# FINAL REPORT

## Study on procurement strategies for a dynamic calculation of FRR means

Follow-up study on the daily prediction of non-contracted balancing energy bids

**December 21, 2022**

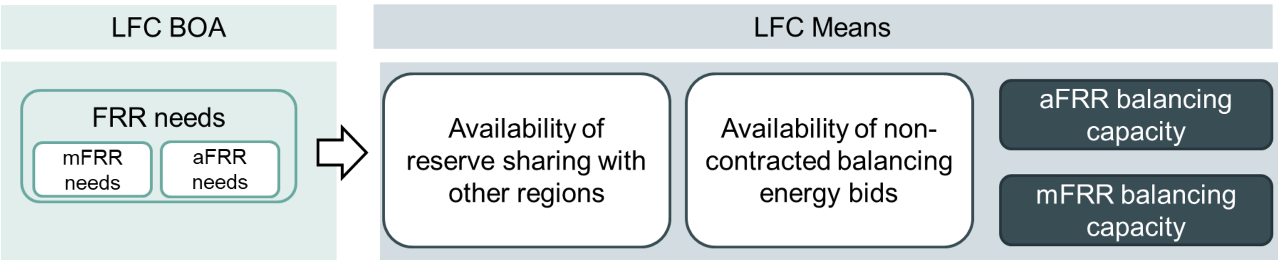
# Table of Contents

# EXECUTIVE SUMMARY

In line with European legislation, Elia specifies the methodology to determine the FRR / aFRR / mFRR reserve capacity needs for its LFC block in its LFC block operational agreement. While FRR / mFRR needs are already dimensioned dynamically, i.e. on a daily basis based on the expected system risks, an implementation plan for a dynamic dimensioning of the aFRR needs was presented in 2020. These dynamic dimensioning methods are developed by Elia to minimize the reserve capacity needs following increasing shares of variable renewable generation.

Elia also conducts an analysis on optimal provision of reserve capacity and calculates the reserve capacity which needs to be procured, i.e. balancing capacity. In doing so, it takes into account the availability of non-contracted balancing means such as sharing of reserves and the volume of non-contracted balancing energy bids which are expected to be available both within the LFC block.

Currently, Elia determines on an 'ad hoc' basis the share of non-contracted balancing energy bids and sharing of reserves which can be accounted as 'firm' in the determination of the balancing capacity to be procured. The scope of this study is on optimizing of the allocation of the required reserve capacity needs to contracted and non-contracted balancing means trough a dynamic calculation of the available non-contracted balancing energy bids which are expected to be available for the next day.




*Overview of the regulatory framework for the determination of Elia's balancing capacity to be procured*

This report concerns a follow-up on the study performed in 2021 on the daily prediction of non-contracted balancing energy bids. It investigates the feasibility of different procurement strategies facilitating a dynamic calculation of the contribution of non-contracted balancing energy bids in the calculation of the balancing capacity requirements. The study on the daily prediction of non-contracted balancing energy bids already confirmed the potential to predict with a good accuracy an available volume of non-contracted balancing energy bids for the next day, particularly for mFRR, although subject to many disclaimers and a robustness check after the implementation of explicit bidding, reduced full activation time and connection to the EU balancing platforms.

In the study on daily prediction, Elia already presented a roadmap towards implementation in three steps. This report concerns the outcome of the second step to investigate the opportunities and risks of implementing dynamic procurement strategies. The third and final step, i.e. the robustness check, will concern an update of the machine learning algorithms and corresponding calculations to incorporate data that take into account the foreseen implementation of explicit bidding and other product evolutions. This robustness check was initially planned in 2023 or 2024, i.e. two years after the then expected implementation date of these evolutions. It needs to be rescheduled towards 2025 following the revision of the planning of the implementation of these evolutions towards the second semester of 2023. Note that in the meantime, the follow-up on the aFRR segment, which already implemented explicit bidding as from October 2020, is useful to investigate the evolution in the availability non-contracted balancing energy bids.

The conclusions and recommendations of Elia presented in this report are based on an analysis of Compass Lexecon, a consultant specialized in energy economics and electricity market design, as well as discussions with stakeholders via two workshops moderated by Compass Lexecon. Elia concludes that the analysis puts a partial procurement strategy forward as the most feasible of the analyzed dynamic procurement strategies. Although no fundamental legal barriers have been identified, it is stressed that attention needs to be paid to several risks, including operational risk and market stability risks, which need to be well managed by:

- Capturing the potential impact of a dynamic procurement strategy on the dispatch behavior of units and the corresponding impact on the availability of non-contracted bids, as well as ensuring sufficient accuracy of forecasting tools, including their ability to anticipate sudden market evolutions.

- Managing the variability of volumes as the absence of clear procurement patterns makes the market environment less predictable and less stable. This could discourage investments and short-term market participation, or even result in operational errors at market side. It could be detrimental to market functioning in the short and long run and increase market power in the balancing energy market.

- Managing the potential decrease in mFRR energy market liquidity as a result of a reduction of mFRR capacity procured, leading to increased balancing costs and potential market power issues. Some generators could gain a more pivotal position if fewer participants submit balancing energy bids. This concern might be mitigated by the accession to the European balancing energy platform, where local mFRR energy bids would compete against bids from other systems.

