STUDY

REMUNERATION OF MFRR & AFRR CAPACITY:
PAY-AS-BID VS. PAY-AS-CLEARED

17 December 2020

Study on the possible evolution from pay-as-bid to pay-as-cleared remuneration of aFRR and mFRR capacity

EXECUTIVE SUMMARY

INTRODUCTION

This document studies the potential shift from the current paid-as-bid towards a paid-as-cleared remuneration for the procurement of aFRR and mFRR capacity.

THEORY

With a paid-as-cleared remuneration (also referred to as “marginal pricing”), bidders have an incentive to submit bids priced at their marginal costs, as they know they will obtain contributions to their long-term costs and profits from the difference between their bid price and the clearing price. Under paid-as-bid, such markups to cover long-term costs and profits need to be included in the bid prices. Therefore, paid-as-bid settlement requires bidders to estimate the bidding behavior of the other market players in order to forecast the market equilibrium and include the best markup in their bid price (i.e. high enough to avoid opportunity losses without jeopardizing the probability of selection). In a perfectly competitive market, paid-as-cleared and paid-as-bid lead to the same procurement costs. However, in a non-perfectly competitive market, paid-as-cleared and paid-as bid affect the market and procurement differently.

This paper concludes that, according to the theory, the introduction of paid-as-cleared remuneration in a non-perfectly competitive market (like the balancing capacity markets) is likely to increase market attractiveness because homogeneous services become remunerated equally, forecasting effort is reduced and the market thereby better acts as a level-playing field, irrespective of bidders’ market shares. Consequently, the new bidding behavior and the attraction of new resources in the market are expected to lead to a reduction of total procurement cost in the long term. Marginal pricing, however, only delivers such benefits when a reasonable level of liquidity and competition is either pre-existing at the time of implementation, or is reached shortly afterwards, i.e. when no significant barriers exist that prevent the expected benefits to materialize.

EUROPEAN FRAMEWORK & EXPERIENCES

Currently, European countries procure FRR capacity under market-based regimes (paid-as-cleared or paid-as-bid) or at regulated prices. European regulation calls for market-based prices, without laying down an obligation for either paid-as-cleared or paid-as-bid for the national procurement of FRR capacities.

Elia surveyed some of its peer TSOs on their plans for or experience with paid-as-cleared remuneration for FRR capacity. Countries with concrete plans to change the remuneration of FRR capacity will introduce paid-as-cleared remuneration: France will do so replacing the currently regulated price for aFRR capacity, while the NORDIC countries plan to make the change as part of the creation of a cross-border cooperation for aFRR capacity and one for mFRR capacity. Denmark, Finland, France (for mFRR) and Spain shared positive experience with paid-as-cleared remuneration of FRR capacity and, in a nutshell, confirmed the theoretical expectations (i.e. they observed increased competition and lower prices after its implementation). Only Swissgrid had a bad experience in 2009 and decided to revert back to paid-as-bid a few months after implementing paid-as-cleared remuneration, due to high prices and lack of liquidity.

The draft methodology for market-based allocation of cross-border capacity in the CORE region (ENTSOE, 2020), however, targets paid-as-cleared remuneration for any future cross-border FRR capacity procurement cooperation within the CORE region. Consequently, introducing a paid-as-cleared remuneration for FRR capacity in Belgium would not prevent Elia from joining any potential future cross-border cooperation.

ASSESSMENT OF INTRODUCING PAID-AS-CLEARED REMUNERATION FOR BELGIAN FRR CAPACITY

The theory and the European context indicate advantages from changing remuneration to paid-as-cleared, given circumstances are favorable to make the change. The question is whether the FRR capacity markets in Belgium are sufficiently liquid and competitive to benefit from the shift to paid-as-cleared, or if not, whether entry barriers are low enough to ensure the markets adapt quickly.

aFRR capacity design

As of 30/9/2020, Elia procures upward and downward aFRR capacity (still with paid-as-bid settlement) in two steps:

- The “all CCTU auction” (executed two days before delivery) allows only indivisible bids for the 24 hours of the delivery day, including both upward and downward volumes. This auction is kept in a transitory phase in the evolution of aFRR and is planned to be progressively phased out.
- The “per CCTU auction” (executed one day before delivery) is organized per direction and accepts only divisible bids, for a delivery period of 4 hours (i.e. Capacity Contracting Time Unit or “CCTU”). This is the target auction for the future aFRR design, which is fully in line with the Guideline on Electricity Balancing (European Commission, 2017) and Electricity Market Regulation (European Commission, 2019).

To progressively shift the demand from the first step (which facilitates the bidding of indivisible volumes with start-up costs spread over a longer period, particularly suitable to CCGTs) to the second step (which facilitates bidding of volumes over a shorter period of time, attracting new entrants in the aFRR market), a specific apportioning rule is applied: the volume procured in the second step can be increased if the price of the last accepted bid in the second step is lower than 120% of the price of the last accepted bid in the first step for the same delivery day.

mFRR capacity design

Since 3/2/2020, Elia procures upwards mFRR capacity (still with paid-as-bid settlement) in a day-ahead auction per CCTU (i.e. blocks of 4 hours) of divisible bids for mFRR Standard and mFRR Flex capacity. BSPs may include either a price for mFRR Standard, or a price for mFRR Flex, or a price for both types in their bid. In a first step, Elia procures a minimum volume of mFRR Standard capacity (640MW since 1/7/2020, 490MW previously). In a second step, Elia procures the remainder of required mFRR capacity (dimensioned on a daily basis) based on a merit-order of remaining capacity bids (using the mFRR Flex price if included in the bid; if not, the capacity remains offered as mFRR Standard).

The theoretical assessment recommends a design based on divisible capacity bids for homogeneous products and merit-order selection to introduce paid-as-cleared remuneration. This implies that Elia would consider this design change for:

- mFRR capacity per product: a separate marginal price for mFRR Standard and mFRR Flex capacity could be defined, with an additional constraint that the clearing price of mFRR Standard shall always be at least equal to the clearing price of mFRR Flex.
- aFRR capacity for the “per CCTU auction” only: this is seen as an enduring approach as it upgrades the enduring part of the current design and makes it more attractive.

ASSESSMENT OF MARKET READINESS

mFRR capacity market

Elia performed quantitative analyses based on data of mFRR capacity bids for the period from 4 February (start of a new design including daily procurement of mFRR capacity) until 31 October 2020.

The initial impact of changing the remuneration to a paid-as-cleared mechanism would be the following:

- If BSPs would not change their bidding behavior (same offers, same bid prices, same selection): the change would result in an increase of about € 10,4 million (or 24%) in total procurement costs per year (9 months data extrapolated to 12 months).
- Simulations using the lowest price per bid (in case of bids with both a Standard price and a Flex price), would lead to an increase of € 6,5 million (20%) on a yearly basis. This assumes that the difference between the Standard price and the Flex price of a bid is only related to the price determination in a paid-as-bid mechanism.

The level of liquidity overall appeared satisfactory, although not fully comfortable. For 90% of the CCTU, the offered volume exceeded by more than 313 MW the mFRR total demand. For mFRR Standard specifically, the excess volumes are more than 284MW for 90% of the CCTU. On two days, insufficient volumes were offered and Elia had to organize second auctions. On two other days, the excess volumes offered were lower than 100 MW.

The readiness of the mFRR capacity market in terms of level of competition is less straightforward. Eight BSPs with small and large portfolios offer mFRR capacity on a daily basis, with seven BSPs offering mFRR Standard during the analyzed period. The BSPs participating to the mFRR Standard capacity market all have CCTU with and without awarded capacity. Some BSP receive the main share in awarded capacity even when there is a lot of volume offered by other BSPs as well. The largest BSP share in the offered Standard volumes ranges from 34% to 100% (on average 53%) in the period February to October, while the largest BSP share in the awarded Standard volumes ranges from 27% to 100% (on average 50%). The level of market concentration in the mFRR Standard capacity market, as expressed by the Herfindahl-Hirschman Index (HHI) calculated per CCTU based on the shares of awarded capacity, mostly shows a high level of market concentration (index of 0,25 or more), ranging between 0,22 and 1 (if calculated based on the shares in offered volumes the index ranges between 0,25 and 1). For 90% of the CCTUs, however, the HHI based on awarded volumes is lower than 0,51 (based on offered volumes lower, it is lower than 0,49).

The data indicate that the mFRR capacity market has attracted a diverse set of players with overall satisfying levels of liquidity (i.e. market depth) for each auction, although some moments are near critical levels. Nonetheless, the level of market concentration is still relatively high. If the change from paid-as-bid to paid-as-cleared has little effect on the estimation of a BSP to have awarded capacity (due to a low impact on competition, at least initially), the incentive for BSPs to change their bidding strategy and reduce their bidding prices immediately after the introduction of a paid-as-cleared remuneration is small (in which case the shift towards paid-as-cleared will solely lead to a procurement cost increase). In addition, despite efforts to reduce barriers to enter balancing markets, the effort required of (existing or even new) BSPs to develop new volumes is not to be underestimated. If a transition period of several months or even a year would pass before the advantages of moving to a paid-as-cleared design kick in, a substantial increase in total procurement costs is certain (provided the demanded volumes do not change).

A last note on the analyzed period (February to October 2020) demands attention. Despite the interesting preliminary conclusions based on daily data of individual capacity bids, a period of nine months is too short to draw firm conclusions. The market first had to adapt to the new design and a period of at least 12 months would be better to account for the possible impact of seasonal evolutions in the electricity markets. In addition, the emergence of the Covid-19 pandemic

has strongly affected the electricity markets, especially in the first months. Therefore, the analyzed period can unfortunately not be regarded as representative and a follow-up of this analysis would be advisable before making a final decision on changing the design to a paid-as-cleared remuneration for FRR capacity. This remark holds even more with respect to liquidity development for the period since July 1st in which 640MW of mFRR Standard is procured.

aFRR capacity market

The possible introduction of paid-as-cleared remuneration for aFRR capacity described earlier, is based on the new design for aFRR of September 2020. Therefore, at the moment of this study, there was no usable historical data available to perform quantitative analyses to get a better view on the liquidity and competitiveness of the market in the framework of such a design. The data available on the design until September 2020 cannot serve as a representative base and would therefore not lead to meaningful results. The data since September 2020 are for a too short period during which not all BSPs interested in offering aFRR were able to implement the necessary changes or prequalify volumes.

At this stage, the liquidity in the aFRR capacity market is restricted. This is the reason why the design (from September 2020 onwards) with the 2-step auction has been chosen for a transitory period. Experience with the new design and future analysis of the evolution of the liquidity and competition within the aFRR capacity market (as described above for mFRR) will provide knowledge to better evaluate the impact of a paid-as-cleared remuneration in the future.

CONCLUSION AND IMPLEMENTATION PROPOSAL

The study generally shows the advantages and feasibility to implement a paid-as-cleared remuneration for FRR capacity. The paid-as-cleared settlement could be introduced for aFRR and mFRR independently and only for the auctions selecting capacity based on a merit order (meaning, in practice, not for the “all CCTU aFRR auction”). In the short term, however, a change from paid-as-bid to paid-as-cleared would increase total procurement costs as it takes time for markets to adapt and the benefits on competition levels to reveal themselves. The paid-as-bid mechanism used today has its merits when the market still shows an insufficient level of competition and the emergence of sufficient competition would take a longer time.

Based on this study, Elia concludes that a transition to paid-as-cleared for mFRR and aFRR capacity would seem feasible and desirable, provided that the markets evolve to higher levels of liquidity and competition than is the case today. A longer and more representative period to follow-up the market evolutions is, however, recommended. Therefore, Elia proposes to reassess the liquidity and competition in the mFRR capacity market in Q2 2021, once data for an entire year of the implemented design with daily procurement is available. The readiness of the aFRR capacity market would be reassessed 6 months after the full phase-out of the “all CCTU” auction. The assessment of market readiness would indicate that the shift to paid-as-cleared can be made without significantly increasing procurement costs on the short term and while having some degree of confidence that the procurement costs will decrease in the medium term.

In terms of timing of implementation, several practical aspects need to be considered.

For aFRR, the above described design has only just been put into operation at the time of writing this report. It is therefore reasonable to first acquire some experience from the actual market functioning – notably in terms of liquidity and competition – before confirming subsequent changes.

For mFRR, the full phase-out of mFRR Flex remains a target but at the time of writing this report, the concrete timing of the phase-out is unclear. The existence of an mFRR Flex product may affect the level of liquidity and competition in

the mFRR capacity market and thereby influence decisions on implementing a paid-as-cleared remuneration. The proposed remuneration scheme can be implemented in the current design as well as in case the mFRR Flex product is fully phased out.

In terms of IT implementation at Elia side, the change itself requires some new developments without posing blocking issues. However, a more concrete planning is only feasible when also considering the developments required at Elia and BSPs’ sides for this and for other design changes planned in the coming years. In their consultation feedback, BSPs have already indicated that the implementation efforts at their side may be substantial and must be carefully planned and prioritized in interaction with the changes needed for other projects.

Changing the remuneration mechanism requires an amendment to the Terms and Conditions (T&C) for the BSP for aFRR and/or mFRR services. This regulatory trajectory comes with a minimum, formal timeline leading to a period of about 4 months between the decision to propose to implement paid-as-cleared remuneration and its entry into force (adding other changes to the T&C could of course lead to longer timelines).

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REPORT

1. INTRODUCTION

1.1 Scope of the study

Every high-voltage Transmission System Operator (TSO) in Europe is responsible for compensating in its control area the residual imbalance that is not resolved by the Balance Responsible Parties (BRPs). TSOs may manage the imbalance in the system via the activation of Frequency Restoration Reserves (FRR) supplied by Balancing Service Providers (BSPs)[1].

FRR replace Frequency Containment Reserves (FCR) if the frequency deviation resulting from an imbalance lasts longer than 30 seconds. FRR can be distinguished between reserves with automatic activation (automatic Frequency Restoration Reserves or “aFRR”) and reserves with manual activation (manual Frequency Restoration Reserves or “mFRR”). aFRR is activated automatically by the TSO in a continuous manner, and is thus directly integrated in the TSO systems. mFRR is activated manually at the request of the TSO in situations of larger system imbalances or of system imbalances of longer duration. While aFRR activations can be modulated continuously, mFRR is always activated for a minimum duration.

BSPs can offer aFRR or mFRR energy on day D, either ‘freely’ (i.e., non-contracted) or in respect of reserve obligations. To ensure that BSPs offer a certain volume of FRR energy on day D, TSOs procure FRR capacity in advance (before the closure of the day-ahead market) via specific procurement mechanisms. This ‘contracted FRR’ is nowadays settled on a “paid-as-bid” basis in Belgium as well as in several other European countries.

This study specifically investigates the change of the settlement schemes of the procured FRR capacity towards a “paid-as-cleared” principle. The study distinguishes where applicable the procurement mechanisms of aFRR and mFRR.

In particular, this study is assessing the following questions:

- What are the key differences from a theoretical perspective between paid-as-bid and paid-as-cleared settlement (also called “marginal pricing”)?
- What are the important aspects which need to be considered when dealing with the topic of marginal pricing?
- What is the current remuneration for procured FRR capacity in other European countries? What are the plans and experiences with paid-as-cleared settlement schemes?
- What is the current remuneration for procured FRR capacity in Belgium and what would the preconditions be to evolve towards an efficient paid-as-cleared settlement scheme for FRR capacity?
- What are the different design options for the determination of the marginal price for the settlement of FRR capacity?
- What are the costs and benefits of such an evolution?

[1] TSOs can also use Replacement Reserves (RR) to balance the system. However, Elia only procures Frequency Restoration Reserves (FRR) for which the remuneration is in the scope of this study.

- What is the recommendation regarding an evolution to marginal pricing?

For sake of clarity, the present study is not studying the evolution to paid-as-cleared for the activation of FRR energy bids. Elia has already studied this previously (see (Elia, 2017)) and the implementation of paid-as-cleared settlement for the activated aFRR and mFRR energy is progressively ongoing. Note that some theoretical parts of the present study have been taken over from this previous study (Elia, 2017).

1.2 Legal/regulatory context

The Guideline on Electricity Balancing (hereafter referred to as "EBGL") (European Commission, 2017) does not impose a specific pricing method for the procurement of FRR services but more generally ask that "*The pricing method used in the procurement of balancing capacity should strive for an economically efficient use of demand response and other balancing resources subject to operational security limits"* (cf. Whereas 14.) and that "*the procurement method shall be market-based for at least the frequency restoration reserves and the replacement reserves*" (Article 32, §2 (a)). The EBGL clearly considers both paid-as-cleared and paid-as-bid settlements as market-based and economically efficient mechanisms. Also the Electricity Market Regulation (European Commission, 2019) demands a market-based procurement of balancing capacity (Article 6.8).

In other words, **a shift towards a paid-as-cleared remuneration for FRR capacity is compliant with the regulation, but not mandatory**.

