES.

	France	**Germany**	**the Netherlands**
Approach to system management	Proactive	Rather reactive	Reactive
Method of redispatch procurement	Market-based (together with mFRR/RR balancing mechanism)	Regulated, cost-based	Market-based ('reserve other purposes' product)
Required information for providers	Same rules as in the balancing mechanism apply	Location; costs	Location; price-volume bids
Participation in electricity markets	yes	yes	yes
Capacity remuneration	yes (mFRR)/no (RR)	no	no
Minimum bid	1MW	n/a	1 MW
Bidding	Mandatory (for units >12MW) and voluntary (for smaller units)	Mandatory for generators >10 MW	Voluntary (additional TSO call possible)
Remuneration of redispatch	Pay-as-bid	Cost-based	Pay-as-bid
Procured jointly with balancing	yes	no	no

TABLE III. POTENTIAL CONFLICTS AND PROVIDER INCENTIVES ASSOCIATED WITH DIFFERENT PROCUREMENT APPROACHES.

Model	Potential conflicts and risks	Effect on incentives
I MB/CB	- Balancing action is not possible due to redispatch - Activation of balancing bids can cause congestion - Risk of diluting wholesale market price signals if redispatch volume is high	- Market actors lack incentives to provide redispatch, so they need to be obligated. Otherwise, market actors may prefer to provide flexibility for balancing or wholesale markets. - Cost-based redispatch creates opportunity costs, not only with regard to the DA market but also the balancing market, which providers factor in.
II MB/MB	- Activation of balancing bids can cause congestion - Risk of diluting wholesale market price signals if redispatch volume is high - High relevance of procurement timeframes: risk of conflicting bidding strategies	- Different incentives: balancing energy is remunerated with the marginal price on the EU platform whereas redispatch is remunerated PaB. - If expected profits from redispatch are high, the cost of capacity reservation that is not explicitly remunerated may be factored into activation bids [10] - Highest incentive and potential for inc-dec gaming
III CMB	- Risk of redispatch actions 'contaminating' the imbalance price. - Risk of diluting wholesale market price signals if redispatch volume is high	- Requires locational information for balancing bids, drastically limiting portfolio bidding for balancing and thus affecting competition. - Redispatch providers will likely take into account balancing energy price developments and expectation of being awarded even if those activated for redispatch are compensated with a PaB price.

The three countries' approaches to redispatch are juxtaposed in Table 2. Germany has a more regulated approach in which generators are compensated for their costs, while France and the Netherlands have a market-based approach to both procurement and remuneration for delivered services. In France, balancing and congestion management reserves are procured together, in the other countries separately.

V. INTERACTION MODELS AND POSSIBLE CONFLICTS

Table 2 summarizes the design options and shows the fundamental differences in the three countries' procurement mechanisms, a combined procurement of balancing and redispatch in France, a cost-based approach to redispatch and a balancing market in Germany and two separate markets for the two services in the Netherlands. Combining this with the planned procurement of balancing energy through EU platforms, three stylized interaction models can be derived:

i) market-based balancing, cost-based redispatch (MB/CB),

ii) market-based balancing, market-based redispatch (MB/MB),

iii) common market-based balancing and redispatch (CMB).

The three stylized models are compared in Table 3. Note that Model II implies the two markets cleared consecutively whereas Model III has a single merit order and requirements. Considering the distinction made between preventive and curative redispatch, it is predominantly the latter that can conflict with balancing as both must be activated close to real time. In turn, units with lower ramping rates can be activated for redispatch as part of preventive redispatch without competing with the balancing resources.

The models are evaluated in Table 4 with respect to their allocative efficiency, availability of resources, susceptibility to gaming, ease of implementation and cost allocation.