The study also recognizes that a partial procurement strategy may provide several economic gains. Firstly, it can reduce procurement costs following balancing capacity requirement reductions. However, one should be careful not to overestimate this gain as periods with high volumes of non-contracted balancing bids are generally periods with a lot of available flexibility, and therefore also periods with lower balancing capacity prices. In addition, an indirect effect of lower balancing capacity requirements is that BSPs may downsize their investments following a decline in expected market revenues which may counteract on the foreseen price reductions on the longer term.

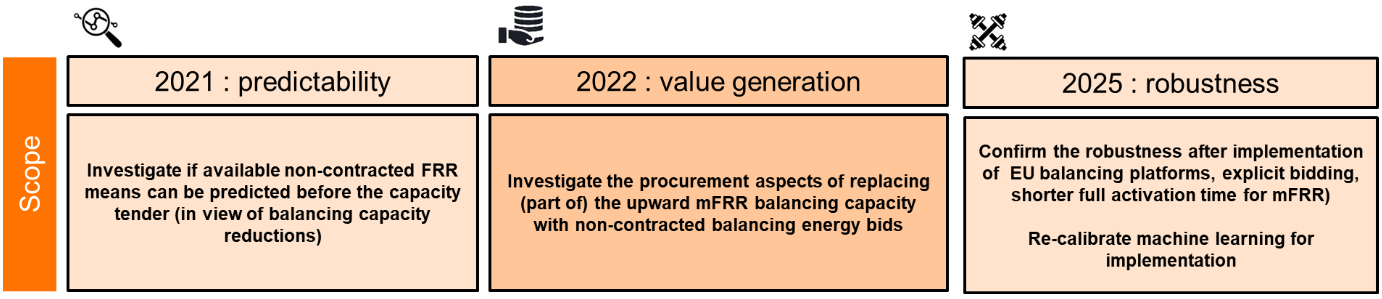
Secondly, partial procurement will likely improve the dispatch efficiency in day-ahead and intraday energy markets. Freeing up capacity for participation in the wholesale energy market could improve the overall dispatch, increase competition and drive prices down. It is also explained here that this effect should not be overestimated considering the limited balancing capacity in Belgium compared to the size of the European wholesale market.

In addition to these expected economic gains, there are also some negative effects put forward in the analyses of Compass Lexecon. Prediction errors are expected to result in re-dispatch measures while balancing capacity requirement reduction may risk to increase balancing energy prices. In addition, part of the cost for balancing capacity might be transferred to the capacity remuneration mechanism following increased missing money of units formerly counting on revenues from the balancing capacity market.

Due to the lack of quantitative tools capturing all markets effect, it is difficult to quantify the final outcome, even if one might qualitatively expect an overall gain. However, it is clear that a partial procurement strategy would impact the cost allocation to grid users. While balancing procurement costs and energy market costs are expected to be reduced, the balancing energy costs, re-dispatching costs and capacity remuneration market costs are expected to increase. Note that these benefits and costs may impact grid users in a different way as some costs are socialized via grid tariffs or surcharges (balancing procurement costs, re-dispatching costs and capacity remuneration costs), while others are accounted to the user of the service (energy costs).

In conclusion, Elia confirms the implementation roadmap steps, with a postponement of the robustness check to 2025 to be able to capture the impact of market evolutions (and in particular the implementation of explicit bidding and the connection to MARI) on volumes of non-contracted bids. **It considers that subject to a positive outcome of the robustness check (i.e. significant non-contracted volumes can be forecasted with a sufficient reliability), a partial procurement strategy could be implemented towards 2027. In other words, a 'go live' before 2027 is not recommended.** Elia also refers to its aim to limit mFRR procurements to the extent possible as soon as there is sufficient guaranteed flexibility in the system following the integration of decentral flexibility (except during particular periods such as for instance near scarcity events). It refers to its CCMD value model (presented in the WG Balancing) and its biannual flexibility study (as part of the adequacy and flexibility study) to track the evolution towards this target. Meanwhile, Elia continues to work on:

- Facilitating market access for all technologies
- Managing expected system imbalance increase
- Benefitting to the extent possible from cross-border flexibility




*Updated roadmap before starting implementation*

# 1. Introduction

## 1.2. Context

### 1.1.1 Reserve dimensioning framework

In line with Article 157(2)b of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereafter referred to as “SOGL”), Elia specifies the methodology to determine the FRR / aFRR / mFRR reserve capacity needs for its LFC block in its LFC block operational agreement. While FRR / mFRR needs are already dimensioned dynamically, i.e. on a daily basis based on the expected system risks, an implementation plan for a dynamic dimensioning of the aFRR needs was presented in 2020. These dynamic dimensioning methods are developed by Elia to minimize the reserve capacity needs due to increasing shares of variable renewable generation. More information can be found in Elia’s LFC block operational agreement[1].