However, Article 3 of the methodology for the allocation of cross zonal capacity for the exchange of balancing capacity by the CORE CCR TSOs (ENTSOE, 2020) puts forward the paid-as-cleared remuneration of FRR capacity within a balancing capacity cooperation of TSOs in the CORE region. Although this methodology was not approved at the time of writing this document[2], **the expectation is that paid-as-cleared settlement will become the norm in case of cross zonal capacity exchange of balancing capacity**.

1.3 Organization of the document

The present document is organized as follows:

A theoretical analysis of the differences between paid-as-bid and paid-as-cleared remunerations is provided in Chapter 2. This evaluation shows that – despite the fact that in theory both approaches lead to the same results under perfect competition assumptions – paid-as-cleared benefits from several advantages over its alternative, as long as certain pre-conditions are met, in particular related to the level of liquidity and competition in the market. Because paid-as-cleared heavily relies on the concept of "marginal cost", Chapter 3 clarifies how this notion applies in the FRR context.

Chapter 4 explains how FRR is currently procured in Belgium – thereby summarizing the various changes which have been implemented during 2020, while Chapter 5 provides an overview of how FRR is procured in other neighboring countries. This latter chapter also comprises the results of a survey that Elia conducted towards its peer TSOs on their experiences and plans with respect to the FRR capacity remuneration scheme.

Chapter 6 then deep dives into the possible ways to implement a paid-as-cleared remuneration in the current aFRR procurement scheme, and concludes with a concrete proposal. Chapter 7 does the same for mFRR.

[2] The version of the methodology of December 2020 (ENTSOE, 2020) submitted for regulatory approval follows from a request for amendment by the regulators based on the first proposal of the methodology submitted in December 2019 (ENTSOE, 2019).

The main conclusions are then gathered in Chapter 8.

1.4 Public consultation and update of the study report

Elia published and distributed a preliminary version of the study report for consultation in order to collect stakeholders’ views on the study in general as well as their feedback on the following, specific questions:

- Do you agree that despite the possible positive impact of paid-as-cleared remuneration, the current paid-as-bid remuneration has its merits given the current market dynamics, and that the data at this stage do not yet clearly support the integration of paid-as-cleared remuneration for FRR capacity?
- Do you agree with the specific designs proposed for aFRR and mFRR in terms of how a paid-as-cleared remuneration would be determined and applied, if decided to do so?
- How important is a design change for FRR capacity towards paid-as-cleared remuneration for you? How should Elia prioritize this change compared to other design changes?
- Based on your above feedback on priorities and taking into consideration the possible workload impact on your side, when should these changes be implemented? The next major design changes are foreseen for the FRR energy markets (in the frameworks of the European FRR energy platforms created in the PICASSO/MARI projects): should the redesign of the FRR capacity remuneration be implemented sooner, at the same time, or later?

The quantitative analyses on mFRR capacity in this preliminary study report were based on the period February until June 2020. The public consultation lasted from 1 September until 1 October 2020[3]. Stakeholder feedback and Elia responses are available in the consultation report.

For the final version of the study report, Elia has updated the quantitative analyses on mFRR capacity based on data until October 2020 and Elia has taken into consideration the stakeholder feedback. Based on the responses to the consultation and further discussion with the stakeholders of the balancing roadmap 2021-2022 during the meetings of the Working Group Balancing of October and November, Elia maintains its proposal to decide on a concrete implementation only after a sufficiently long period of experience with the designs for mFRR and aFRR entered into force in 2020 allow for a better assessment of the market situations.

[3] Visit the consultation web page: https://www.elia.be/en/public-consultation/20200901_public-consultation-on-the-study-on-pay-as-bid-vs-pay-as-cleared

2. PAID-AS-CLEARED VS. PAID-AS-BID THEORY

The choice between paid-as-cleared vs. paid-as-bid in the power market has been largely discussed in the scientific and industry literature. Though, most studies focused more generally on wholesale power prices than specifically on balancing services, whether energy or capacity. In this chapter, we discuss both approaches from an abstract and theoretical perspective.

2.1 Definitions

Let us first start with definitions of both options:

2.1.1 Paid-as-bid

Paid-as-bid is a pricing mechanism that enables a different price for each transaction, i.e. each transaction price is determined by the price set in the accepted bid. Bidders therefore have every good reason to include in the price of their bid – on top of the avoidable cost for the delivered units – a margin to cover long-run costs and generate profit. Such a margin is naturally set to be as large as possible, though keeping in mind that the offer is retained if more attractive than other offers.

In other words, **under paid-as-bid, bidders will price their bids above their own marginal cost, as the approach implies that the bid price should also contribute towards recovery of their fixed charges and profits.** In addition, the bid price target is just below the (forecasted) marginally accepted bid price for this product, i.e. the price of the last accepted unit (provided this forecasted bid price is still above their own marginal cost).

Paid-as-bid is a standard pricing mechanism in continuous markets and has historically been applied in several capacity markets, including FRR.

2.1.2 Paid-as-cleared / Marginal pricing

Paid-as-cleared is a uniform pricing mechanism that offers the same price to all transactions of a given product at a certain point in time, based on the marginally accepted order. The clearing price is determined by the equilibrium between demand and offer and therefore represents the marginal market value of the last unit added to the transaction set to achieve this equilibrium.

From a theoretical point of view[4], **providers offering in an effectively competitive market with marginal pricing have incentives to price each bid that they offer at approximately their marginal costs**.

By doing so, they know that if any of those bids is rejected, it is because there are other bids at better prices in sufficient quantity to satisfy the demand. Non-selected bids were therefore “out of the money” and their rejection protects their bidders from having to commit themselves to transactions at prices that fail to cover their avoidable costs. More importantly, bidders know also that for their accepted bids they will receive the uniform settlement price allowing them not only to recover the variable production costs but also to recover (a part) of their fixed costs (depending on the difference between their variable production costs and the settlement price).

Paid-as-cleared is becoming the norm for pricing short term energy auctions (spot and balancing markets).

[4] Source: (P.Cramton, 2001)

2.2 Basic theory

From economic theory, paid-as-cleared and paid-as-bid provide the same results in a market with perfect competition. These perfect competition assumptions are:

1. atomistic market structure (i.e. many independently owned market parties with no market power)
2. homogeneity of the product (i.e. all products within a market are identical, divisible and substitutable to each other)
3. no entry or exit barriers (i.e. market parties can freely enter or exit the market)
4. perfect information (i.e. all parties have perfect information about the market and the products, including the quantities of products offered and demanded).

Under such assumptions, bidders can perfectly predict the demand and offer curves and consequently the equilibrium price (or market clearing price). Under paid-as-bid, they will set the price of their bids at the level of (their expectations of) the equilibrium price, as this provides the largest possible contribution to covering long-run costs. Under paid-as-cleared, they will set the price of their bids at their own marginal cost, but will be remunerated the price of the last accepted bid, i.e. the market clearing price. Consequently, in a perfectly competitive market, the same dispatch and welfare repartition should occur under paid-as-cleared and paid-as-bid (see Figure 1).

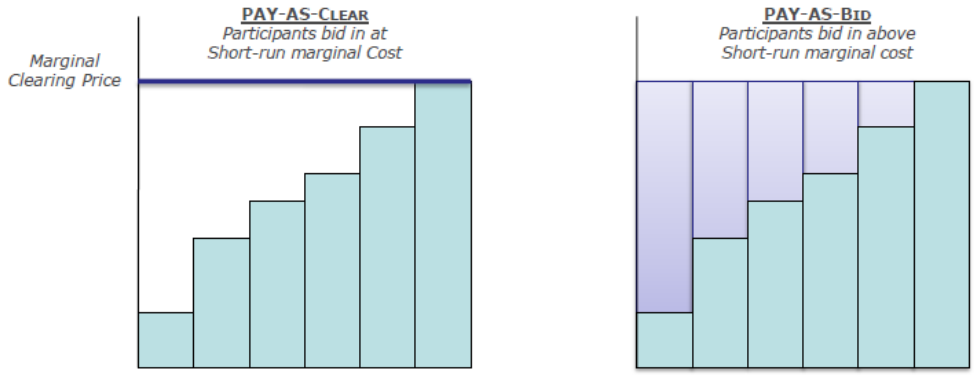


Figure 1 : Under marginal pricing, bidders have an incentive to bid their short-run marginal costs (green). With paid-as-bid, bidders have an incentive to complement their bid price with a mark-up (blue) such that the bid prices reach the system marginal cost. Under perfect competition assumptions, an identical selection should occur under both pricing schemes, leading to the same total expense for the buyer.[5]

In practice though, for the particular case of FRR services, the conditions for a perfectly competitive market are not met:

1. Firstly, balancing markets are typically – mainly due to historical and/or technical reasons – dominated by one or a few incumbents. Consequently, market power is very often suspected or alleged, and the market is not “atomistic” regardless of efforts to improve the competition in the markets.
2. Secondly, although electricity is in principle a very homogeneous and divisible commodity, the underlying assets that generate or consume the commodity have a wide range of characteristics (flexibility, location, …), so that tradable products are heterogeneous to at least some extent (e.g. some assets are able to provide the full spectrum of ancillary services while others are only able to deliver ancillary services under strict conditions,

[5] Picture from (Ofgem, Undated)

some assets may be ill-placed and be forbidden to provide balancing services due to impact on congestion risks, etc.). Therefore, there are technical entry barriers that are not equal to all providers.

3. Thirdly, there exist multiple entry (or exit) challenges in the power market in general, and in ancillary services in particular. These can be financial (e.g. scaling effects), legal/regulatory (e.g. DSO/TSO interface) or technical (e.g. flexibilization of assets, see point 2). Ancillary services therefore suffer from some entry or exit barriers, regardless of the efforts in the design of ancillary services to keep these barriers low and develop technology-neutral markets.
4. Finally, although transparency and predictability have drastically improved in the last years, information is not perfectly known or predictable. Especially for smaller players, accessing and processing information may result in a relatively higher costs than for bigger players.

In summary, **the perfect competition assumptions do not hold in the studied context**. Consequently, economic theory does not perfectly hold either and it is likely that an evolution from a paid-as-bid to paid-as-cleared remuneration will affect the market output.

The question debated further in this study is the added value of an adoption in the Belgian FRR capacity procurement market of a paid-as-cleared settlement mechanism (as opposed to the current use of a paid-as-bid approach).

2.3 Theoretical advantages of paid-as-cleared

2.3.1 Market efficiency under imperfect information

The balancing market structure is in practice quite diverse (ranging from very small to very large players) and treatment of information (and related uncertainties) is far from easy and perfect. Under paid-as-bid, offers do not only depend on the relative technical efficiency and (opportunity) costs of the offered capacity but also on the bidder’s potential to successfully forecast the market equilibrium (i.e., the price of the last accepted bid for FRR capacity). Such forecasting is a rather fixed effort and thereby relatively more expensive for smaller players. Indeed, under paid-as-bid, any forecasting error of the expected marginal cost of bids of other providers can lead to an alternative sequence of activation in their merit order, and consequently a non-optimal selection of the resources (i.e. most efficient assets are not selected first).

Figure 2 illustrates such a possibility of non-optimal usage of resources for a given set of 5 assets (labelled A, B, C, D, E). Under marginal pricing, we assume that the bids are priced at their marginal cost (colored in blue in the figure), thereby reflecting their economic efficiency. Under paid-as-bid settlement, a contribution to fixed cost and profit (colored in red in the figure) needs to be estimated based on the expectation of the market outcome. In the example depicted in the figure, these contributions have been misestimated leading to a suboptimal dispatch as the efficient asset B is priced too high and ends last in (the non-selected part of) the merit order.

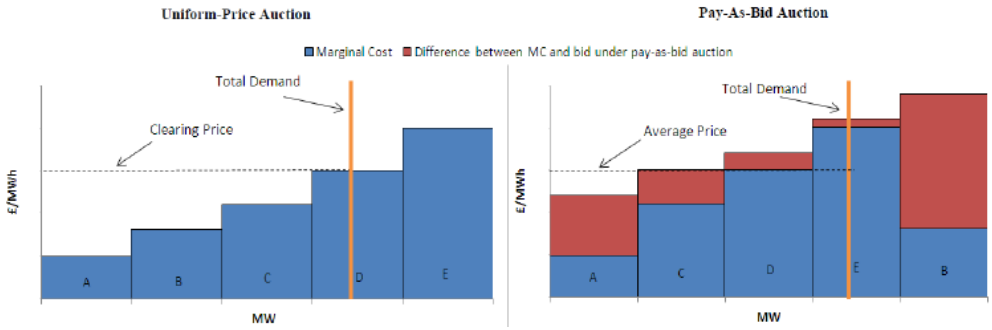


Figure 2 : Non-optimal dispatch in case of paid-as-bid, compared to paid-as-cleared[6]

In conclusion, the higher probability of an economically efficient selection of bids is why paid-as-cleared pricing is therefore often cited as preferable to accommodate a market with players of heterogeneous sizes with different access to information.

2.3.2 Monitoring, market power and liquidity

As marginal pricing provides incentives for participants to bid at marginal cost, they also make the markets applying such a scheme easier to monitor, as **supervision agents can more objectively verify the coherence between individual bids and the marginal costs of the corresponding assets.** Note that verifying the cost structure of FRR capacity is substantially more complex than for the marginal cost structure of balancing or spot energy (see Chapter 3).

In case a market player with a dominant position abuses its position and, by bidding largely above its marginal cost, increases the settlement prices, some argue that paid-as-bid is to be preferred because the buyer only pays the artificially high price to the market party with the dominant position and not to all market parties. However, others argue that – even if this may be true in the short-run – such a reasoning does not hold in the long-run because it fails to address the primary issue of market power: since players abusing their dominant position genuinely obtain larger revenues than those who cannot or do not abuse, a paid-as-bid remuneration scheme impedes stronger competition to emerge.

This latter reasoning is also reflected in the fundamental assumption on which deregulation itself was predicated, namely that the wholesale electricity market is - or at least can become - effectively competitive, and that **bidding competition is notably facilitated by homogeneous remunerations for homogeneous services, as is the case in a marginal pricing scheme**. The market is therefore more attractive for smaller participants or new entrants under a paid-as-cleared, which in turn increases competition and reduces market power.

However, in order to trigger bidding competition, first a sufficient number of participants needs to be present in, or at least easily able to enter, the market. This is why the adoption of a paid-as-cleared mechanism becomes more relevant when other entry barriers are sufficiently low and when there is already a certain level of competition. This will be rediscussed more extensively later.

Irrespective of market power, **a decent level of liquidity still remains a genuine prerequisite to implement marginal pricing.** This is the case because the absence of a minimal market depth may imply “evitable price spikes” (i.e. spikes caused by a lack of liquidity in the market).

[6] Picture from (Ofgem, Undated)

2.3.3 Long-term incentives

Some authors (Susan Tierney, 2008) also note that the auction design may have unintended consequences for the longer-term investment incentives in different types of technologies. Under a pay-as-bid auction, technologies with low marginal costs may bid more conservatively than technologies with high variable cost. Because low-cost plants earn large margins when they are selected, these plants face a greater (opportunity) cost if their bid is inadvertently rejected due to a price forecast error. To avoid this risk, owners of low-variable-cost technologies may reduce (or shade) their bids below their price forecast. However, systematic bid shading by owners of low-cost technologies creates a new problem: long-run plant revenues and the incentives for development of low variable-cost technologies (e.g. batteries) would be reduced relative to technologies with higher variable costs and lower fixed-costs (e.g. diesel generators). Thus, **a pay-as-bid auction may inefficiently shift the mix of technologies providing the service, by reducing the share of certain cheaper technologies, and increasing reliance on more expensive ones**.

2.4 Theoretical advantages of paid-as-bid

This section presents some of the key theoretical advantages of the paid-as-bid approach. As will be shown, these advantages are not always straightforward in the FRR context, and are not necessarily more advantageous compared to the ones of the paid-as-cleared alternative. However, they may prevail e.g. as long as liquidity and competition remain limited in the FRR capacity market.

2.4.1 Simplicity

The key perceived advantage of paid-as-bid resides in its conceptual settlement simplicity: if they are accepted, bidders are simply paid what they ask for.

However, the alleged simplicity of a paid-as-bid settlement is very often challenged: it may be more complicated to set optimal bid prices such that profit is maximal while the bid price remains low enough to be selected; compared to a paid-as-cleared settlement mechanism where only the limit under which the bids are no longer profitable has to be computed. Either way, the provider must have sufficient information to estimate his own marginal cost or minimum price at which the transaction would become profitable. In addition, under paid-as-bid settlement, the provider also needs to estimate the equilibrium market price to ensure that its own offer is selected and generates a sufficient profit margin.

The paid-as-bid mechanism remains valuable when the determination of a marginal cost is complex for some reason. In a “new electric world” with big portfolios of small units, it is not so clear if setting bid prices is easier with paid-as-cleared than with paid-as-bid, if when placing the bid, the provider or aggregator doesn’t always know which unit(s) will deliver the requested balancing capacity.

2.4.2 Cheaper total sourcing cost

Because by construction paid-as-bid never pays more than the bid price, one may allege – based on intuitive thinking – that the total acquisition cost is lower compared to the alternative (i.e. one model pays “only” the bid prices whereas the other pays more than the bid prices to all infra-marginal bids and the assumption is that some bids will be offered significantly below the final equilibrium price).