Allocative efficiency refers to how much the value of flexibility used for different purposes is maximized (balancing and redispatch) [7]. In Model II, market actors can plan how much to bid in each of the two markets. As different types of providers can participate, allocative efficiency is likely to be high. In Model III, allocative efficiency might be low as, due to the procurement close to real time, this approach is not amenable to preventive redispatch and the pool of the available resources is likely to be limited. Besides, if the same pool of resources is used for both, the use of units for redispatch will limit the choice of resources for balancing and may cause a need for a larger volume of balancing capacity reservation, leading to higher costs.

Resource availability is higher in the market-based approaches as compared to Model I as the actors have an economic incentive to participate. The main issue with Model I is that cost-based redispatch only considers generation and not load or storage, for which the costs cannot be determined in the same way (i.e. based on their variable costs) [18], lowering resource availability. As potential providers have no incentives to participate in cost-based redispatch, they must be compelled instead. Besides, additional mechanisms are likely to be needed to avoid early decommissioning of plants relying on market prices alone [10], causing additional costs, which have to be factored in when evaluating efficiency and costs of procurement. Models II and III may reduce or make it superfluous to procure additional grid reserves.

Concerning *susceptibility to gaming,* Model II has the highest potential for inc-dec gaming, making regulatory oversight hardly avoidable. Market actors can leverage their network positions and affect electricity market results; yet, the risk exists mostly if congestion is structural, i.e. frequent and predictable. The ultimate risk is that market distortions induced by redispatch erode the DA marginal price as the reference price and cause welfare losses. Yet, cost-based redispatch is not immune to strategic bidding either. A limited number of predefined providers coupled with the information asymmetry existing between the providers and the TSO may

TABLE IV. SUMMARY OF THE PERFORMANCE OF BALANCING AND REDISPATCH SERVICES IN THE THREE MODELS

Approach	Allocative efficiency	Availability	Susceptibility to gaming	Ease of implementation	Transparent cost allocation
I MB/CB	low	low for redispatch	moderate	high	high
II MB/MB	high	high	high	moderate	high
III CMB	low	high	low	low	low

mean that the reported costs are likely to deviate from reality if no caps on costs or benchmarking practices exist [10]. Cost-based redispatch can be justified by low competition, according to the Clean Energy Package (CEP), but this is a circular argument: if cost-based redispatch is applied, competition levels are likely to be low, which justifies the cost-based approach.

The gaming potential in Model III is likely the lowest if the bidders do not know in advance if their bids are going to be used for balancing or redispatching. In Model III, if a certain balancing bid is expected to provoke or aggravate congestion, it can be taken out of the merit order, i.e. the bid is skipped, or the bids for the two purposes are co-optimized [7]. The latter is difficult to achieve if, besides its cost, the effectiveness of the unit is to be considered for redispatch.

Europe-wide implementation of Models I and II clearly entails lower transition costs than a common market, although Model II may require more effort as specific product requirements need to be defined. It is questionable whether Model III can be easily reconciled with the planned balancing platforms. Besides, based on EU regulation, activations of balancing bids for any purpose should follow the merit order, which is not necessarily possible for redispatch bids due to effectiveness considerations [7]. Conversely, if a balancing bid cannot be activated due to congestion, its actual cost was not accounted for in the price, which is in fact higher.

The allocation of costs between redispatch and balancing can be accomplished much easier in Models I and II rather than in Model III where there is a risk of redispatch costs 'contaminating' the imbalance price. As balancing and redispatch costs tend to be recovered in different ways, allocating their costs in a transparent cost-reflective manner is more difficult in a common market.

VI. Solutions

The CEP requires redispatch methods to provide *"efficient economic signals to the market participants and TSOs involved"* [15]. This requirement is incompatible with Model I, which also has low allocative efficiency and resource availability and is not immune to gaming. If the volume is high and congestion is structural, then the likelihood of eroding the short-term market price is high. Therefore, when assessing the potential for strategic bidding, the presence of structural congestion is a crucial factor, regardless of the approach [18]. If structural congestion is tackled prior to day-ahead market clearing, the remaining congestion can no longer be predicted by market actors, therefore reducing the room for gaming [18].