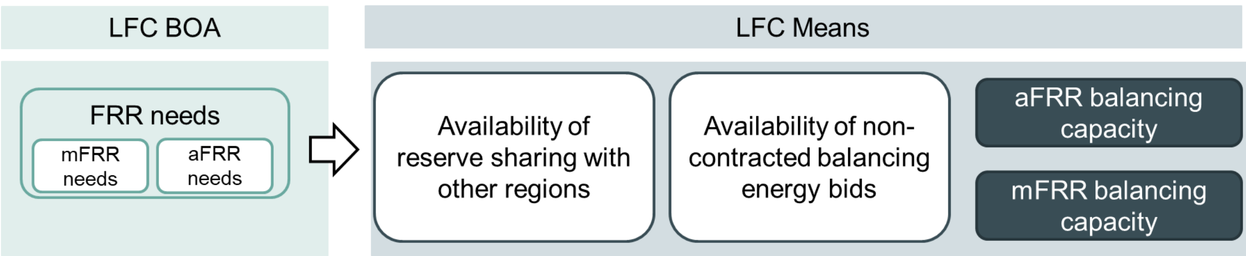



*Figure 1 – overview of the regulatory framework for the determination of Elia’s balancing capacity to be procured*

In accordance with Article 32 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing, hereafter referred to as “EBGL”, Elia conducts an analysis on optimal provision of reserve capacity. This analysis takes into account the following options for the provision of reserve capacity:

- procurement of balancing capacity within control area and exchange of balancing capacity with neighboring TSOs, when applicable;
- sharing of reserves, when applicable;
- the volume of non-contracted balancing energy bids which are expected to be available both within their control area and within the European platforms taking into account the available cross-zonal capacity.

Currently, Elia determines on an ‘ad hoc’ basis the share of non-contracted balancing energy bids and sharing of reserves which can be accounted as ‘firm’ in the determination of the balancing capacity to be procured.

Following this ‘static’ analysis, the aFRR balancing capacity is always considered to be equal to the aFRR needs (taking into account the absence of aFRR sharing and the limited potential of non-contracted energy balancing bids). The

[1] https://www.elia.be/en/electricity-market-and-system/system-services/keeping-the-balance

aFRR capacity is determined symmetrically meaning that the downward reserve capacity is equal to the upward reserve capacity. In contrast, the upward mFRR needs are assumed to be partially covered with the sharing of mFRR but not by non-contracted balancing energy bids, which are showing limited potential at least when analyzed on a ‘static’ basis. Finally, the downward mFRR needs are assumed to be fully covered with sharing of mFRR and non-contracted balancing energy bids. More information can be found in Elia’s LFC Means[1].

Elia is currently investigating the possibility to optimize the allocation of the required reserve capacity needs to contracted and non-contracted balancing means trough a dynamic calculation of the available balancing means, i.e. the available non-contracted balancing energy bids, the available reserve sharing and the required balancing capacity to be procured. This is in contrast to the current approach in which this allocation is still calculated periodically based on the availability of non-contracted balancing means, by subtracting the potential ‘firm’ non-contracted capacity from the required mFRR / aFRR balancing capacity to be procured.

### 1.1.2 Elia’s study on the daily prediction of non-contracted balancing energy bids

As a first step, Elia published in 2021 a study with the objective to analyze if Elia’s available non-contracted balancing energy bids for the next day can be predicted. For this, a machine learning approach was used in which algorithms are trained, based on historic observations, to predict the available non-contracted balancing means for each period of the next day. These non-contracted balancing means include the non-contracted balancing energy bids and the available reserve sharing with other TSOs. This prediction is assumed to be conducted before the balancing capacity auctions, in parallel with the daily dimensioning of the reserve capacity needs, i.e. at the latest 7 AM of the day for which the balancing capacity is to be procured.

The first conclusion was that the non-contracted upward mFRR balancing means can be predicted to an acceptable extent, demonstrating a potential volume of 500 MW, on average, while a volume of 1000 MW can be ensured for 14% of the time (Figure 2, left). It has to be remarked that a large contribution is provided by the available mFRR reserve sharing, of which a large part (250 MW) is currently captured in the ‘static approach’. Nevertheless, it can be concluded that there is a potential value for such prediction tool and this potential is expected to further increase with additional volumes brought by a consumer-centric market design and the upcoming EU balancing energy platforms. However, one of the main conditions to harness this value is to find appropriate procurement mechanisms to deduct this volume from the balancing capacity to be procured.

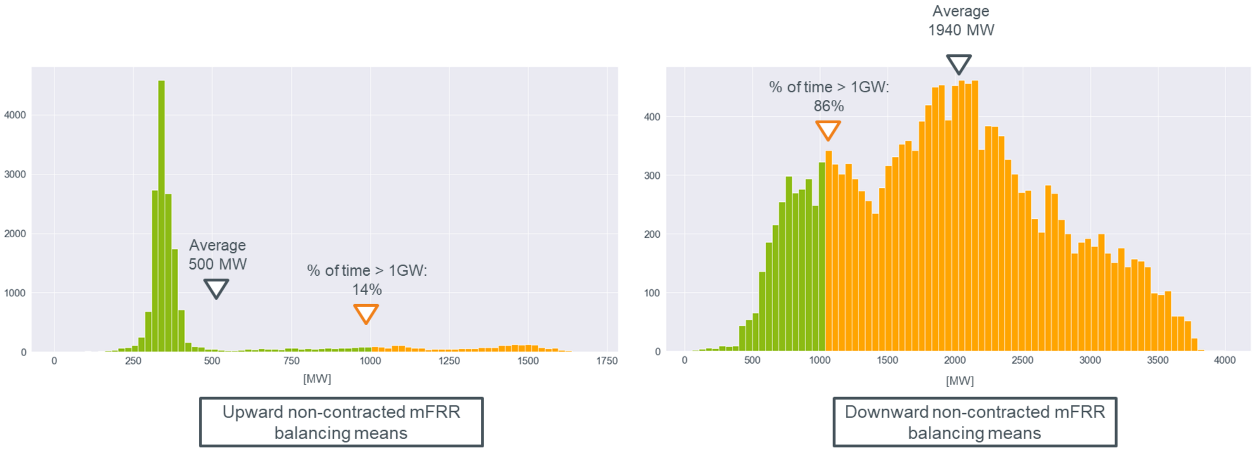



*Figure 2: Histogram of available non-contracted mFRR balancing means for upward (left) and downward (right)*