This reasoning is unfortunately biased as it ignores that the bid prices in the two models will necessarily be different. Provided that there is sufficient competition, the **paid-as-cleared settlement, at least in theory, drives bid prices**

lower (closer to marginal cost level) and therefore the price of the last selected bid may be lower than in case of paid-as-bid settlement (as shown in Figure 3).

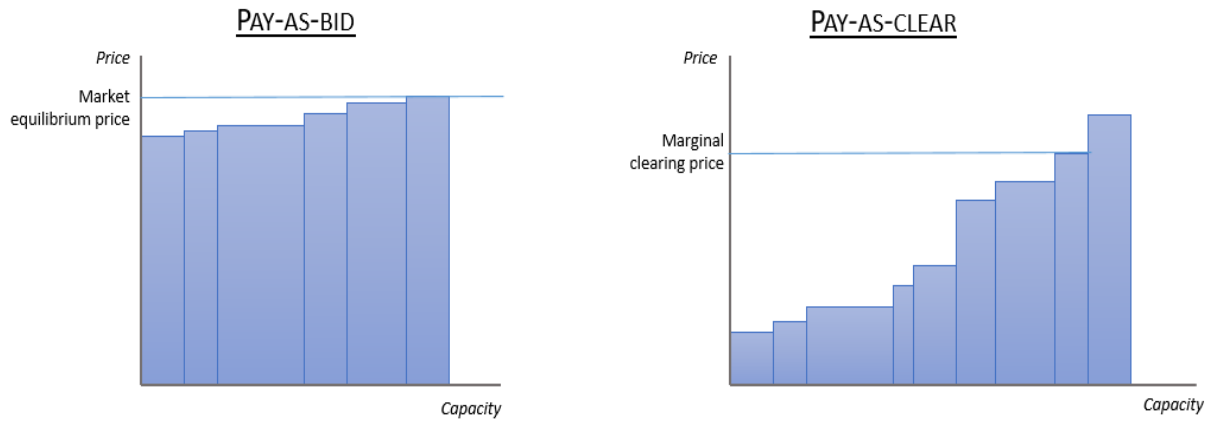


Figure 3 : Example of different pricing leading to different procurement costs

However, it is reasonable to state that – even if mark-ups are lower under paid-as-cleared compared to paid-as-bid, they will not fully disappear (in particular not in a balancing market with dominant positions, uncertainty and potential scarcity situations). It therefore remains quite unknown which settlement principle will deliver the lowest procurement cost in practice. This is a fundamental question which can hardly be answered from a purely theoretical perspective. Generally speaking, it is commonly accepted that low mark-ups only materialize in case of competition pressure. This is why paid-as-cleared requires a minimal level of competition: if bidders expect to be selected anyway and leave bid prices unchanged (especially if this is the case for the marginal bid), implementing a paid-as-cleared settlement scheme will not lead to lower procurement costs.

2.4.3 Heterogeneity

A key advantage of paid-as-bid is that it is a convenient way to remunerate heterogeneous products or services, with the reasoning that products with different characteristics do not necessarily deserve the same price. On the contrary, paid-as-cleared settlement is more appropriate to remunerate homogeneous products. The question is whether this advantage of paid-as-bid is applicable in the studied context.

For FRR provision, the various technologies offering the services can suffer from different technical and economic constraints. This is notably why their marginal costs and bidding constraints differ. However, from the TSO’s perspective, any offer for a given product (such as e.g. upward aFRR) must fulfil the same set of minimal requirements (e.g. availability, ramping rate, …). TSOs – with the purpose to define technology neutral products – do not valorize over-satisfaction of these minimal requirements and, therefore, all bids for a given capacity product can be considered as homogeneous. As a result, there is no argument to remunerate FRR paid-as-bid that relates to heterogeneity.

2.4.4 Volatility

One may also argue that paid-as-bid reduces volatility of prices and of costs because of the natural incentive to bid close to the expected market equilibrium price, multiple bids are priced at similar price levels even though they have significantly different marginal costs. This implies flatter bidding curves, which in turn can lead to reduced volatility and better predictability of prices. Such an argument is, however, more relevant for markets where demand is hard to

predict, which isn’t the case for FRR (characterized so far by a fairly stable demand that is systemically communicated upfront).

Similarly, the cost of procurement may also be less volatile under a paid-as-bid scheme, particularly in case markets are not sufficiently liquid. Due to selection of high-priced bids that are neither directly due to a fundamental scarcity or market power issues (but rather to inefficient market functioning caused by other technical, regulatory, operation or practical flaws), the total procurement costs become abnormally volatile and high under paid-as-cleared settlement (as the high price would be paid to all transactions).The effects would be less severe under paid-as-bid since high-prices are only cashed out to the last activated bids.

2.5 Pre-conditions to implement paid-as-cleared

We summarize in this section some key prerequisites to apply an efficient paid-as-cleared mechanism from a theoretical perspective (Chapters 6 and 7 will then compare how the Belgium FRR design satisfies these conditions for aFRR and mFRR respectively).

2.5.1 Merit-order based closed-gate auction

First of all, paid-as-cleared or marginal pricing is a uniform pricing mechanism. This supposes that the selection of bids and the corresponding clearing price is determined at once, hence via an auction. Although some variants have been explored in other contexts, capacity (or energy) auctions are typically “closed-gate”, meaning that there is a gate-closure time after which all bids are frozen and firm, and that a clearing auction then determines which bids are accepted or rejected.

In principle, under marginal pricing, all the bids which are compatible with the clearing price must be selected, and all the bids which are incompatible with the clearing price must be rejected (see Figure 4). In other words, **the bid selection must respect the merit order, such that all the “in the money” bids are accepted and “out of the money” bids are rejected**. The price is set at the level of the fractionally accepted bid (i.e. the marginal bid, graphically found at the intersection of the offer and demand curves in Figure 4), which is therefore by definition “at the money”.

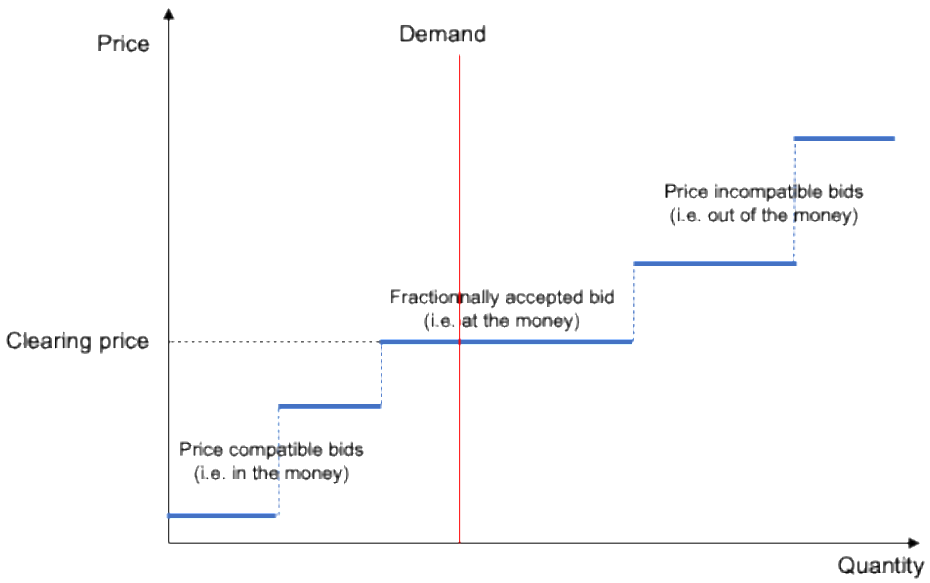


Figure 4: Merit order acceptance of bids under paid-as-cleared settlement

Importantly, “merit order based selection” is typically perturbed in presence of indivisible bids. It might indeed be impossible to find solutions such that (1) all “in the money” bids are accepted, (2) all “out of the money” bids are rejected, and where (3) the fractionally accepted bids set the price. This would, for example, be the case in the above figure if the third bid (the one fractionally accepted) would be indivisible. In such a case, it would either be fully accepted or fully rejected, and there would be no solution respecting these three constraints.

2.5.2 Homogeneity

As mentioned before, remunerating all accepted bids identically (i.e. uniform pricing) supposes a certain level of homogeneity of the service or product represented by the bids, as it wouldn’t make sense to remunerate equally products with fundamentally different appreciable characteristics. On the contrary, paid-as-bid can be used either to remunerate homogeneous or heterogeneous products (in this latter case, a bid with better appreciable characteristics can logically be better remunerated).

Homogeneity is typically ensured in the products’ specifications/requirements**. If all the bids and offers for a given product are deemed indistinguishable, they are by definition homogeneous and therefore compatible with a paid-as-cleared remuneration**.

2.5.3 Liquidity and competition

Generally speaking, markets function more efficiently with a certain level of liquidity and competition.

A shift from paid-as-bid towards paid-as-cleared settlement will have a different impact depending on the level of competition in the market:

- The easier bidding at marginal cost with the knowledge of being remunerated at a higher clearing price (except for the marginal bid of course) would facilitate market participation, especially for small and/or new entrants. This would, in theory, reduce the effects of market power (as the benefit of a high clearing price is shared by all bidders and attracts investments in liquidity) and the increased competition would provide a downward pressure on prices (including the price of the marginally selected bid) and thereby on procurement costs.
- However, if entry barriers remain or if the lead time is long between the moment that the investment signal is given and the new capacities come to the market (because it takes time to create or expand a portfolio of flexibility), then there is a risk that high prices remain for a longer time. Procurement costs would therefore remain high (even higher than under a paid-as-bid mechanism) due to inertia in developing increased levels of liquidity and competition.

Therefore, for the society to grasp the benefits of paid-as-cleared settlement, **a minimum level of liquidity and competition must already be present or must be achievable relatively rapidly after the introduction of a paid-as-cleared mechanism (i.e. limited entry barriers).**

2.6 Summary

From a pure theoretical point of view of perfect competition theory (which holds unrealistic assumptions; §2.2) paid-as-cleared and paid-as-bid deliver the same results. The question studied in this document focuses on the well-functioning and the attractiveness of the market, because a liquid and competitive market is in Elia’s view the best way to strive for a good service level at a fair societal cost.

In markets that are not perfectly competitive (as the balancing market) two main aspects justify the choice for either a paid-as-cleared or a paid-as-bid mechanism, namely the type of product(s) and the level of liquidity and/or competition in the market.

Paid-as-bid is often used in contexts where offers are heterogeneous (where different level of service are paid differently). The balancing market, however, aims for standardized products with a set of minimum requirements that all offers must abide (homogeneity). TSOs do not valorize over-satisfaction of those requirements but they may define different products (with different requirements) to attract more liquidity into the market if needed. The existence of different products with different requirements could justify a paid-as-bid remuneration or a paid-as-cleared remuneration with a different clearing price per product type.

Paid-as-cleared attracts competition through the facilitation of market entry (all accepted bids are remunerated equally). Bidding under paid-as-cleared is relatively easier, as it leans on the marginal cost theory, and is thereby likely to provide more efficient bid selections in case of uncertainty (§2.3.1). By definition, it also ensures that all products are remunerated equally, which ensures a better level playing field for all participants and calls for more competition and liquidity (§2.3.2). In the long-run, paid-as-cleared provides better investment incentives and is likely to lead to a better technology mix (§2.3.3).

Although paid-as-bid in principle may at first glance appear as easier (§2.4.1) and leading to a lower societal cost (§2.4.2), such arguments are not necessarily correct, as – in case liquidity and competition are putting pressure on bid prices – paid-as-cleared remuneration is expected to lead to cheaper procurement costs. A paid-as-bid settlement mechanism can on the contrary keep the FRR procurement costs less volatile. As will be shown later, the FRR capacity design has been recently upgraded with the objective to limit as much as possible technical, regulatory or other barriers, while transparent and stable TSO needs reduce the risk of volatility on the demand side. Though, the benefits of these upgrades have not necessarily yet fully materialized.

Paid-as-clear settlement applied to FRR procurement auctions appears, in theory, as a more open mechanism which facilitates the arrival of new entrants and stimulates competition. Paid-as-cleared therefore is a desired settlement mechanism, but only provided a sufficient level of liquidity and competition pre-exist in the market (as otherwise there might be insufficient competitive pressure to reduce bid prices and only bid marginal costs).

Implementing a paid-as-cleared settlement scheme thus requires a number of pre-conditions to be met (§2.5), which relate to the procurement mechanism (merit order auction), the product definition (homogeneity) and – most importantly – pre-existing liquidity and competition. It therefore must be analyzed whether these requirements are met (see below).

3. COST STRUCTURE OF BALANCING CAPACITY

This chapter describes the theoretical cost structure of assets to offer FRR capacity (which occurs before the closure of the day-ahead market), with the purpose to clarify the notion of “marginal cost” for balancing capacity.

3.1 Marginal capacity cost and short-term energy costs

3.1.1 Definitions

Marginal cost for energy is a typical notion in the power sector, where it traditionally refers to the fuel cost necessary to produce one additional unit of energy, and is therefore a rather straightforward theoretical concept (although it is in practice often not so obvious to determine, e.g. for less traditional assets such as storage or demand management, or for any costs which potentially add up to the fuel costs).

The marginal cost for offering one additional unit of FRR capacity is a less obvious concept than the marginal cost of energy (although it is directly impacted by the cost and price of the energy). To further elaborate this notion, let us first define the following terms:

- By “**marginal FRR capacity cost**”, we refer in this document to the marginal cost for the provision of one additional unit of FRR capacity. There exists a distinct marginal cost for upward and downward FRR capacity.
- By “**short-term energy cost”** we mean, for electricity production assets, the marginal cost for the additional production of one energy unit or in other words, the price at which the provider is willing to supply energy. For electricity consumption assets, the “short-term energy cost” refers to the marginal opportunity loss for non-consuming one additional energy unit[7] or in other words, the price which the electricity consumer is willing to pay for the energy.
- By “**stand-by costs**”, we refer to costs incurred to ensure assets are ready to produce or consume FRR energy when activated. This may imply start-up costs and costs to produce or consume at a minimum power level.

3.1.2 Relations between marginal capacity cost and short-term energy cost

Generally speaking, reserving FRR capacity – whether upward or downward – implies that the provider’s choices whether or not to deploy this capacity in the spot markets are being reduced. The reservation of FRR capacity may therefore lead to a potential loss for the provider. The provider needs to estimate such losses as input to determine the price of the FRR capacity bid. Such losses are either opportunity costs (e.g. the lost opportunity to make profits in the spot market) or explicit costs (e.g. the need to produce or consume at a loss to maintain the promised capacity).

Let us distinguish the following cases: the determination of the marginal capacity costs is different from the perspective of offering upward or downward FRR services using production assets or consumption assets depending on the position of the asset in the spot markets. As a summary, Figures 5(a-f) visualize the explained reasoning.

[7] Also sometimes referred to as the “willingness to pay” of consumers

Offering upward FRR capacity:

1. **The lower the opportunity costs, the lower the marginal cost.**

All else equal, the lowest capacity bid prices will be offered by **electricity producing** assets that would not otherwise sell energy on the spot markets (i.e. assets for which short-term energy costs > expected market price, also referred to as “out of the money” assets). Any costs related to actually increasing production in real-time, would be included in the price for activation of FRR energy.

Production assets which are deeply “in the money” (i.e., which are expected to sell energy on the spot markets because their short-term energy costs are below forecasted market prices) are expected to be producing at their maximum output and thereby generating profits. Offering upward capacity implies that these assets would have to decrease their output purposefully if they are selected, and thereby imply an opportunity cost due to the lost profits. The larger the lost profits, the higher the opportunity cost and therefore the higher the marginal capacity cost.

The lowest capacity bid prices will be offered on **electricity consuming** delivery points that would buy energy on the spot markets (high willingness to pay). As these consumption assets would already be consuming based on spot market opportunities, reserving upward capacity does not lead to any substantial cost: no stand-by costs would be incurred to provide upward FRR capacity (i.e. reducing consumption if FRR is activated). Recall that any costs related to lowering consumption, would be included in the price for activation of FRR energy.

2. **Marginal capacity costs increase due to stand-by costs for providing upward FRR capacity.**

If applicable, costs of maintaining a “standby mode” during the contracted period would increase the marginal capacity cost. Indeed, some assets may incur costs to remain ready to deliver FRR capacity and, therefore, may also include these in their marginal capacity costs. For example, slower production assets that need to be spinning to offer FRR capacity due to technical reasons, will include a stand-by costs in their marginal capacity costs in case the expected market prices are not sufficient to cover the cost of the fuel necessary to reach these technical levels.

Consumption assets not planning to consume due to too high spot prices (and therefore having no opportunity costs) would incur additional costs if they would need to consume merely to provide the upward FRR services (i.e., requiring them to lower consumption for balancing purposes). Such stand-by costs for consumption (or “must-consume” cost) would increase the capacity bid prices offered.