The integration of balancing and redispatch into a single market (Model III) is likely to reduce strategic bidding behavior and the conflicts between the two services. Co-optimization using a common platform can solve the conflicts between redispatch and balancing but also creates a number of challenges linked to EU-level balancing energy procurement. This approach does not actually lead to an optimal allocation: if redispatch is integrated into the balancing platform, which closes close to real time, a significant share of redispatch resources would not be utilized. This increases the likelihood that e.g. renewables are curtailed before slower thermal plants due to the operational restrictions of the latter [18]. The choice of timeframe of redispatch needs to "ensure the right balance between availability and liquidity" [7, p. 23].

Table 4 shows that Model II, separate markets for balancing and redispatch, produces the fewest tradeoffs. Both TSOs and DSOs suggest using the market approach in the so-called orange phase, i.e. when congestion is expected [7]. Different rules should be followed in the red or emergency phase when the TSO cannot secure sufficient flexibility resources. They further call for standard congestion management product requirements on the national level [7, p. 11]. Indeed, similar to the best practice from the balancing markets, standardization of product requirements, such as such as activation parameters, availability and baseline methodology for validation of service delivery, is crucial for stimulating competition. By facilitating transparency and comparability, standardization makes it easier to estimate the business case of service provision and investment needs.

The often-cited concerns against market-based redispatch are justified in many cases. Local markets are by definition more concentrated, which can make it easier to exercise market power, so it is unlikely that the risk of strategic bidding can be fully eliminated. Yet, these concerns are often based on a number of assumptions that are not universally applicable but rather country or even case-specific. The fact that market-based redispatch is already used in several countries without posing serious issues implies that the main source of concern is not the market approach *per se*. For instance, it is possible that the expected issues in Germany are linked to economic considerations as much as they are to the reality of the German grid, characterized by particularly pronounced structural congestion on the North-South axis. That said, market-based approach is viable only under the condition that structural congestion has been solved either before market clearing or through grid reinforcement.

Besides the timeframe of procurement and the presence of structural congestion, the choice of remuneration of redispatch units is an important factor defining the actors' incentives. By capping the maximum redispatch price at the DA price, for instance, market distortion can be minimized [10]. As redispatch is used in different timeframes, an alternative solution could be to integrate it with the day-ahead market (an approach enabling such integration was developed in [19] and [20]) or with the intraday market (e.g. Dutch pilot project, IDCONS [21]). This would address allocative efficiency, as preventive redispatch can be accommodated and therefore the pool of providers increased. It can also lower the gaming risk as market actors still bid in the wholesale markets and are incentivized to bid competitively. In this way it can ensured that only a small amount of curative redispatch is needed, limiting the conflict between redispatch and balancing.

VII. Conclusions

This paper addresses the relations and potential conflicts between balancing and redispatch and their effect of the incentives of services providers. We compared three approaches to their procurement, i) market-based balancing, cost-based redispatch, ii) separate redispatch and balancing markets, and iii) a combined market for the two services.

Procurement of the two services in separate markets was shown to have the fewest tradeoffs, as compared to the other two approaches. We show that the efficiency of the chosen approach depends on 1) the timeframes of procurement of the two services, 2) the presence of structural congestion, and 3) the remuneration of redispatch. The timeframes for procurement should be carefully considered: redispatch must be prioritized as fewer resources are inherently available at a specific location as compared to balancing. Redispatching prior to balancing may allow the TSO to access slower plants preventing competition for scarce short-term flexibility close to real time.

In the presence of structural congestion, the problem is not a market-based approach but rather the frequent and predicable nature of congestion itself, a situation that cannot be removed by market design. In this situation, grid reinforcement should be prioritized if the long-run cost to society is lower than the cumulative cost of the congestion. Integrating redispatching with day-ahead or intraday markets may help reduce gaming risks while preventing a conflict with the balancing market. Regardless of the approach, standardized product requirements for redispatch are essential to enable competition.

Further research should include a quantitative assessment of the three models to give additional insights into efficiency, distribution of costs and incentives.

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