The second conclusion was that the non-contracted downward mFRR balancing means demonstrate a potential volume of nearly 1940 MW, on average, while a volume of 1000 MW can be ensured for up to 86% of the time (Figure 2, right). It is important to keep in mind that these volumes are generally lower than the observed availability. This is explained as the forecast tool aims to forecast guaranteed volumes, expected to be available with a 99.0% confidence level. For instance, when looking at the available volumes on the downward side over the same period (from April 16, 2019 until April 15, 2021), a volume of 1000 MW could be ensured for 97% of the time. The results confirm the current approach to not procure downward mFRR balancing capacity and it can therefore be concluded that there is no potential value for this prediction tool as long as observed non-contracted balancing means continue to cover the downward reserve capacity needs.

The third conclusion was that the results for the non-contracted aFRR balancing means demonstrate that no substantial volumes can be predicted at this point in time. This was explained by the fact that the available data was limited to only 9 months (as from the implementation of the new product design in October 2020) while during this period largest part of the time, no or very limited volumes were available, and this in particular for upward aFRR. Conclusion was that no potential for predicting the available non-contracted aFRR balancing means could be confirmed at this time due to the lack of a robust context and data set.

### 1.1.3 Implementation roadmap

Based on the above-mentioned results, Elia proposed to follow an implementation roadmap to pursue a dynamic calculation of the allocation of the balancing means (Figure 3). In first instance, a follow-up study was proposed to confirm the robustness of the algorithms and results, taking into account upcoming system evolutions, as well as recent system evolutions for which not sufficient data could have been collected to properly account in the machine learning exercises. Some foreseen evolutions are expected to have an effect on the available volumes of non-contracted balancing means which can be predicted, although it is currently very uncertain to which extend. This concerns :

- For aFRR, the new product design was only launched in October 2020 and suffered of teething problems. In addition, the connection to the European aFRR energy platform (PICASSO) in 2022 could not have been taken into account yet.
- For mFRR, explicit bidding, the reduction of the full activation time and the connection to the European mFRR energy platform (MARI) in 2023 could not have been taken into account. Nevertheless, these evolutions are expected to have a substantial impact on the results.

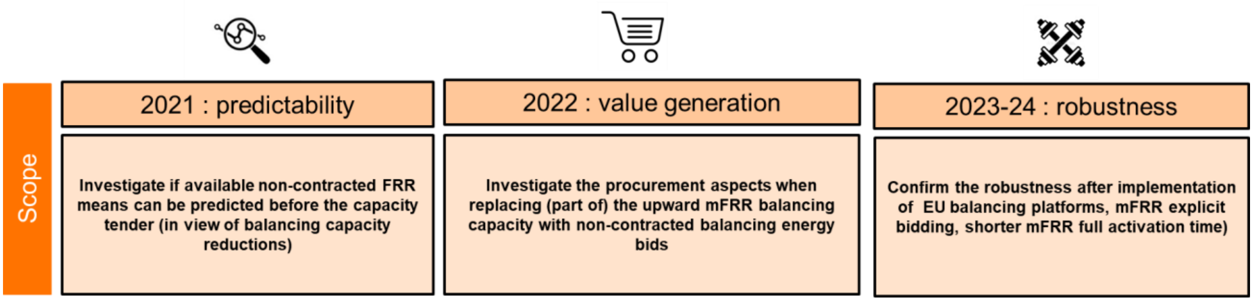


*Figure 3: Proposed implementation roadmap*

Although Elia will conduct its best efforts to make the methods as robust as possible, the algorithms are likely to be required to be updated after a return on experience on these evolutions. The robustness study was initially foreseen in 2023-24 following the implementation of market evolutions that were expected to take place in 2022. Due to a revision of the planning of these market evolutions in the second semester of 2023, this planning needs to be revised to 2025 (cf. recommendations presented in Section 4).

While awaiting the results of the robustness check, expecting to confirm the potential, Elia proposed to already analyze procurement aspects of a dynamic allocation in 2022. The analyses of this study, presented in this document, focus on the possibilities and impact of partially / intermittently reduce mFRR capacity procurement. Note that Elia also committed to, where possible, update in this study the analyses on the availability of non-contracted balancing energy bids. This update will be conducted for aFRR, but not for mFRR due to the above-mentioned revision of the planning of the foreseen market evolutions for mFRR, and to the unavailability of data based on explicit bidding. As explained, the latter is a prerequisite to analyze the availability of non-contracted balancing energy bids.