In addition, errors in forecasting the spot markets may make it difficult to correctly estimate the marginal capacity costs. In case of assets that are slightly in or out of the money (i.e. assets with short-term energy costs that are close to the expected electricity market prices), a wrong estimation of the spot markets could lead to an underestimation of the opportunity costs and thereby of the marginal capacity cost. For consumption assets, uncertainty on the spot markets would result in questions whether or not to include a stand-by cost. For these reasons, providers may include a risk premium to cope with this uncertainty.

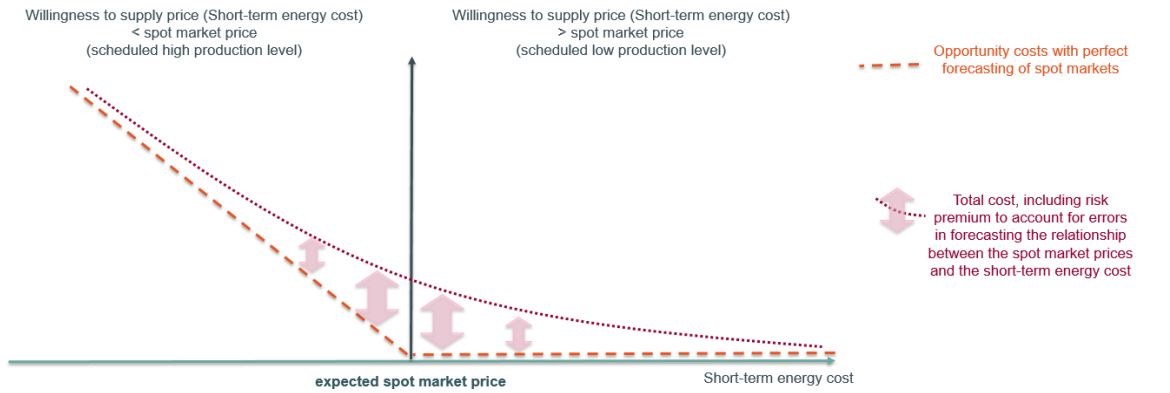
Offering downward FRR capacity:

A similar reasoning can be applied to determine the marginal capacity cost for offering downward FRR capacity. Providing downward capacity from production assets supposes a certain level of pre-existing output. Deeply in the money production assets have little additional cost for offering downward balancing capacity as they are either way producing at their maximum capacity. Out of the money production assets will logically require to be compensated for the losses caused to deliver the output necessary to be able to offer downward capacity (which may include start-up and/or must-run costs related to minimum production levels that must be achieved to be ready for downward activation). Such stand-by costs justify that downward marginal costs are higher for more out of the money production assets.

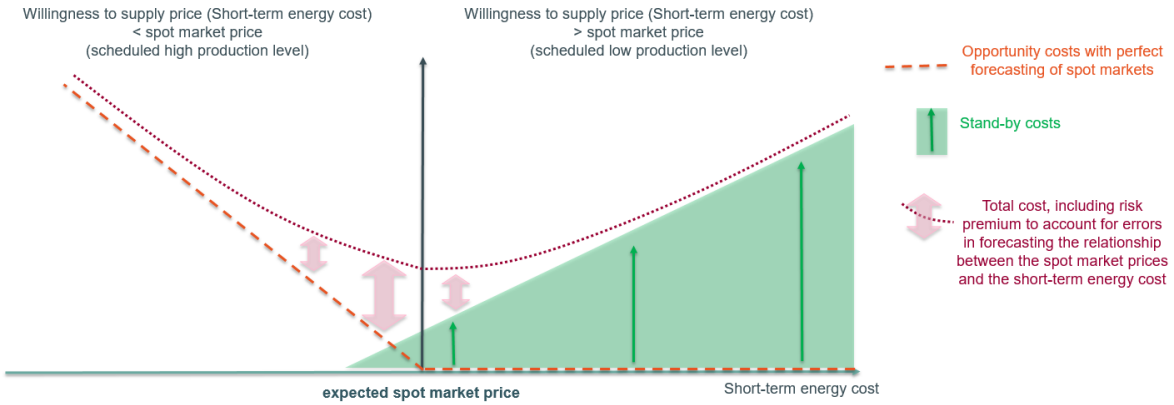
Assets scheduled to consume little to no electricity and that would not incur costs for being ready to increase their consumption would also offer FRR capacity at a low marginal cost.

Consumption assets with a high willingness to pay for electricity compared to the spot prices require a high compensation to make downward capacity available as it implies that they need to consume less (in order to be able to increase their consumption upon request). The marginal capacity cost for downward FRR capacity on consumption assets could increase in case a stand-by cost would be applicable or if the provision of FRR capacity would imply opportunity losses in the spot markets.

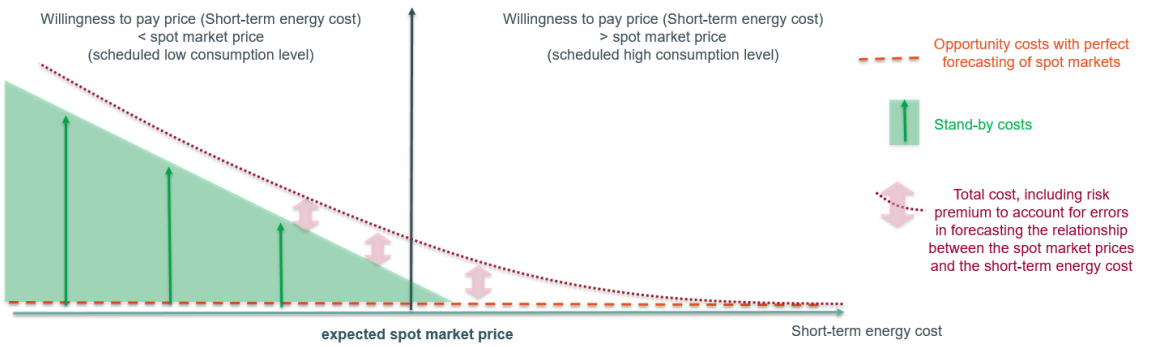
In addition, providers may include a risk premium to cope with the risk of price forecasting errors.



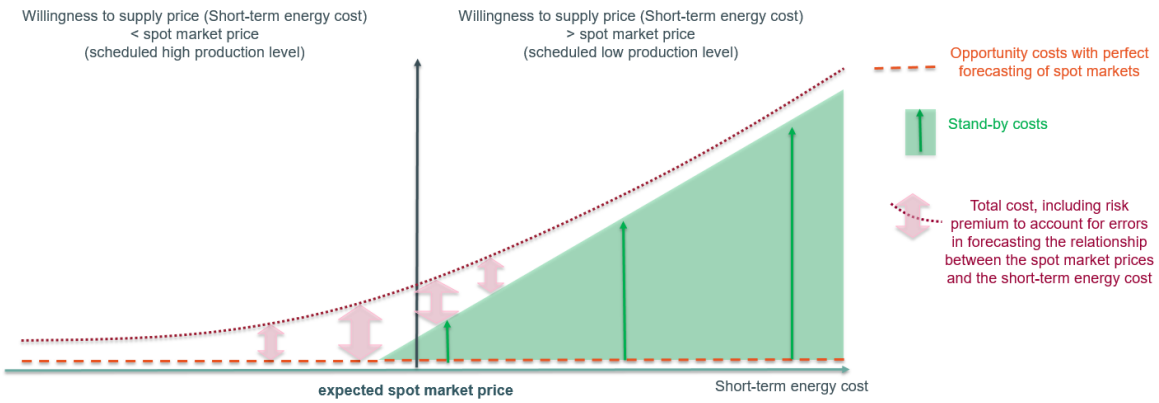
5a. Marginal cost of upward FRR capacity on production assets (without stand-by costs)



5b. Marginal cost of upward FRR capacity on production assets (with stand-by costs)

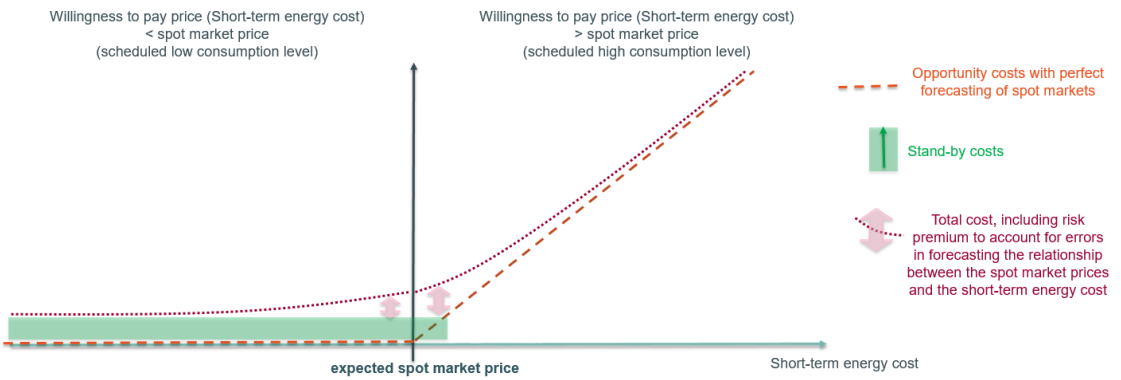


5c. Marginal cost of upward FRR capacity on consumption assets



5d. Marginal cost of downward FRR capacity on production assets

5e. Marginal cost of downward FRR capacity on consumption assets (without stand-by costs)



5f. Marginal cost of downward FRR capacity on consumption assets (with stand-by costs)

Figure 5: schematic representation of the marginal cost of FRR capacity as a function of expected power prices relative to short-term energy cost

3.2 Summary

The notion of “marginal cost” for FRR capacity is less straightforward than for energy, because the capacity value depends on the relation between the expected spot power prices and the short-term energy costs (i.e. the avoidable/marginal costs for the production, or the “willingness to pay” for demand). Bottom line, it shows that the capacity is the cheapest if the asset is already planning to reach the desired setpoint based on the expected market prices. If not, the capacity price will be increased due to the inclusion of stand-by costs.

4. DESCRIPTION OF THE CURRENT BELGIAN MECHANISM

FRR is split into two markets: reservation and activation. Close to real time, Balancing Service Providers (i.e. BSPs) submit FRR energy bids that the TSO can activate to restore balance. Such bids are either “free bids” (non-contracted capacity) or energy bids from contracted “FRR capacity”. The TSO indeed secures a minimum volume of FRR energy bids in real-time by reserving FRR capacity. The FRR capacity market therefore is a market ahead of real-time where the TSO acts as a single buyer and remunerates awarded BSPs for the obligation to submit energy bids equivalent to the procured capacity during the contracted period. Since 2020, FRR capacity in Belgium is procured daily via the auction procedures described below.

Participation to FRR capacity products is voluntary, although production assets and storage units larger than 25 MW (types C&D as defined in Article 226 of the Federal Grid Code) are in any case obliged to put their spare UP or DOWN active power at the disposal of Elia for balancing purposes. Concretely this means the available active power on these units is to be submitted in the form of energy bids, even if the capacity was not contracted in an FRR auction.

FRR can be distinguished between reserves with automatic activation (aFRR) and reserves with manual activation (mFRR). aFRR is activated automatically and in a continuous manner. aFRR is thus by its nature more deeply integrated within the TSO systems. The aFRR activation signal varies constantly, and aFRR resources should be able to constantly ramp up or down, with a full activation time (i.e. the time necessary to deliver the entirety of the bid volume) of 7,5 minutes.[8]

mFRR is activated manually by the system operator to cope with more severe or longer lasting imbalances. Contrary to aFRR, mFRR is activated at least per quarter-hour and currently requires a full activation time of at most 15 minutes.[9]

All FRR products are designed to be technology neutral.

4.1 Description of aFRR procurement in Belgium (as of 30/09/2020)

While aFRR capacity was previously acquired on a weekly basis (and together with FCR until 1/7/2020), it is procured daily as of delivery on 30th September 2020. This section uses the aFRR procurement design applicable at the end of 2020 as basis for further reflections.

4.1.1 Product mix

Elia currently has two capacity products: upward and downward aFRR, applicable to Capacity Contracting Time Units (CCTU) of 4 hours. For a given day, these products are auctioned at two different moments, with slightly different auctioning rules:

- Daily procurement in D-1 at 09:00 (“**per CCTU auction**”)

  A total of 12 independent auctions are run simultaneously: one auction for upwards aFRR and one auction for downward aFRR for each of the 6 CCTUs of the day. Each bid is defined for a direction and a CCTU, and consists of a price-quantity pair where quantities are always fully divisible.

[8] In accordance with article 3(8)(g) the Implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation, the maximum ramping period shall be 5 minutes by 18 December 2024.

[9] In accordance with article 2(1)(v) the Implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with manual activation, the maximum ramping period shall be 12.5 minutes by 24 July 2022.

- Daily procurement in D-2 at 16:00 (“**all CCTUs auction**”)

  A single procurement mechanism is run for all upward and downward aFRR CCTUs of the day after the next one (D+2). Each bid includes one price and two volumes (one for upward and one for downward capacity - which can also be zero for one direction in case of asymmetric bids). The provided volumes are always indivisible and apply to all CCTUs (i.e. for the 24 hours of the delivery day) of the respective direction. Bidders in this auction may submit multiple mutually exclusive bids (i.e. different sets of volumes and prices, for which at most one set can be accepted).

  To avoid that one indivisible bid overtakes all the capacity demand, so-called “bidding obligations” are imposed: a bidder willing to offer more than 5MW of aFRR in one direction has the obligation to complement its bid with additional mutually exclusive bids in smaller steps of at most 5MW. For example, if a bidder wants to offer 20 MW aFRR UP and DOWN, it must also submit at least 4 additional bids with e.g. [5 MW Up, 5 MW Down), [10 MW Up, 10 MW Down], [15 MW Up, 15 MW Down], in addition to its bid [20 MW Up, 20 MW Down].

  Further, the bidder has also the obligation to offer its volume asymmetrically, again in steps of at most 5 MW. In the example above, it therefore also must submit additional bids such as for instance [5 MW Up, 0 MW Down], [10 MW Up, 0 MW Down], [15 MW Up, 0 MW Down], [20 MW Up, 0 MW Down], [0 MW Up, 5 MW Down], [0 MW Up, 10 MW Down], [0 MW Up, 15 MW Down] and [0 MW Up, 20 MW Down].

  The total cost of a bid should never exceed the total cost of a bid with larger offered volume.

The long-term goal is to decrease the amount of aFRR capacity procured in D-2 and to shift the volume to the D-1 process (cf. the description of the rule to apportion volume to be procured between both auctions below).

4.1.2 Procurement

The first “all CCTUs auction” (D-2 at 16:00) thus combines symmetrical and asymmetrical bids with constant volumes per direction over the 6 CCTUs (i.e. for the 24 hours of D+2). The matching algorithm selects among all available bids the set that satisfies at least the requested volume for this auction such that the total procurement cost is minimized.

In the “per CCTU auction” (D-1 at 09:00), upward and downward products are fully separated (asymmetrical procurement only) and the volumes for each CCTU are fully independent. The auction selects the bids based on their merit order. Because all bids are divisible, the merit order selection is fully equivalent to a welfare maximization or to a cost minimization.

4.1.3 Volumes to be procured

The total aFRR need is currently determined on a yearly basis and remains fix during this period (e.g. 145 MW for 2020)[10]. The total volumes to be procured for each product is published by Elia on D-3 at 16:00.

The rule to apportion the total aFRR need between the “all CCTU auction” and the “per CCTU auction” for day D is meant to gradually increase the share of aFRR capacity auctioned per CCTU – as it is considered as more open to competition / more technology neutral. The splitting mechanism though keeps control over the procurement prices during the transition phase as it only releases more capacity in the “per CCTU auction” (by steps of at most 4MW) if

[10] Elia also investigates the opportunity of a daily sizing of aFRR needs – see (Elia, 2020)

the “per CTTU auction” prices do not exceed by more than 20% the prices of the “all CCTU auction”. The details of the apportioning method can be found in Annex 7 of the T&C aFRR BSP (Elia, 2020) and are summarized in footnote[11].

Note however that consequently to the bidding behavior observed in the second half of October 2020 during the aFRR capacity auctions, Elia and the CREG decided to apply as of the delivery date of 25 October 2020 a protective measure aiming at better aligning the aFRR capacity auction design with market circumstances. The volume demand to be procured in the per-CCTU auction has been capped to the total prequalified aFRR volume corresponding to delivery points DPpg (“non-CIPU”). In consequence, all remaining aFRR capacity has been procured in the first step of the aFRR capacity auction (“all-CCTU capacity auction”). The process to update the BSP Contract aFRR accordingly was ongoing at the date of submission of this report

4.1.4 Rationale of the approach

This 2-steps approach is proposed as an interim solution. The target is to remain, in the long-run, exclusively with the ”per CCTU auction”: asymmetrical procurement of aFRR on a daily basis, the day-ahead delivery, via 4-hours products, with selection of bids according to their merit order. This target is fully compliant with Article 32 of the EBGL (European Commission, 2017) and Article 6(9) of the Electricity Market Regulation (European Commission, 2019) and is seen as more suitable to attract new technologies/players in the aFRR market.