## 1.3. Objective, scope and approach

The objective of the study is to qualitatively examine possible solutions for the consideration of non-contracted balancing energy bids in the allocation of balancing means and to identify, for each approach, the benefits and risks for the parties involved, as well as the possible impact on market functioning. This includes:

- Investigation of different procurement strategies in Section 2, including a 'partial procurement' formerly analyzed in Elia study on dynamic procurement[2]
- Evolution of offered non-contracted balancing energy volumes and impact of new market evolutions to the extent possible (including 'go live' Picasso in 2022) in Section 3.1
- Analysis on potential interactions with reserve sharing and implementation of the EU balancing energy platforms in Section 3.2
- Update of the implementation roadmap based on the presented conclusions in Section 4.

The quantitative impact of mFRR market design evolutions (go live Mari, 12.5' full activation time and explicit bidding) on the results of the predictions of non-contracted balancing energy bids is considered out of scope of this report as the latest planning foresees an implementation of these evolutions in the second semester of 2023. Therefore, an update of the machine learning algorithms at this point would be of little use as the impact of these evolutions can only be captured after sufficient time after implementation.

Note that this study was supported by Compass Lexecon, specialized in power system economics and electricity market design. After preparing a detailed qualitative assessment of different procurement strategies, two workshops were organized with stakeholders:

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[2] https://www.elia.be/-/media/project/elia/elia-site/electricity-market-and-system---document-library/balancing---balancing-services-and-bsp/2018/2018-study-report-on-the-evolution-towards-a-daily-procurement-of-mfrr.pdf?la=en

- Workshop 1 to discuss possible solutions for a dynamic procurement and market impact
- Workshop 2 for in-depth discussion of feedback of the market parties

Based on the analyses, and the discussions during the workshops, a full report was written by Compass Lexecon, which is made available in Annex. The analyses presented by Compass Lexecon in this report are used by Elia to support the recommendations provided in this document. It is to be noted that the recommendations and positions taken in this document are the sole responsibility of Elia.

# 2. Assessment of dynamic procurement strategies

## 2.1. Identification of procurement strategy options

In its study, Compass Lexecon presented three dynamic procurement strategy options:

- **No procurement based on post-market re-scheduling**. In this option, no procurement of balancing capacity (at least of a certain type) is organized. If Elia anticipates a lack of balancing means in real time based on market participants' generation, storage and consumption programs, it decides to order re-scheduling or start-up of generation, storage or demand response assets in the intra-day timeframe to free up sufficient reserve capacity.

- **Intermittent procurement**. In this option, Elia avoids the procurement of balancing capacity in day-ahead when predicted available non-contracted balancing energy bids, complemented with reserve sharing, are sufficient to cover the entire reserve capacity needs. Should they not be sufficient, Elia would still procure the whole amount of required balancing capacity (except potentially the deduction of volumes provided through sharing of reserves with neighboring countries).

- **Partial procurement**. In this option, Elia reduces the balancing capacity volumes to be procured in function of the predicted available non-contracted balancing energy bids (and sharing of reserves). This option differs from the all-or-nothing procurement strategy presented in the intermittent procurement option.

Based on a stakeholder's suggestion, another potential strategy was analyzed aiming to increase balancing capacity procurement above the reserve capacity needs. This option implies raising network reliability standards for operational security above minimum criteria set by the legal framework specified in the system operation guidelines and the regulatory framework specified in the LFC block operational agreement. As this option deviates from the scope of this study on assessing dynamic procurement strategies, and focuses instead on increasing reliability levels beyond the minimum levels put forward in Article 157 of the SOGL, and implemented in the dimensioning method approved by the regulator in Elia's LFC block operational agreement, this is not further considered.

## 2.2. Identification of assessment criteria

Compass Lexecon presented five criteria to evaluate the different procurement strategy options:

- **Operational security:** this criterion assesses if the procurement option guarantees sufficient amounts of reserve capacity to cover system imbalances and ensures adequate levels of operational security in Belgium.

- **Economic efficiency**: this criterion assesses if the procurement option results in efficient real-time dispatch of generation, storage and demand response assets and if it does provide efficient long-term incentives to attract sufficient flexibility in the system. This criterion assesses the total costs to meet real-time demand and also includes the impact on the wholesale market as well as the impact on investment signals sent to flexible capacity to provide required balancing services.

- **Cost for grid users**: this criterion assesses if the procurement option allows to reduce system security costs for grid users through grid tariffs.

- **Market functioning**: this criterion assesses if the procurement option impacts the functioning of market mechanisms and price formation in balancing and wholesale markets and provides a clear and stable framework for market participants.

- **Legal compatibility**: this criterion assesses if the procurement option is compatible with European and Belgian legislation.

Amongst these criteria, the operational security and the legal compatibility were considered as 'decisive criteria' as an option that leads to an unacceptable level of operational security or that is not legally compliant would not be an acceptable solution, even if it scores well on the other criteria.

## 2.3. Impact assessment of dynamic procurement strategies

### 2.3.1 No procurement based on post-market re-scheduling

Not procuring upward mFRR capacity and relying on the re-scheduling of generation (or storage / demand response) units in the intra-day or balancing time frame will raise operational security risks. As demonstrated in the study on prediction of non-contracted balancing energy bids, situations where the volume of non-contracted upward mFRR means are below Elia's reserve capacity needs will occur frequently: according to Elia, the predicted non-contracted balancing energy bids were only larger than 1000 MW for 21% of the time between 2019 and 2021, resulting in the reserve capacity needs being uncovered for most of the time. In addition, the study comes with several disclaimers on these results following the uncertain impact of explicit bidding, shorter activation times and the connection the European mFRR platform foreseen in 2023.

- In the current market framework, this would translate in frequent balancing energy shortages, resulting into frequent area control errors. Without fallback measure, it is difficult to justify that Elia complies with Article 157(4) specifying that "*All TSOs of a LFC block shall have sufficient reserve capacity on FRR at any time in accordance with the FRR dimensioning rules. The TSOs of a LFC block shall specify in the LFC block operational agreement an escalation procedure for cases of severe risk of insufficient reserve capacity on FRR in the LFC block.*"

- Note that the LFC block operational agreement foresees an implementation of the escalation procedure as an exceptional balancing measure as from the implementation of the European mFRR energy platform (2023). This measure qualifies as a post-market re-scheduling as it entails the activation by Elia of units with a slow start to provide more upward mFRR in the balancing market. Note that this measure is foreseen to be exceptional by nature and may only involve generation units larger than 25 MW[3], and that the availability of the flexibility remains unguaranteed. It is thus unlikely that this measure will cover the operational risk specified in the previous paragraphs.

[3] Elia refers to its study of 2021 in which it proposed a design of the contractual and operational framework for enabling the participation of all technologies in the exceptional balancing measures

While it is doubtful that such approach is under the current circumstances compatible with the European legislation. It is to be stressed however that this might be different in the long run. If sufficient flexibility would be available, including through decentralized flexibility which is expected to develop strongly, and is able to cover almost systematically full reserve needs without contracting, this model could become feasible in terms of operational security and compatibility with the market framework. Indeed, sufficient flexibility could make potential re-scheduling actions sufficiently rare, and thus falling under the scope of exceptional balancing measure. The probability that this results in balancing energy shortages can be managed to be sufficiently low. In fact, this approach is to some extend comparable with the current assessment for downward mFRR balancing capacity, where sufficient downward flexibility is expected to be present to cover the needs.

Nevertheless, as the adequacy and flexibility study concludes that under the reference scenario, sufficient upward flexibility is not expected to be present before 2032 to facilitate this option for upward mFRR, Elia does not further consider this a feasible option for the coming years.

### 2.3.2 Intermittent procurement

A forecast of the available flexibility for the next day in order to assess if procurement of reserve capacity is deemed necessary would substantially reduce the operational risk compared to the previous method. However, compared to the current procurement strategy, important operational risk are also identified with intermittent procurement which will need to be managed:

- Firstly, avoiding balancing capacity procurement during some periods may impact the dispatch of certain units which were observed to deliver non-contracted balancing energy bids in the past. Indeed, some units might be dispatched following the delivery of balancing capacity and offer their remaining flexibility as non-contracted balancing energy. If these units would not be dispatched due to the absence of the balancing capacity tender, the non-contracted balancing energy would neither be available anymore, resulting in an under dimensioning. This issue can likely be addressed in the prediction method by filtering non-contracting balancing energy bids related to units delivering balancing capacity from the historic data on which the prediction algorithms are trained.

- Secondly, as any forecasting application, the prediction of non-contracted balancing energy bids is subject to a certain forecast accuracy. This can be managed by setting sufficiently high confidence intervals, such as 99.0% or higher. Note that the dimensioning of reserve capacity already assumes a reliability level of 99.0%, i.e. covering 99% of expected imbalances and that TSOs are ought to cover the resulting needs with 'firm' capacity. Question is which confidence interval when assessing the availability of non-contracted balancing energy bids can be considered sufficiently firm. In addition, one has to account that machine learning methods base their forecasts on historic data and are generally not performing well in capturing sudden evolutions. These issues can likely be addressed by setting a high confidence interval, e.g. above 99.0%, and by combining this with additional fallback measures such as the escalation procedure currently specified in the LFC block operational agreement.

Concerning the compliancy with the legal framework, it is assumed that as long as the above-mentioned risks are well managed and TSOs adequately cover the dimensioned reserve capacity with sufficient reliability, complemented with an escalation procedure, the approach is in line with Article 157(4) of the SOGL. Indeed, Article 32 of the EBGL explicitly permits to take into account the volume of non-contracted balancing energy bids which are expected to be available within the control area.

Nevertheless, the fundamental problem which arises with intermittent procurement is that it raises serious concerns regarding market stability. Based on its prediction of non-contracted bids' availability on given periods, Elia would organize or not an mFRR capacity auction. A lack of predictability and systematism of such auction may create an unstable market environment, raising barriers for participation or even result in operational errors. In particular, due to the absence of auctions on certain periods, smaller market participants may need to downsize their operating teams, fostering this kind of situations. This could be detrimental to the mFRR capacity auctions in the short and long run, reducing market liquidity and increasing risks for market power in the balancing energy market. Note that the problem of market stability could be limited if intermittent procurement arrangements follow regular patterns which are predictable and constant across time. Seasonal, monthly or weekly patterns of intermittent procurement would provide more visibility to market participants but such patterns could not be found in historical data.