However, Elia requested a temporary exemption for a delayed implementation of the Guidelines’ rules, conform with its Article 32(§3), in order to ensure a smooth transition towards this target. The reasoning held to request and implement such an interim solution has been based on the fact that historically, the aFRR market has been exclusively fulfilled by CCGTs, and that the previous market design was particularly well-suited for the specific needs of this type of assets. The following principles were therefore considered:

- Impact on the aFRR cost: The cost of the new aFRR design should remain acceptable (compared to today’s budget). Therefore, cost risks should be mitigated where possible.
- Attractiveness for new technologies: Enable new entrants (i.e. using other technologies than CCGTs) to become active on the aFRR market with small volumes and become selected in case they offer competitive prices.
- Transparency: The price formation and selection criteria should be transparent in order to facilitate bidding competition.
- Complexity: The capacity tendering procedure should be organized each day in a period of 30 minutes. Therefore a robust and performant tendering process is required.

[11] The volume for the “all CCTU auction” to be procured in D-2 is the difference between the total aFRR need and the volumes for the “per CCTU auction” to be procured in D-1. The “per CCTU auction” volumes to be procured in D-1 are computed per direction in accordance the following procedure: (1) A “rolling horizon period” is defined as the 7 auction days period preceding the volume publication (i.e. between D-9 and D-3). (2) For each CCTU within this “rolling horizon period”, Elia determines for each direction the volume of “per CCTU” aFRR bids which are at a price below 120% of the price of the most expensive accepted “all CCTU” bid for the same day. (3) Elia then computes the average of these volumes (per direction) over the rolling horizon period. (4) If this averaged volume is lower than 10MW in one direction, then Elia procures 10MW in D-1 in this direction (10 MW is the absolute minimum volume for per CCTU procurement). If this averaged volume is lower (respectively larger) by more than 4 MW than the volume procured during the last per CCTU auction – i.e. auction in D-3 for delivery on D-2 – then the volume procured in the upcoming per CCTU auction equals the volume of the last per CCTU auction minus (resp. plus) 4 MW. Otherwise (i.e. if this average volume does not vary by more than 4MW compared to the last per CCTU auction), this averaged volume is procured in the upcoming per CCTU auction

Indeed, at the beginning of the opening of the aFRR market to all technologies as of the end of September 2020, CCGTs were still expected to be indispensable for the delivery of the aFRR services. Though, CCGTs have a specific cost structure which include fixed startup and other must-run costs. Startup costs only need to be recovered once for CCGTs to provide FRR services. Therefore, it is preferable to allow aFRR bidders with CCGT assets to offer as much FRR capacity as possible at once, in order to spread these fixed startup and must-run costs over larger volumes. This is why “all CCTU auctions”, where it is possible to offer 24-hours symmetrical capacity with indivisible volumes, are temporarily maintained. Otherwise, i.e. with only “per CCTU auctions” with divisible bids, aFRR bidders with CCGT assets may have to bid at higher prices in order to recover their fixed costs through independent per CCTU bids. In general, fixed costs are better managed with indivisible bids spanning over sufficiently long periods of time and for large volumes (incl. possibly in both directions).

This interim procedure therefore intends to attract new technologies in the aFRR market, while keeping the possibility to source aFRR from CCGTs at reasonable cost in the meantime.

4.1.5 Settlement

The remuneration for aFRR capacity is currently paid-as-bid for all products. It is precisely the objective of the current study to envisage a shift towards a paid-as-cleared remuneration of aFRR capacity bids.

4.2 Description of mFRR procurement in Belgium (as of 4/2/20)

Let us describe the way mFRR has been procured since 3rd February 2020 (for delivery on February 4th). While it was previously acquired via monthly auctions, mFRR is nowadays procured daily, at 10:00 of the day ahead of the concerned contracted period (i.e. D-1). The procurement results are available at 10:30.

4.2.1 Product mix

Elia currently has two capacity products for upward mFRR[12]: mFRR Standard and mFRR Flex. The main differences are that for mFRR Flex there is a neutralization time of 8 hours between two energy activations (no neutralization time for mFRR Standard) and the maximum period of subsequent energy activations is 4 hours (no maximum for mFRR Standard).

Considering the lower certainty of availability of mFRR Flex during the contracted period (as they are not available if in neutralization time) Elia procures a minimum amount of the mFRR Standard product (in accordance with the LFC Means[13]) while the remaining capacity required for the day is procured as either mFRR Standard or mFRR Flex.

4.2.2 Procurement mechanism

For the procurement of mFRR Capacity Elia currently organizes 6 simultaneous auctions on day D-1 for delivery during a specific contracted period of 4 hours on day D. Each auction consists of two steps:

- In the first step, Elia procures a minimal volume of mFRR standard (see §4.2.3);

[12] Elia has no capacity products for downward mFRR capacity.

[13] (Elia, 2019)

- In the second step, Elia procures either mFRR Standard or mFRR Flex to cover the rest of Elia’s mFRR balancing capacity (calculated dynamically for the concerned delivery period of 4 hours).

For this second step, the mFRR standard capacity bids not selected during the first step are put in competition with the mFRR flex bids for the remaining volume of reserves which need to be procured.

BSPs participating to mFRR auctions can thus provide three types of bids:

- An mFRR Standard capacity bid with a single price (P1). This price will be used in the merit order of the first and (if not yet awarded) the second step of the auction.
- An mFRR Flex capacity bid with a single price (P2). This price will be used in the merit order of the second step only.
- An mFRR capacity bid with two prices P1 & P2. The first price P1 will be solely applicable to the first step where standard capacity is procured. If the bid remains in the merit order for the second step, then the second price P2 will be applicable and if the bid is awarded in the second step, it is considered as mFRR Flex capacity.

The Figure below illustrates the procurement process by means of an example.

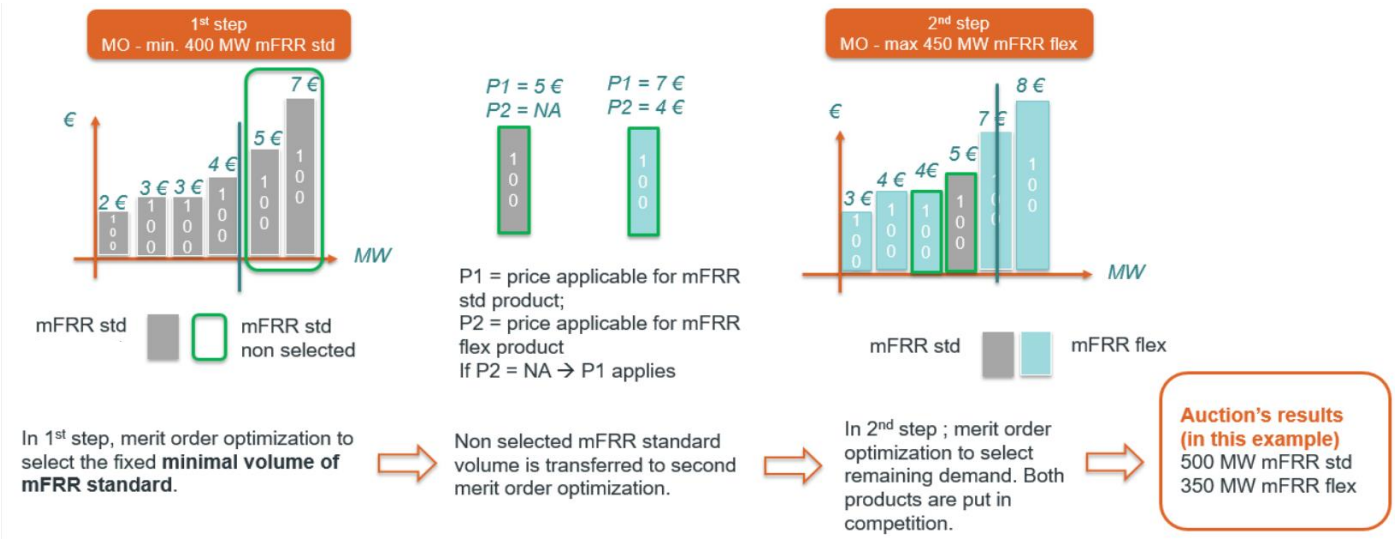


Figure 6 : 2-steps mFRR procurement with bids offering 2 distinct prices for each step

In practice, a significant proportion (33% on average per CCTU) of mFRR Standard volume is submitted with an alternative Flex P2 price, which represents on average 364MW per CCTU and maximum up to 686MW. In 89% of the CCTU there were bids with P1 & P2. When Standard P1 and Flex P2 prices were submitted in the same capacity bid, it was with a price difference: the average price difference was 1,63€, and the maximum price difference 18,46€. For 0,18% of the capacity bids, the P2 price was higher than the P1 price (on in total 7 days). One third of price differences were below 0,90€, half of the price differences were above 1,36€, and 10% were above 2,98€. Although more than 89% of the awarded capacity stemming from such bids with 2 prices were with the P1 of mFRR Standard capacity, mFRR Flex was also awarded regularly.

Each bid for these products consists of a price-quantity pair, which is fully divisible. An accepted bid leads to the right to receive a remuneration in exchange of the obligation to submit the corresponding amount of upward mFRR energy bids during the concerned contracted period.

The target is to eventually eliminate the need of the second step and solely keep the “standard mFRR” capacity product. These standard products are fully compliant with the requirement of standard balancing products in accordance with

the methodology on list of standard products for balancing capacity for frequency restoration reserves and replacement reserves in accordance with Article 25(2) of the Guidelines (European Commission, 2017).

Importantly, the selection of the bids in each step is made on a merit order basis, but – because there are two distinct steps – it is in principle possible that an mFRR Flex capacity bid is not selected despite the fact that mFRR Standard bids at higher prices have been selected. This would be due to the fact that these flex bids are not present in the step1.

4.2.3 Volumes to be procured

The volumes to be procured are published by Elia in the morning (around 7:00 am) of the day of the auction when the results of the dynamic dimensioning methodology are known. In accordance with the LFC Means (Elia, 2019), Elia procures the following volumes:

- As of 3rd February 2020 (start of daily procurement), a minimum of 490 MW of Standard mFRR UP was procured in the first step.
- As of July 2020, this minimum volume of Standard mFRR UP has been increased to 640 MW.

In accordance with the amended LFC Means approved by the CREG on 17 December 2020[14] the proportion of positive sharing capacity will increase from 50 to 250MW in the dimensioning of the reserve capacity for delivery as of 7 January 2021. Thereby, all else equal, the total mFRR capacity that will be procured daily will decrease. The minimum volume of Standard mFRR UP has not changed.

Further adjustments will be decided later, based on observed experience, with the objective to procure exclusively mFRR Standard products in the long run.

4.2.4 Settlement

The remuneration for mFRR capacity is currently paid-as-bid. It is precisely the objective of the current study to investigate a shift towards a paid-as-cleared remuneration of mFRR capacity bids.

4.3 Summary

aFRR and mFRR are currently settled on a paid-as-bid principle (unlike FCR and DA markets – not discussed in this paper – which are already settled based on a uniform marginal price).

All aFRR and mFRR capacity is procured on a daily basis – the day ahead of the delivery except for the first aFRR auction which is run in D-2. This first aFRR auction is meant to be a temporary scheme that facilitates the transition towards the new aFRR design where only the “per CCTU auction” will remain. mFRR is also procured in two steps. These two steps are run sequentially during the same process: the first only considers standard bids to satisfy the minimum requested mFRR Standard volume, and the second also considers flex bids for the remainder of mFRR capacity. The objective is to only procure mFRR Standard product in the future.

[14] More information is available on the consultation web page: https://www.elia.be/en/public-consultation/20201008-public-consultation-on-a-modification-of-the-methodology

5. HIGH-LEVEL COMPARISON OF FRR PROCUREMENT IN EUROPE

5.1 Overview of current FRR capacity procurement and settlement in Europe

Both the Electricity Guidelines (European Commission, 2017) Article 32.2.a and the Electricity Market Regulation (European Commission, 2019) Article 6.8 call for market-based procurement of FRR capacity without specifying the exact settlement mechanism. An overview of the designs for aFRR and mFRR Procurement across European TSOs in 2019 (see (ENTSOE, 2020) survey on Ancillary Services in Figure 7) shows that both the market-based paid-as-bid and paid-as-cleared mechanisms exist in addition to the use of a regulated price in some countries. The evolution away from regulated prices in some countries is to be expected in the near future for compliance with the European regulation, but a mandatory choice towards either paid-as-cleared or paid-as-bid remuneration is less clear for TSOs.

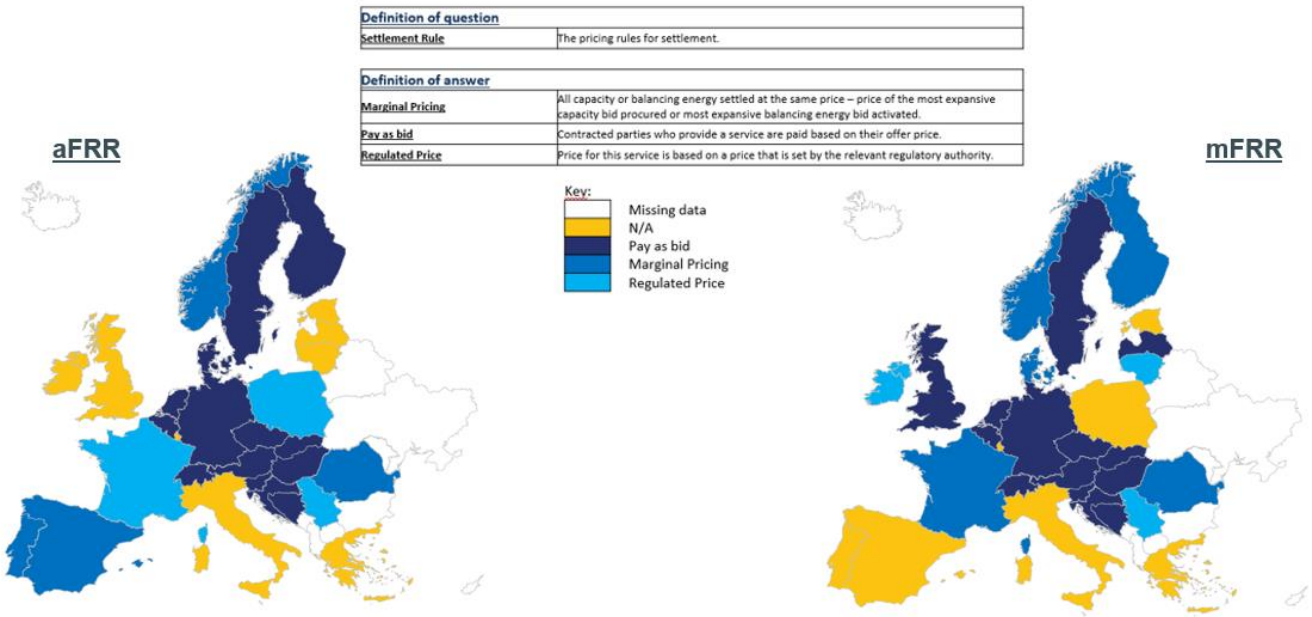


Figure 7 : overview of aFRR and mFRR capacity settlement per country (Source ENTSOE 2020)

5.2 Elia’s survey on future changes in FRR capacity settlement in Europe

5.2.1 Paid-as-bid or paid-as-cleared

In addition to the ENTSO-e survey on ancillary services, Elia performed a separate survey questioning some TSOs on their plans to change the design of balancing capacity in the near future and, in the relevant case, on the TSO’s experience with the paid-as-cleared remuneration scheme.Figure 8 shows the overview for each country of the current remuneration scheme(s) and the planned changes in design (if any).

	aFRR capacity		mFRR capacity	
Elia (Belgium)	Paid-as-bid →	[Analyzing]	Paid-as-bid →	[Analyzing]
50Hertz (Germany) APG (Austria) TenneT (Netherlands)	Paid-as-bid	Currently no plans to change	Paid-as-bid	Currently no plans to change
CEPS (Czech Republic)	Paid-as-bid	[Analyzing]	Paid-as-bid	[Analyzing]
RTE (France)	Regulated price	**Paid-as-cleared**	**Paid-as-cleared**	
NGESO (England)	/ (no aFRR)		Paid-as-bid (monthly auction) Paid-as-cleared (trial weekly auction)	Currently no plans to change
Energinet (Denmark) Fingrid (Finland)	Paid-as-bid	**Paid-as-cleared**	**Paid-as-cleared**	
Statnett (Norway)	**Paid-as-cleared**		**Paid-as-cleared**	
REN (Portugal) REE (Spain)	**Paid-as-cleared**		/ (no mFRR capacity product)	
Swissgrid (Switzerland)	Paid-as-bid	Currently no plans to change	Paid-as-bid	Currently no plans to change

Figure 8 : overview of the responses of Elia's survey

Elia contacted 12 TSO's in Austria, the Czech Republic, Denmark, Great Britain, Finland, France, Germany, the Netherlands, Norway, Portugal, Spain and Switzerland.

- France will replace the regulated price for aFRR capacity by a paid-as-cleared remuneration to ensure compliance to the Electricity Market Regulation (calling for a market-based procurement). mFRR capacity in France is already remunerated paid-as-cleared.
- The NORDIC countries are all planning a change to paid-as-cleared if it is not yet the current remuneration mechanism in preparation of balancing capacity cooperation in the region applicable to both aFRR and mFRR.
- Portugal and Spain already remunerate aFRR capacity paid-as-cleared (there is no mFRR capacity procurement). In Portugal the paid-as-cleared remuneration was introduced at the start of the balancing capacity market; in Spain the change from paid-as-bid to paid-as-cleared was introduced more recently with positive experience.
- Other TSOs currently have no plans to change from paid-as-bid to paid-as-cleared remuneration, although in the Czech Republic the TSO CEPS is assessing whether a design change would be interesting.

5.2.2 Experiences with paid-as-cleared remuneration for FRR capacity

Elia asked the TSOs that currently remunerate FRR capacity paid-as-cleared about their experience compared to former paid-as-bid remunerations. The TSOs from Norway and Portugal could not share feedback as they remunerate paid-as-cleared from the start of the balancing capacity market and can therefore not make the comparison. **The feedback given by the TSOs from Spain, Denmark, Finland and France confirmed the advantages of a paid-as-cleared mechanism as identified in the economic theory:**

- In Denmark there are currently two mFRR capacity products: the daily product is highly competitive and remunerated paid-as-cleared, while the 5-year contract has low competition and is paid paid-as-bid. The mFRR capacity is selected based on the merit-order of the individual capacity bids. In 2021 the 5-year contracts will be replaced by monthly procurement with also a paid-as-cleared remuneration. Energinet decided for this evolution in the opinion that paid-as-cleared remuneration triggers competition by attracting capacity due to the smaller need for market knowledge and the fair remuneration.

- In Finland since 2019 mFRR capacity is remunerated paid-as-cleared. The TSO Fingrid observed a large impact on the (formerly small) market: new players entered the market and the increased competition significantly reduced the prices.
- In France, the TSO RTE experiences a strong decrease in its procurement costs of mFRR capacity after introducing paid-as-cleared remuneration. RTE points out that paid-as-cleared remuneration is a more favorable mechanism for providers, thereby attracting new market players.
- In Spain aFRR capacity is remunerated paid-as-cleared (there is no mFRR capacity market). The TSO REE is convinced that a paid-as-cleared approach is most efficient in a sufficiently liquid market as providers can bid at prices close to the marginal cost. REE points out that in a paid-as-bid scheme setting the bid price is more difficult.

The Swiss TSO Swissgrid experienced the disadvantages of paid-as-cleared remuneration in a market with a lack of liquidity. In 2009 the Swiss FRR balancing capacity market opened with a paid-as-cleared remuneration scheme, but Swissgrid changed the remuneration to paid-as-bid after a couple of months: the capacity prices were very high, probably due to a lack of liquidity in the market. Because of this experience at this moment Swissgrid is not considering changing the remuneration of FRR capacity. Swissgrid acknowledges the advantages a paid-as-cleared remuneration scheme can bring but points out that the advantages can only prevail in the market if there is sufficient liquidity.

In Austria, Germany and the Czech Republic the TSOs are satisfied with the current paid-as-bid mechanism (although the Czech TSO CEPS is investigating possible changes). A main concern to change to paid-as-cleared is the possible cost increase if the competition is too low.

5.3 FRR capacity exchanges

In accordance with Balancing Guidelines Articles 2(25) and 33 (European Commission, 2017)), European TSO’s may set up cooperations for the exchange of balancing capacity, meaning that a TSO may procure balancing capacity from BSPs connected in a different scheduling area. Availability of cross-border capacity and compliance with operational security requirements should, however, be ensured. To do so, TSOs will likely reserve cross-zonal capacity and will therefore have to comply with the (future) methodologies for allocation of cross-zonal capacity for the exchange of the balancing capacity or the sharing of reserves in accordance with Articles 40, 41 and 42 of the EBGL (European Commission, 2017). For market-based allocation of cross-border capacity in the CORE region (for which an amended methodology proposal has been submitted for regulatory approval in December 2020 in accordance with EBGL article 41) the TSOs proposed that the target remuneration model for balancing capacity cooperations is paid-as-cleared and that during a transitory period a paid-as-bid remuneration scheme would remain acceptable.

5.4 Existing and planned exchanges of FRR capacity in Europe

Currently the TSOs in **Germany and Austria** are involved in a cooperation for the exchange of aFRR capacity. The aFRR capacity is procured daily based on a merit-order selection with a paid-as-bid remuneration.

In the **NORDIC region** the TSOs will establish two cooperations for aFRR capacity and for mFRR capacity in the coming years. The capacity would be procured daily based on a merit-order selection with a paid-as-cleared remuneration.

Other European TSOs in Elia’s survey are currently not actively investigating opportunities for FRR capacity exchange.

A precondition for FRR capacity exchanges is that the design for FRR capacity is harmonized across the participating TSOs. A high-level overview of the FRR capacity designs in the CORE countries surrounding Belgium (see Figure 9) shows that some design harmonization is still needed before considering cooperations. A further redesign of the Belgian aFRR (with full aFRR capacity procurement on day D-1) would be needed before Elia could join the existing German-Austrian cooperation for aFRR capacity.

Design changes in France and the Netherlands, especially the introduction of daily procurement, are also needed before cooperations for aFRR or mFRR capacity could be considered.

	aFRR capacity				mFRR capacity			
	Remuneration	**Time of procurement**	**Selection of capacity bids**	**BSP Participation**	**Remuneration**	**Time of procurement**	**Selection of capacity bids**	**BSP Participation**
Elia (Belgium)	Paid-as-bid	‘Daily’ (D-1 + D-2)	Total cost optimization (D-2) Merit-order (D-1)	Voluntary	Paid-as-bid	Daily	Merit-order	Voluntary
50Hertz (Germany)	Paid-as-bid	Daily	Merit-order	Voluntary	Paid-as-bid	Daily	Merit-order	Voluntary
RTE (France)	Regulated price => Future: paid-as-cleared	[not relevant: mandatory] => Future: daily auction	[not relevant: mandatory] => Future: market-based	Mandatory primary market / Voluntary secondary market	Paid-as-cleared	Yearly => Future: yearly + daily	Merit-order	Voluntary
TenneT (Netherlands)	Paid-as-bid	Monthly & weekly => Future: daily	Other => Future: possible change	Voluntary	Paid-as-bid	Monthly => Future: daily	Other => Future: possible change	Voluntary

Figure 9 : comparison of FRR procurement in neighboring countries

5.5 Conclusion on possibilities for Elia in the European context

Currently both paid-as-bid and paid-as-cleared mechanisms are applied for the remuneration of aFRR and mFRR capacity in European countries. Paid-as-cleared mechanism have been introduced in the pursuit of, amongst others, increasing the competition level in the national capacity market and thereby reduce costs. Some paid-as-bid mechanisms currently remain in place due to satisfying results and/or uncertainty on market readiness in terms of competition level to change the design (which would result in an unacceptable increase of costs). Current efforts of surrounding TSOs in redesigning FRR markets focus more on energy design (in the framework of the MARI and PICASSO projects) and on legal compliance with regulations applying to balancing capacity markets, rather than on the creation of new cooperation initiatives for the exchange of balancing capacity. Considering the proposed target remuneration model of paid-as-cleared for balancing capacity cooperations in the CORE region, **a design change from paid-as-bid to paid-as-cleared for Belgian aFRR and mFRR capacities should be a no-regret choice**.

6. PAID-AS-CLEARED MODELS FOR AFRR

As described in the current design of aFRR procurement (§4.1), there are currently two auctions executed at different moments to procure aFRR capacity of a given day. This chapter discusses whether the pre-conditions to apply a paid-as-cleared settlement are met in the two auctions and, if so, the possible design based on paid-as-cleared settlement of aFRR balancing capacity procurement.

The aFRR market has historically been highly dependent on a few CCGTs, and the new design as of September 2020 is, in line with the EBGL’s prescriptions, precisely meant to facilitate the entrance of all technologies in the aFRR market. To ensure a smooth transition, in a first stage the “all CCTU” auction is maintained two days ahead of delivery while the “per CCTU” auction is organized in day-ahead. This allows new entrants to gradually increase their share of aFRR capacity, without taking the risk of an abrupt price increase for the end-consumers.

6.1 No paid-as-cleared settlement of the “all CCTU” auction (D-2 at 16:00)

The “all CCTU” auction itself is not designed to work with paid-as-cleared remuneration and is targeted to disappear in the medium-term.

The “all CCTU” auction itself also does not satisfy the pre-conditions for a smooth implementation of paid-as-cleared settlement. The presence of mutually exclusive and indivisible bids pose various technical difficulties. The aFRR selection method for the “all CCTU auction” step is based on a cost minimization algorithm[15]: it selects the set of bids (which are fully indivisible and may be part of a group of bids with mutual exclusivity for selection) in such a way that both the upward and the downward demand is (at least) satisfied and that the total procurement cost is minimized. The fact that bids are not straightforwardly selected based on their merit order makes the determination of a unique clearing price challenging. Although experience from other markets (cf. single day-ahead coupling, MARI, FCR Cooperation, …) shows that these challenges are addressable (i.e. that it is possible to determine acceptable rules to clear auctions with indivisible or complex bids with a uniform marginal price), they also clearly show that such rules imply complex algorithms and/or more complicated market rules.

Elia does not intend to further invest in improving the design for the “all CCTU” auction, especially not if it risks slowing down the further development of the liquidity for the “per CCTU” auction.

6.2 Paid-as-cleared settlement possible for “per CCTU” auctions (D-1 at 09:00)

The “per CCTU auction” that takes place the day before delivery at 09:00 and actually consists of 12 completely separated closed-gate auctions (6 CCTUs of upward capacity and 6 CCTUs of downward capacity) which are run simultaneously.

There are no technical links between the capacity bids offered for these 12 auctions and the bids are also fully divisible. It is therefore technically straightforward to **procure aFRR capacity based on a simple merit order**: in such a setup, selecting the bids in their ascending price order is indeed fully equivalent to a welfare maximization or to a minimization of procurement costs.

[15]It concerns the same cost minimization algorithm as previously used for the weekly procurement of aFRR (before July 2020, jointly with FCR).

By definition of the aFRR product, all offers for a given direction/CCTU are also considered as **fully homogeneous** from the TSO perspective, as all bids meet the technical aFRR requirements and are therefore indistinguishable.

For what concerns **liquidity**, one can note that the “per CCTU” auction is specifically developed with the aim to limit as much as possible barriers to enter the aFRR market and thereby attract liquidity. Further, the splitting rule included in the design to apportion the volume of aFRR capacity to be procured in the “all CCTU” and the “per CCTU” auction (see §4.1.3) is such that volume cleared in the “per CCTU” auction depends on whether its prices are reasonably competitive compared to the ones observed in the “all CCTU” auction during the previous days. However, as **the new design has only been operational for a few months**, it is currently difficult to assess how the liquidity in the aFRR capacity market will evolve towards the point where the “all CCTU” auction will no longer be organized and how the liquidity will be once the target design is put in place.

In short, as far as the “per CCTU” auction is concerned, **there are no technical obstacles** that would prevent the shift towards a paid-as-cleared settlement provided that the liquidity and competition in the market are sufficient at that time to avoid an inacceptable increase of procurement costs**.**

6.3 Implementation practicalities

From the above, changing the remuneration scheme of the “per CCTU auction” in D-1 towards paid-as-cleared appears as desirable in the future. However, to decide on the change in design, an assessment would be needed to verify whether the necessary liquidity and competition conditions are present to make the shift without significantly increasing procurement costs shortly after entry into force and while having some degree of confidence that the procurement costs would decrease in the medium term. To introduce paid-as-cleared settlement for the “per CCTU” auction, **Elia proposes to reassess the liquidity and competition in the aFRR capacity market 6 months after the “all CCTU” auction has been phased out.**

No major challenges for the IT implementation at Elia side have been identified at this stage. However, when deciding to move towards paid-as-cleared settlement, a more thorough IT analysis will need to be executed in order to assess the impact on the systems at Elia side as well as at BSP side. As pointed out by the BSPs in their consultation feedback, the concrete impact at their side is yet to be precisely assessed but they indicate that the implementation efforts would be substantial. Elia will, as presented to the Working Group Balancing meetings in October and November, take into account the interactions with other project in the balancing roadmap for the next years.

In addition, to change the product in coherence with a new design, the BSP Contract for aFRR will need to be amended. The concrete planning (including a formal consultation and approval process leading to a period of at least 4 months between the decision to propose to implement paid-as-cleared remuneration and its entry into force) will need to be determined taking into account the planning for other contractual changes that may be required at that time

Note that the adoption of a paid-as-cleared remuneration for aFRR is not expected to prevent a participation to a cross border aFRR capacity cooperation, given that no such initiative is currently planned for Belgium, and that in the target model FRR cross-border capacity projects in the CORE region are expected to be settled on a paid-as-cleared basis.

7. PAID-AS-CLEARED MODELS FOR MFRR

This chapter discusses the possible design based on paid-as-cleared settlement of mFRR balancing capacity procurement. It firstly discusses the preconditions to apply a paid-as-cleared, assuming the mFRR design is unchanged. The proposed design options are then discussed, and complemented with numerical simulations.

7.1 Paid-as-cleared pre-conditions for the current design

In this section, we review how the preconditions to apply a paid-as-cleared remuneration (as identified in §2.5) apply to the current mFRR design.

7.1.1 Homogeneity

The current design comprises of two distinct mFRR products: mFRR Standard and mFRR Flex. Each product can be considered as homogeneous since the TSO does not distinguish the bids within each product category, which all satisfy the same requirements.

Though, since the two products are different, they are by definition not homogeneous and thereby, logically, a different clearing price may apply to these two products.

Concretely, the mFRR Flex product differs from the mFRR Standard product given the existence of a neutralization time, a maximal activation time, and a lower probability of activation as placed at the end of the mFRR energy merit order. mFRR Flex thus leads to looser constraints for the bidder, is thereby a less reliable FRR capacity for Elia and consequently valued less by Elia. The necessity to mechanically enforce such a difference in value in the clearing prices will be discussed again later.

7.1.2 Liquidity and competition

The current mFRR design is operational since 3/2/2020 (for delivery on 4/2/2020) and it is therefore possible to use the historical data for quantitative analysis. The dataset used below covers the delivery period from 4/2/2020 to 30/6/2020 as input for the analysis in this version of the report. During this period the minimum volume of mFRR Standard procured per CCTU was 490MW. On July 1st, this minimum volume increased to 640MW.

The “market depth” – which compares the total amount of bids of a product with the traded ones – is one way to get a view over the **liquidity of a market**. During the studied period, the total mFRR procured capacity has been on average 840 MW (median 843 MW; with a maximum of 857 MW and a minimum of 805MW). During the same period, on average 1336MW of mFRR capacity has been offered (median 1339MW; with maximum 1732 MW and minimum 860MW).

If we compute the excess mFRR capacity (i.e. the total of mFRR bids which have not been awarded) per CCTU per day, we observe that on average 497MW of mFRR remained unmatched (median of 500MW; with a maximum of 889MW and a minimum of 3MW). In 90% of the CCTU, the offered volume exceeded by more than 313MW the mFRR total demand. Figure 10 provides a more detailed view of the distribution of this “excess mFRR capacity” (with values per CCTU and per day, and the histogram of values).