While the operational security and legal compliancy criteria score similar to the partial procurement strategy discussed in the next section, the economic gains are per definition higher and market stability issues seem easier to manage in partial procurement. Now that it is shown that both approaches are feasible, an intermittent procurement is seen as inferior to partial procurement and is therefore not further considered.

### 2.3.3 Partial procurement

For the same reasons as intermittent procurement, partial procurement may raise operational risk due to forecast risks and dispatch impact. If this operational risk can be managed and TSOs are able to adequately cover their reserve capacity requirements following the dimensioning rules specified in Article 157 if the SOGL, no legal compliancy issues should be present as explained in the previous section.

Concerning market stability, the same issues as with intermittent procurement remain present but to a lower extent as balancing capacity requirements are expected to be more stable, and additional measures can be taken to limit the variability or reduce the prediction risks (generally at the cost of balancing capacity reductions). Nevertheless, the variability and limited predictability will always remain inherent aspects of a dynamic procurement strategy and might still discourage investment and participation in the balancing capacity market. This might in its turn increase operational risk when required reserve capacity cannot be covered due to a lack of market liquidity, or economic efficiency when this reduced liquidity translates into higher balancing capacity prices. Such liquidity problems may also translate in market power issues following a lack of competition.

Nevertheless, it is recognized that a partial procurement strategy may provide several economic gains. Firstly, the most obvious gain is the reduction of procurement costs following balancing capacity reductions. While the intermittent procurement strategy results in a volume effect (no procurement costs when reserve capacity needs are expected to be fully covered by the non-contracted balancing energy bids), the partial procurement strategy results in both (i) a larger volume effect (as there are also procurement cost reductions when reserve capacity needs are expected to be partially covered), and (ii) a price effect (the volume reduction is expected to reduce the marginal bid price, as well as impact the infra-marginal bid prices if BSPs would bid above their marginal costs in the pay-as-bid auction). However, the price effect should not be overestimated as periods with high volumes of non-contracted balancing bids are generally periods with large volumes of flexibility available, translating in lower balancing capacity prices. In addition, an indirect effect of lower balancing capacity requirements is that BSPs may downsize their investments following a decline in expected market revenues, which may counteract on the foreseen price reductions on the longer term.

Secondly, partial procurement will likely improve the dispatch efficiency in day-ahead and intraday energy markets, as demonstrated by Compass Lexecon. Freeing up capacity for participation in the wholesale energy market could improve the overall dispatch, increase competition and drive prices down. It is to be understood that this effect should not be overestimated considering the limited balancing capacity in Belgium compared to the size of the European wholesale market. Also, previous analyses have shown that mFRR balancing capacity is mainly provided with units with large marginal costs such as turbojets, gas turbines and demand response. For this reason, these units are generally not dispatched in the energy market

Besides the expected economic gains, there are also some negative effects put forward by the analyses of Compass Lexecon. First of all, prediction issues will result in costly re-dispatch measures and economic inefficiency (as part of the initially available capacity might have become unavailable close-to real-time due to start-up times or other technical constraints). Secondly, a balancing capacity reduction may risk to increase balancing energy prices as less balancing energy bids might be available and bids with higher energy prices at the end of the merit order would then be used more often. This effect can even be re-enforced when units falling outside the capacity tender due to higher balancing capacity prices offer low energy activation costs. Thirdly, part of the cost for balancing capacity might be transferred to the capacity remuneration mechanism following increased missing money of units formerly counting on revenues from the balancing capacity market.

It is clear that a partial procurement strategy would impact the allocation of costs to the grid incurred to ensure system security. While balancing procurement costs and energy market costs are expected to be reduced, the balancing energy costs, re-dispatching costs and capacity remuneration market costs are expected to increase. Note that these benefits and costs may impact grid users in a different way as some costs are socialized via grid tariffs or surcharges (balancing procurement costs, re-dispatching costs and capacity remuneration costs), while others are accounted to the user of the service (energy costs).

While a net benefit is likely to be realized, this is difficult to quantify due to the lack of tools which allow to capture the benefits and costs over the entire electricity system. This would require complex simulation techniques which are not available in the framework of this study.

# 3. Additional considerations

## 3.1. Evolution of non-contracted balancing energy bids

In its report on the predictability of non-contracted balancing energy bids, Elia conducted analyses on the available non-contracted balancing energy bids for aFRR and mFRR based on observations until June 2021.

For **mFRR non-contracted balancing energy bids**, implementation of explicit bidding for mFRR was foreseen after the study (delivered in 2021), which left no other choice than to resort to current implicit calculations where available bids are calculated by Elia, based on day-ahead and intra-day schedules of large generation units and pumped-hydro storage[4], taking into account the unit's scheduled availability, and minimum and maximum power levels.

An analysis of the available volumes in 2020 was presented in the report showing that upward volumes are predominantly delivered with pumped-hydro storage (PHS) and combined-cycle gas turbines (CCGT). It is however to be noted that the available volumes of pumped-hydro storage are uncertain due to implicit calculations by Elia, while the upward flexibility provided by CCGTs are overestimated following accounting capacity during unscheduled periods. The contribution of other technologies is relatively small. Note that the downward volumes are pre-dominantly delivered with pumped-hydro storage, CCGT units and wind power.