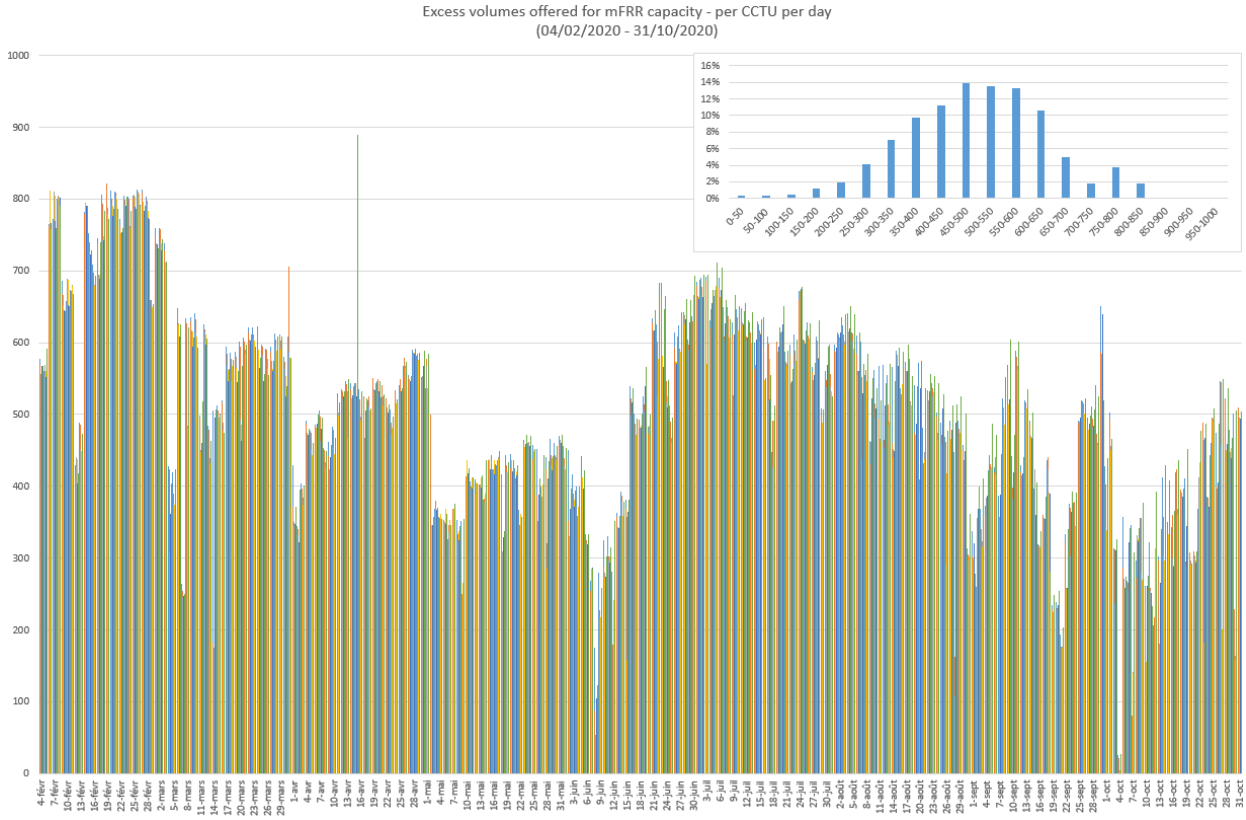


Figure 10 : total unselected mFRR volume per CCTU per day

On average 1005MW of **Standard mFRR capacity** has been offered (median 1023MW; with maximum 1403 MW and minimum 585MW). The minimum volume of mFRR Standard to be contracted changed in the studied period: the minimum mFRR Standard capacity to procure was 490MW from 4 February until 30 June and increased to 640MW on the 1st of July. The excess Standard mFRR capacity (i.e. the total of mFRR Standard bids minus 490MW or 640MW) per CCTU per day was on average 447 MW (median of 447MW; with a maximum of 816MW and a minimum of 95MW). In 90% of the CCTU, the offered mFRR Standard volume exceeded by more than 284MW the mFRR Standard minimum volume. Figure 11 illustrates the distribution of the “excess mFRR Standard capacity” (with values per CCTU and per day, and the histogram of values).

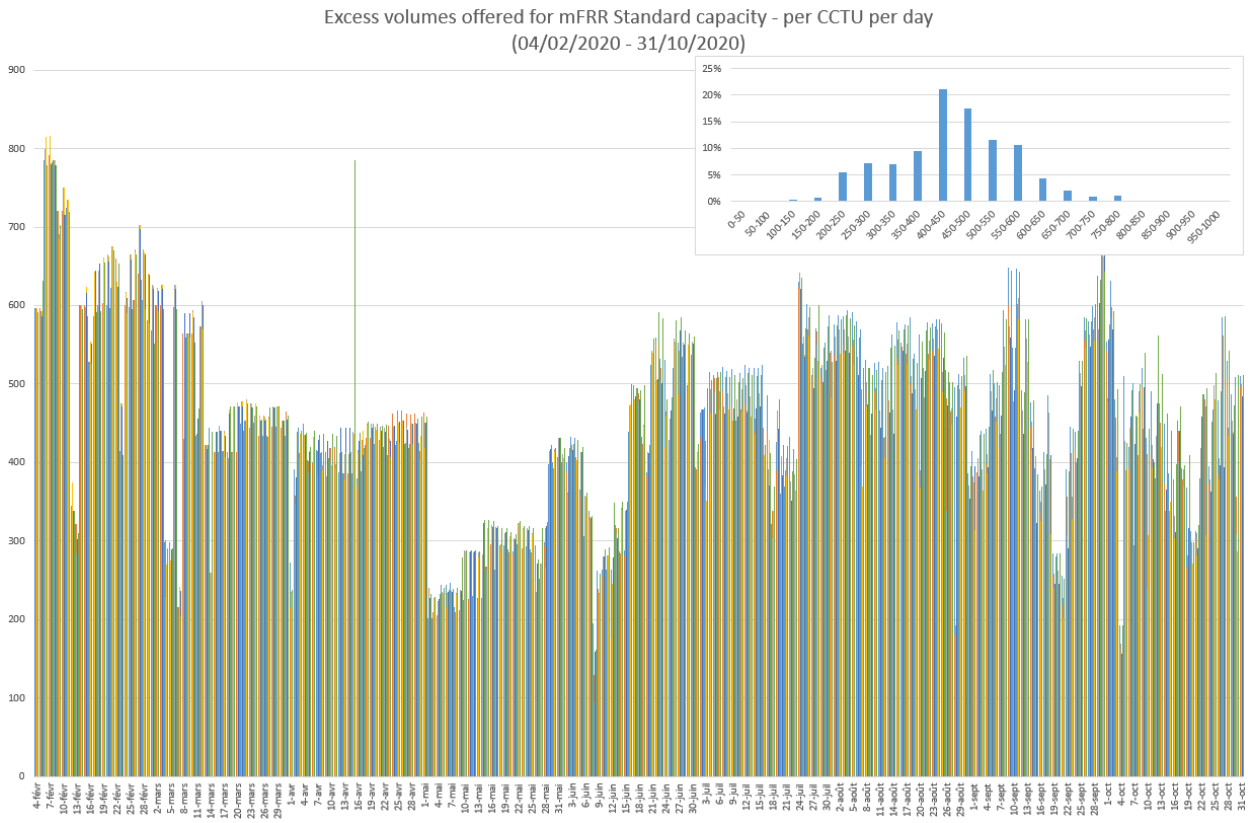


Figure 11 : Excess volume offered for Standard mFRR per CCTU per day

As shown by these figures, the volume of mFRR capacity offered is generally sufficient. The volumes offered are though rather volatile, and there are several CCTUs where the unmatched volumes are relatively narrow as well as two days in October that required a second auction as the offers in the first auction did not cover the mFRR capacity demand. On the 4th of October Elia organized a second auction for all CCTUs: the needed mFRR capacity could be procured but there was hardly any excess offered capacity for the day (between 3 and 27MW for the six CCTUs). On the 10th of October Elia organized a second auction for two CCTUs (08:00-12:00 and 12:00-16:00): the needed mFRR capacity could be procured and excess offered capacity was eventually 74 MW and 156MW respectively. On the 8th of June and 7th of October no second auctions were needed but the offered mFRR capacity was low (excess volume lower than 100MW).

At this stage, liquidity of total and Standard mFRR capacity can therefore mostly be considered as satisfactory but not fully comfortable, and there seems to remain room for improvements. The market situation during the winter is to be awaited, as is the impact of the amended LFC Means methodology that will enter into force for the capacity auctions of January 6th, 2021 (for mFRR delivery on January 7th). Preferably, liquidity should evolve towards higher excesses before moving to a paid-as-cleared settlement.

Liquidity alone does not provide a full picture. Even in case of more than sufficient volumes on offer, if only a limited number of BSPs make the offers, there is a risk of high prices due to a lack of competition in the market. The mFRR capacity market since February consists of 8 BSPs with small or large portfolios, of which 7 BSPs offer mFRR Standard capacity. Zooming in on the **mFRR Standard market** (as this is the target for mFRR) the data from February to June show the strong presence of a minority of BSPs having a large share in offered and awarded mFRR Standard capacity. The maximum BSP share in **offered** volumes of **mFRR Standard** (calculated per CCTU) ranges from 34 to 100% (with an average of 53% and in 90% of the cases the maximum share remains below 62%). The maximum BSP share in

awarded volumes of **mFRR Standard** (calculated per CCTU) ranges from 27 to 100% (with an average of 50% and in 90% of the cases the maximum share remains below 66%).

The Herfindahl-Hirschman Index (HHI)[16] is a measure often used by regulators (especially to evaluate mergers) to reflect the level of competition in the market. In general, an HHI of 0.25 or more is regarded as representing a market with a high level of market concentration or, in other words, a market with limited competition. Applying the **HHI on the BSP shares in awarded (respectively offered) mFRR Standard capacity per CCTU** shows values of at least 0.22 (respectively 0.25) and in 10% of the cases ranging above 0.51 (respectively 0.49) and even up to 1 (i.e., this is during the CCTU in which 1 BSP was awarded all the mFRR Standard capacity). Therefore, at this stage, the level of competition in the Standard mFRR market cannot be considered as sufficiently comfortable, as Elia cannot completely rule out the possibility that the relatively high observed market concentration could result in higher procurement costs (especially in case of paid-as-cleared settlement).

Per CCTU	Largest BSP share in awarded mFRR Standard	Herfindahl-Hirschman Index	Largest BSP share in offered mFRR Standard	Herfindahl-Hirschman Index
Minimum	27 %	0,22	34 %	0,25
Average	50 %	0,38	53 %	0,41
Median	49 %	0,37	53 %	0,40
90th percentile	66 %	0,51	62 %	0,49
Maximum	100 %	1,00	100 %	1,00

7.1.3 Merit-order based selection

All mFRR bids – whether for Standard of Flex mFRR – are divisible. This facilitates a straightforward merit order selection, and thereby makes the shift towards paid-as-cleared easier. Though, as explained in §4.2.2 (see for example Figure 6 on page 21), the procurement is split into 2 steps. This is worth being discussed more in depth.

Both steps use the merit order principle to fulfil the demands, but use different bid stacks:

- in the first step, the minimum mFRR Standard volume can only be filled with mFRR Standard bids;
- in the second step the remainder mFRR demand can be filled from either mFRR Standard bids or mFRR Flex bids. All the mFRR Standard bids that were not selected in the first step, are participating in the second step. Importantly though, mFRR Standard bids may be provided with 2 prices P1 & P2. If an mFRR Standard bid (remaining from the first step) includes a P2 price, this one will be used in the second step of the auction (in which case the bid acceptance implies a commitment to offer Flex mFRR capacity, i.e. neutralization time is allowed).

Strictly speaking, a simple merit order selection is not possible with such a setup because some bids can have two prices, and it is therefore not straightforward which price should be used. In practice, Elia has given priority to the

[16] The HHI index is one way to calculate a simple metric that gives an indication of the competitiveness of a market. The index varies between 0 and 1, and is obtained by summing the square of the market shares. See for example: https://en.wikipedia.org/wiki/Herfindahl%E2%80%93Hirschman_Index

Standard mFRR price P1, by first selecting this type of capacity (i.e. Step1), because this is a more stringent and valuable product.

Actually, there are two possible reasons for a BSP to bid two different prices P1 & P2:

- On the one hand, the products’ characteristics are different (Standard vs. Flex mFRR), so that the P2 price asked for Flex mFRR might be set to a lower level than the P1 price applicable to the more exigent mFRR Standard. The BSP may, therefore, deploy its portfolio differently to honor the mFRR obligation for the Standard product than for the Flex product. Consequently, the different prices would reflect heterogeneous bids with a different marginal capacity cost.
- On the other hand, because there are two steps settled on a paid-as-bid principle, BSPs might estimate a different price equilibrium for these two steps, and therefore ask for a different profit margin for these two steps (irrespective of the fact that the offered product becomes different) to increase the probability of selection. A BSP may thus decide to set a P2 price lower than P1 because the BSP estimates that due to the added competition of Flex mFRR in step 2, the price equilibrium would be lower. P2 may thus be used as a “second chance” offer.

Although this latter aspect is fully justified in the current design, it is less evident under a paid-as-cleared settlement regime because of the natural incentive to bid at marginal costs. Hence, assets which are currently submitting P1 and P2 prices because they forecast the two steps differently – but which are not negatively affected by long activation periods or absence of neutralization time – are likely to only submit a single price for their bids, at the level of their marginal costs. This aspect will be further discussed when performing quantitative analysis (cf. §7.3).

7.2 Design options

Let us now explore the possible design options for mFRR paid-as-cleared settlement. The assessment is based on the current design where part of the demand must be specifically fulfilled by mFRR Standard while the remainder can be satisfied by either mFRR Standard or mFRR Flex. As stated above, Elia targets an mFRR service consisting only of a standard product without neutralization time.

Firstly, a hybrid model where one product remains settled paid-as-bid (i.e. the mFRR Flex, given its foreseen phase-out) and the other product (i.e. the more enduring mFRR Standard product) is settled paid-as-cleared has not been considered. Indeed, as both Standard and Flex are procured in a common auction, all bids are pooled together and selected at a single point in time. A model where bids participating to the same auction are remunerated with different regimes is very likely to lead to unsatisfactory results due to the fundamentally different incentives in setting the bid prices. Indeed, while the bids under the paid-as-cleared regime would be incentivized to submit their marginal costs (which potentially leads to steep segments in merit order curves), bids under the paid-as-bid regime will try to price their bids close to the expected price equilibrium (which leads to rather flat merit order curves). This latter category will thus mechanically be placed later in the bid curve. In other words, a shift towards paid-as-cleared for mFRR is only meaningful if implemented to all mFRR products at once.

Secondly, mFRR Standard and mFRR Flex differ because the latter allows for a neutralization time and a maximum activation time. They therefore clearly deserve to have a distinct clearing price as they are valued differently due to different requirements[17]. This means that a “per product marginal pricing” is the only considered way forward.

[17] Cf. discussion on homogeneity of products as a necessary condition for paid-as-cleared implementation in §7.1.1

Thirdly, mFRR Standard offers more reliable capacity for the TSO, and leads to more obligations for the BSP. Logically, the clearing price for mFRR Standard bids should therefore always be at least as high as the price of mFRR Flex. If this is not the case based on the price of the marginal Standard bid, then it gives a wrong incentive for BSP operating assets able to provide mFRR Standard to shift their offers to mFRR Flex. This is why it is suggested to possibly impose that the clearing price for mFRR Standard is always at least as high as the clearing price for mFRR.

Bottom line, the design proposal if implementing a paid-as-cleared remuneration for mFRR capacity in the current design consists of a marginal clearing price determined per product:

- A marginal clearing price for selected mFRR Standard capacity bids that is equal to the bid price of the marginally selected mFRR bid (regardless of product).
- In case the mFRR Flex product is still used, a marginal clearing price for selected mFRR Flex capacity bids that is equal to the bid price of the marginally selected mFRR Flex bid.

7.3 Costs and benefits analysis / quantitative simulations

In this section, we try to quantitatively estimate the impact of a change towards paid-as-cleared settlement for mFRR capacity procurement.

As explained all along this document, one of the key advantages of marginal pricing is that it allows a simpler bidding strategy, because bid prices can be directly based on the marginal cost of providing the product, and therefore do not depend on the quality of the forecasted price equilibrium. The incentives for BSPs to adapt bid prices after the change from paid-as-bid to paid-as-cleared, however, depend on how BSPs expect that the new design will affect their chance of selection. This in turn depends on the level of liquidity and competition in the market and how these would be impacted by the change towards paid-as-cleared.

The problem is that neither short-term nor long-term information about marginal FRR capacity cost is readily available. It is therefore not possible to perform simulations by using actual marginal FRR capacity costs as input (as a proxy of what BSPs would submit as offers). Similarly, modifying the historical bid prices is a risky approach, as the assumptions taken when modifying the bid prices directly set the simulations results (for example, if all bid prices are reduced by 10%, the resulting procurement will be reduced by roughly the same 10%).

On the other hand however, simply using the same bids submitted in a paid-as-bid context without modifying them, and simulate the impact over the procurement cost of a shift towards paid-as-cleared settlement, will inevitably lead to a cost increase, as it would not take into account any of the short- or long-term positive effects. This is illustrated in Figure 12: the left part of this figure depicts a paid-as-bid settlement, where bids are priced by taking into account the marginal FRR capacity costs (blue) and markups to finance other costs and generate a profit (orange). This leads to a certain procurement cost. In the middle of the figure, the same bids are used for paid-as-cleared simulations. Because the selected bids and their prices remain the same, **the total procurement cost can only be inflated** (green). The expectation though is that bid prices will no longer contain markups as these will be automatically granted by the settlement scheme. This is illustrated on the right hand-side of the figure: the bid selection is modified and the total procurement cost has become lower than under paid-as-bid.

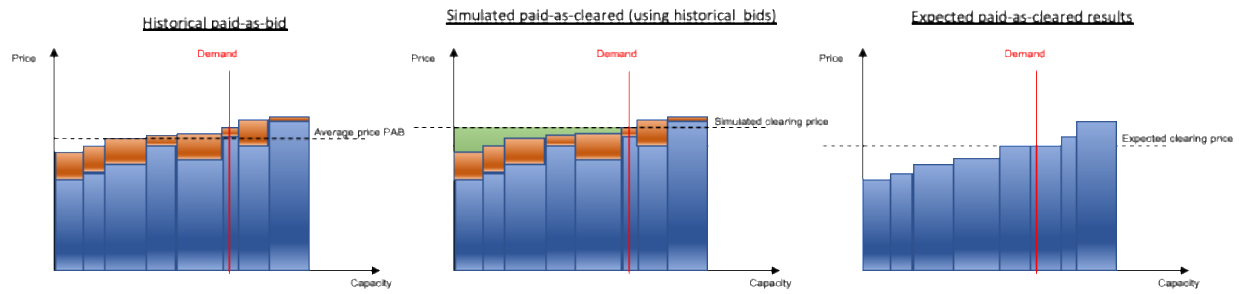


Figure 12 : Simulations using historical bids will inevitably lead to a cost increase as they will not consider the change in bidding behavior

A first set of simulations have been run, acknowledging the above explained deficiency that bid prices are not modified (despite the incentive to do so under paid-as-cleared remuneration). To reduce somewhat the effect of this issue, a second set of simulations – where it is assumed that the lowest prices (if two prices P1 & P2 are provided) is a reasonable first step towards reduced bids’ markups – have been executed.

The details of these simulations (based on the data from 4/02/2020 (launch of the new mFRR design) until 31/10/2020) are the following:

- **Reference case**: the mFRR cost during the considered period (during which the remuneration is paid-as-bid) amounted to € 32,2 million.
- **Simulation1a**: the mFRR cost if everything remains unchanged (i.e. same bids, same selection) except that selected mFRR Standard bids and mFRR Flex bids are remunerated with paid-as-cleared mechanism – with independent prices for mFRR Standard and mFRR Flex – would have been €39,8 million. This represents a cost increase of 23,6 % compared to the reference case.
- **Simulation1b**: The only difference compared to Simulation1a is that the remuneration of mFRR Standard bids for a given CCTU cannot be lower than the remuneration for mFRR Flex remuneration for the same CCTU (i.e. the mFRR Standard clearing price is constrained to be at least equal to the mFRR Flex clearing price). In this case, the total procurement cost would have been €40,1 million. **Such a +24,5% compared to current cost can be considered as the worst-case upper bound of cost increase due to a shift towards paid-as-cleared** (i.e. the maximum increase in mFRR procurement costs which would have happened if the bids are not modified but however set such that they all get the highest possible marginal price).
- **Simulation2a**: for this simulation, the bids have been modified such that, for all bids for which two prices P1 & P2 were provided, only P2 has been used (meaning: P2 is also assumed applicable for the first step where the minimum mFRR Standard volume is procured). The underlying assumption is that, under the current paid-as-bid remuneration, the submission of two different prices primarily relates to the expectation that the price equilibrium will be different in the first and in the second steps (and hence that the fact that the underlying commitments are different does not have a significant impact over the marginal FRR capacity cost). P2 is thereby assumed to be closer – while still above – the marginal FRR capacity cost of this bid than P1[18]. A new bid selection is then made using these modified bids, using the same selection method as in the current design. Remunerating paid-as-cleared the resulting bid selection (i.e. one clearing price for mFRR Standard

[18] see also §7.1.3 for a further discussion on this matter

and one clearing for mFRR Flex) leads to a total procurement cost of € 38,5 million. This is an increase of 19,7% compared to the Reference case.

- **Simulation2b**: for this last simulation, the same bid prices and selection as for Simulation2a are considered. The only difference with Simulation2a is that – similar as for the difference between Simulation1a and Simulation1b – the remuneration of mFRR Standard bids for a given CCTU cannot be lower than the remuneration for mFRR Flex remuneration for the same CCTU. With this additional constraint, the total procurement cost would amount to € 38,8 million, which is 20,5% above the historical procurement cost.

These data are summarized in the table provided below:

Name	Bids	Bid selection	Remuneration scheme	Total cost
Reference	Historical bids	Historical selection	Historical paid-as-bid	32,2 M€
Simulation1a	Historical bids	Historical selection	Paid-as-cleared: for each CCTU, selected mFRR Standard bids (resp. mFRR Flex bids) are remunerated the price of the last accepted mFRR Standard bid (resp. mFRR Flex bid)	39,8 M€ (+23,6%)
Simulation1b	Historical bids	Historical selection	Paid-as-cleared: Same principle as for Simulation 1a. However, mFRR Standard price ≥ mFRR Flex price	40,1 M€ (+24,5%)
Simulation2a	For all mFRR Standard bids where P1 ≠ P2, P1 is replaced by P2	The same bid selection method is used – however with modified bids	Paid-as-cleared: Same principle as for Simulation 1a – though with alternative selection	38,5M€ (+19,7%)
Simulation2b	Same as Simulation2a	Same as Simulation2a	Paid-as-cleared: Same principle as for Simulation 1b (mFRR Standard price ≥ mFRR Standard price with alternative selection)	38,8 M€ (+20,5%)

It is important to bear in mind that – given the assumptions taken to perform these simulations – the expected benefits of a shift towards a paid-as-cleared settlement are not factored in. Rather, the simulations provide an indication on how the procurement costs would increase in case the change in the remuneration scheme leads to none of the expected rewards. Depending on the assumptions above, such a cost inflation would be in the [+19,7%; +24,5%] range according to the simulations run over the 4/2/2020 - 31/10/2020 period.

Separately, the simulations also show a limited total cost difference between the results of Simulation1a vs. Simulation1b and Simulation2a vs. Simulation2b. This confirms the expectation that mFRR Standard capacity is typically more expensive than mFRR Flex, and that the cost of imposing that the mFRR Standard remuneration is always as good as mFRR Flex remuneration remains limited (in the order of magnitude of 1%). Given the higher contribution of mFRR Standard products to the system security and the willingness to simplify the future product offering, it is logical to incentivize the offering of this product. As this mechanism would not significantly increase costs even in a worst case scenario (it is actually expected to lower the costs in practice, as a result of stimulating liquidity in step 1), it seems appropriate to mechanically impose that mFRR Standard clearing price is always at least as high as the mFRR Flex clearing price. This indeed ensures that assets that are able to deliver both services for the same cost will prefer to offer mFRR Standard capacity.

In order for the procurement cost of an mFRR capacity auction per CCTU to remain the same when moving from paid-as-bid to paid-as-cleared settlement, the price of the marginally selected bid in paid-as-cleared should be equal to the average price of selected bids in a paid-as-bid mechanism. The required reduction in the price of the marginal bid, when simulated based on the mFRR Standard bids from February until October 2020, would be on average 14% (ranging between 0% and 78% per CCTU) or, when expressed in euros, the mFRR Standard capacity bids prices would have to drop with on average 1,45€ per MW per hour (ranging from 0 to 1,64€ in 75% of the CCTU, with outliers

up to 52,7€ per MW per hour). There were 18 CCTU in which the difference between the average and the marginal price for awarded mFRR Standard bids was larger than 10€ per MW per hour.

(per CCTU)	% reduction for current marginal price to be equal to current average price	€ reduction for current marginal price to be equal to current average price
Minimum	0%	0,00€
Average	14%	1,45€
Median	11%	0,67€
75th percentile	19%	1,64€
Maximum	78%	52,70€

7.4 Implementation practicalities

From the above, a shift towards a paid-as-cleared remuneration for the mFRR capacity procurement auction appears as desirable in the long term. However, the quantitative analysis puts in doubt whether the necessary liquidity and competition conditions are already present to make the shift without significantly increasing procurement costs in the short term and while having sufficient confidence that the procurement costs would decrease in the medium term. In addition, the quantitative analysis itself, although interesting, is performed on a period that is considered too short and not representative enough to conclude on the topic. The analyzed period from February to October 2020 does not allow to detect and isolate possible, seasonal effects (especially as no winter period is included) and the Covid-19 pandemic strongly affected everyday life and thereby electricity markets (especially in the first half of the year). To confirm this change in design, therefore, Elia proposes to reassess the liquidity and competition in the mFRR capacity market in Q2 2021, when at least a full year of data of daily procurement of mFRR capacity will be available. Additionally, by that time, Elia will have continued to reflect upon the phase out calendar of the mFRR Flex product and will be able to consider this in the proposed review of the paid-as-cleared question for mFRR capacity.

No major challenges for the IT implementation at Elia side have been identified at this stage. However, when deciding to move towards paid-as-cleared settlement, a more thorough IT analysis will need to be executed in order to assess the impact on the systems at Elia side as well as at BSP side. As pointed out by the BSPs in their consultation feedback, the concrete impact at their side is yet to be precisely assessed but they indicate that the implementation efforts would be substantial. Elia will, as presented to the Working Group Balancing meetings in October and November, take into account the interactions with other project in the balancing roadmap for the next years.

In addition, to change the product in coherence with a new design, the BSP Contract for mFRR will need to be amended. The concrete planning (including a formal consultation and approval process leading to a period of at least 4 months between the decision to propose to implement paid-as-cleared remuneration and its entry into force) will need to be determined taking into account the planning for other contractual changes that may be required at that time.

Note – as for aFRR – that the adoption of a paid-as-cleared remuneration for mFRR is not expected to prevent a participation to a cross border mFRR capacity cooperation, given that no such initiative is currently planned for Belgium, and that in the target model FRR cross-border capacity projects in the CORE region are expected to be settled on a paid-as-cleared basis.

8. CONCLUSIONS

This document studies the potential shift from the current paid-as-bid mechanism for procurement of FRR capacity towards a paid-as-cleared remuneration.

The **theoretical analysis** of this paper concludes that paid-as-cleared remuneration is likely to increase market attractiveness because homogeneous services become remunerated equally, forecasting effort is reduced and the market thereby better acts as a level-playing field, irrespective of bidders’ market shares. Consequently, the theory suggests that total procurement cost would decrease with the implementation of a paid-as-cleared settlement, potentially in the short-term (due to a better selection of available resources), but more importantly in the longer-term (due to attraction of new resources). Marginal pricing however only delivers such benefits when reasonable liquidity and competition levels are either pre-existing at the time of implementation, or are reached afterwards, i.e. when there exist no significant barriers that prevent the expected benefits to materialize and when the additional capacities resulting from new investments have come to the market.

These theoretical expectations have been confirmed by the **European TSOs surveyed** by Elia in the context of this study, who observed increased competition and lower prices after its implementation. Only one TSO has had a bad experience and had to revert back to paid-as-bid a few months after implementing paid-as-cleared remuneration, back in 2009.

A paid-as-cleared remuneration for FRR capacity in Belgium will also not prevent a potential future cross-border cooperation, as any cross-border FRR capacity cooperation in the CORE region is expected to be settled paid-as-cleared in the future.

A **preliminary version of the study report**, containing the initial thoughts of Elia about the possible implementation of a paid-as-cleared remuneration of FRR capacity, was publicly consulted in September 2020. Possible implementation was also discussed with the Working Group Balancing in October-November 2020. Based on this concertation, Elia maintains its initial proposal regarding implementation. Elia confirms a paid-as-cleared remuneration scheme as a desirable target model for FRR capacity but is at this stage not capable of proposing a concrete implementation date. More experience is needed with the designs for aFRR and mFRR services introduced in 2020.

Concretely for aFRR, the **recommendation** of this study is to implement a paid-as-cleared remuneration only in the second “per CCTU auction” step once sufficient competition has been established. A paid-as-cleared implementation in the “all CCTU auction” has been judged counter-productive as it is fundamentally more complex and there is no intent to invest to improve the attractiveness of this step, which is planned to be abandoned. It is proposed therefore to first acquire some experience from the actual market functioning – notably in terms of liquidity and competition – after the “all CCTU auction” has been phased out before confirming these subsequent changes.

Concretely for mFRR, the **recommendation** of this paper is to define a separate marginal price for mFRR Standard and mFRR Flex capacity, with an additional constraint that the clearing price of mFRR Standard shall always be at least equal to the price of mFRR Flex. Elia will continue to reflect upon the phase out calendar of the mFRR Flex product allowing the proposed review of the paid-as-cleared question for mFRR capacity to include the considerations of the mFRR Flex phase out calendar. The proposed remuneration scheme can be implemented in the current design as well as in case the mFRR Flex product is fully phased out. The quantitative analysis also showed that the liquidity in the mFRR market is currently not fully comfortable, and that competition is occasionally lacking. Other evolutions in the dimensioning and in the use of mFRR Flex may affect the level of liquidity and competition in the mFRR capacity market and thereby influence decisions on implementing a paid-as-cleared remuneration. This is why ELIA proposes to reassess the liquidity and competition in the mFRR capacity market in Q2 2021. To move to a paid-as-cleared

mechanism, the assessment of market readiness would need to indicate that the shift can be made without significantly increasing procurement costs on the short term and while having some degree of confidence that the procurement costs will decrease in the medium term.

REFERENCES

Elia. (2017, December 18). *Study on Paid-as-Cleared settlement for aFRR & mFRR activated energy*. Retrieved from file:///Users/yveslanger/Downloads/2017%20Study%20Report%20on%20Paid-as-cleared%20settlement%20for%20aFRR%20and%20mFRR%20activated%20energy.pdf

Elia. (2018, December 20). *Public consultation on the implementation plan on the evolution towards daily procurement of mFRR.* Retrieved from www.elia.be: https://www.elia.be/en/public-consultation/20181109-implementation-plan-on-the-evolution-towards-daily-procurement-of-mfrr

Elia. (2019, December 6). *Elia’s methodology to determine the required balancing capacity.* Retrieved from https://www.elia.be/-/media/project/elia/elia-site/electricity-market/system-services/keeping-the-balance/lfcmeans_fr_maindocument.pdf

Elia. (2019, March 10). *MFRR 2020 PRODUCT DESIGN NOTE.* Retrieved from www.elia.be: https://www.elia.be/-/media/project/elia/elia-site/electricity-market/system-services/system-services-pdf-document-library/03-balancing-services-bsp/05-mfrr/02-design/2019-design-note-mfrr-2020_version-01032019.pdf

Elia. (2020, June 2). *Public consultation on the methodology for the dimensioning of the aFRR needs*. Retrieved from https://www.elia.be/en/public-consultation/20200602_public-consultation-on-the-methodology-for-the-dimensioning-of-the-afrr-needs

Elia. (2020, March 03). *Terms and Conditions for balancing service providers for automatic Frequency Restoration Reserve (aFRR).* Retrieved from https://www.elia.be/-/media/project/elia/elia-site/electricity-market-and-system---document-library/balancing---balancing-services-and-bsp/2020/20200303_tc-bsp-afrr_en.pdf

Elia. (2020, October 9). *Public consultation on a modification of the methodology to determine the balancing capacity in the Elia LFC block.* Retrieved from: https://www.elia.be/en/public-consultation/20201008-public-consultation-on-a-modification-of-the-methodology

Emissions-EUETS.com. (2020, May 05). *FRR European Union Electricity Market Glossary*. Retrieved from Emissions-EUETS.com: https://www.emissions-euets.com/internal-electricity-market-glossary/794-frequency-restoration-reserve-frr

ENTSOE. (2019, December). *Core CCR TSOs’ Methodology for a market-based allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with article 41 of the Commission Regulation on (EU) 2017/2195 of 23 November 2017 establi.* Retrieved from https://consultations.entsoe.eu/markets/ebgl-art-41-a-market-based-proposal-of-czca/supporting_documents/20190920_Art%2041%20Core%20TSOs%20Methodology_Marketbased%20allocation%20process%20of%20CZC.pdf

ENTSOE. (2019, December 19). *Core CCR TSOs’ Methodology for a marketbased allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with article 41 of the Commission Regulation on (EU) 2017/2195 of 23 November 2017*. Retrieved from ENTSOE: https://www.entsoe.eu/Documents/nc-tasks/EBGL/EB_GL_A41.1_CORE_CCR_Methodology_Market-based%20allocation%20process%20of%20CZC.pdf

ENTSOE. (2020, December 4). *Core CCR TSOs’ Methodology for a marketbased allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with article 41 of the Commission Regulation on (EU) 2017/2195 of 23 November 2017 establis*. Retrieved from ENTSOE:

https://eepublicdownloads.entsoe.eu/clean-documents/nc-tasks/EBGL/201206_Core_EB_Art_41_MB_CZCA_Amended_Proposal.pdf

European Commission. (2017, November 23). *Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing*. Retrieved from http://data.europa.eu/eli/reg/2017/2195/oj

European Commission. (2019, June 5). *Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R0943

Ofgem. (Undated). *Pay-as-bid or pay-as-clear pricing for energy balancing services in the Balancing Mechanism*. Retrieved from https://www.ofgem.gov.uk/ofgem-publications/40790/pay-bid-or-pay-clear-presentation.pdf

P.Cramton, A. K. (2001). *Uniform Pricing or Pay-as-Bid Pricing: A Dilemma for California and Beyond*. (Electricity Journal) Retrieved from ftp://cramton.umd.edu/papers2000-2004/kahn-cramton-porter-tabors-uniform-or-pay-as-bid-pricing-ej.pdf

Susan Tierney, P. T. (2008, March). *Uniform-Pricing versus Pay-as-Bid in Wholesale Electricity Markets: Does it Make a Difference?* Retrieved from http://www.analysisgroup.com/: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.365.2514&rep=rep1&type=pdf

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