While Elia initially expected to already have some explicit bidding for units larger as 25 MW[5] data as from 2022 (initial implementation date of the EU mFRR platform), the implementation has been rescheduled to 2023. For this reason, it is not considered useful to conduct an update of the calculations at this point. Indeed, no substantial evolutions are expected to be observed while the limitations of the data persists.

In contrast, the **aFRR non-contracted balancing energy bids** in the previous study were already analysed based on the explicit bids received from market parties. In the report on the predictability of non-contracted balancing energy bids, Elia collected the relevant time series of up- and downward aFRR non-contracted balancing energy bids between October 2020 until June 2021.This was considered to be a relatively short time frame to analyze correlations with system conditions. In addition, the observations right after the implementation of a new product design could impact the representativeness of the data. Finally, it was demonstrated that most of the time low or negligible volumes of non-contracted balancing energy bids were observed.

Nevertheless, it was found that the largest part of the observed non-contracted balancing energy bids was provided with CCGT units, which can be related to the fact that these units were typically also scheduled for the provision of contracted aFRR balancing energy bids. Correcting the non-contracted volumes for these cases where they would not be available without the reservation of these units would even further increase periods with low or negligible volumes of non-contracted balancing energy bids.

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[4] $DP_{SU}$ formerly referred to as CIPU units falling under the bidding obligations following Article 248 of the Federal Grid Code.

[5] Note that in line with the results of the previous study on the predictability of non-contracted balancing energy bids, no significant volumes are observed in 2021, 2022 to be offered from explicit bids offered by smaller units (including energy constrained units), formerly referred to as non-CIPU units ('Bidladder').

While the potential for prediction on non-contracted balancing energy bids could not be confirmed in the first study due to the above-mentioned data limitations, the present study allows to update the historic availability to have a view on the evolution of non-contracted balancing energy bids for aFRR since the previous study. The analysis presented in Figure 4 based on a probability distribution of the data, as from August 1, 2021 until July 30, 2022 shows that on average, volumes of 6 MW (upward) and 39 MW (downward) were available. For the upward side, the distribution shows that the availability of the non-contracted balancing energy bids is relatively rare (70% of time less than 10 MW), and almost never exceed 30 MW. For the downward side, the availability of these volumes is relatively frequent (62% of the time larger 10 MW) with volumes which can sometimes exceed 50 MW, or even 100 MW. Nevertheless, these volume remain most of the time under 30 MW.

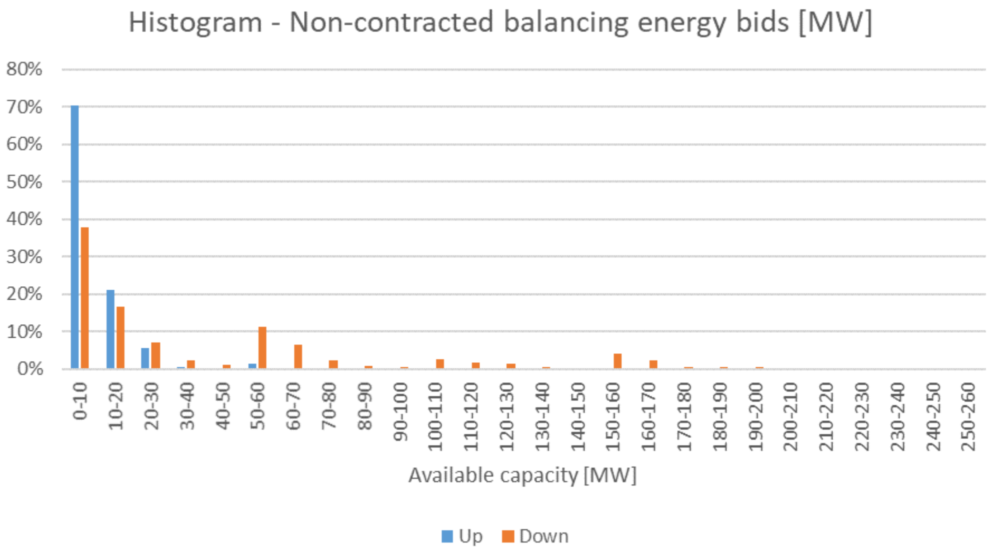


*Figure 4 – Distribution of available non-contracted balancing energy bids on aFRR*

Figure 5 depicts these volumes as average volumes available per month and per technology and demonstrates that available volumes are mainly provided with CCGT units, of which some are known to be related to co-generation processes. In second instance, some volumes seem to be offered by decentralized units (DP PG). Note that the participation of other technologies remain relatively limited. Finally, the result shows large variations over the months with higher volumes observed during the winter months.

It is concluded that the current potential remains uncertain, also for the downward side, as the volumes observed are likely further reduced when:

- Taking into account confidence bandwidths to allow predictions to operate with sufficient reliability levels (e.g. 99.0%). Nevertheless, it can be expected that some predictability might be expected following relations of the participating units with electricity prices.

- Taking into account corrections for balancing capacity procurement. Non-contracted bids from a unit contracted in up- or downward aFRR balancing capacity need to be filtered out to avoid overestimations.

It is concluded that it remains useful to continue to follow-up on evolutions of the aFRR market. In addition, the potential contributions of wind power following some pre-qualifications in 2022 could provide additional liquidity on the downward side.

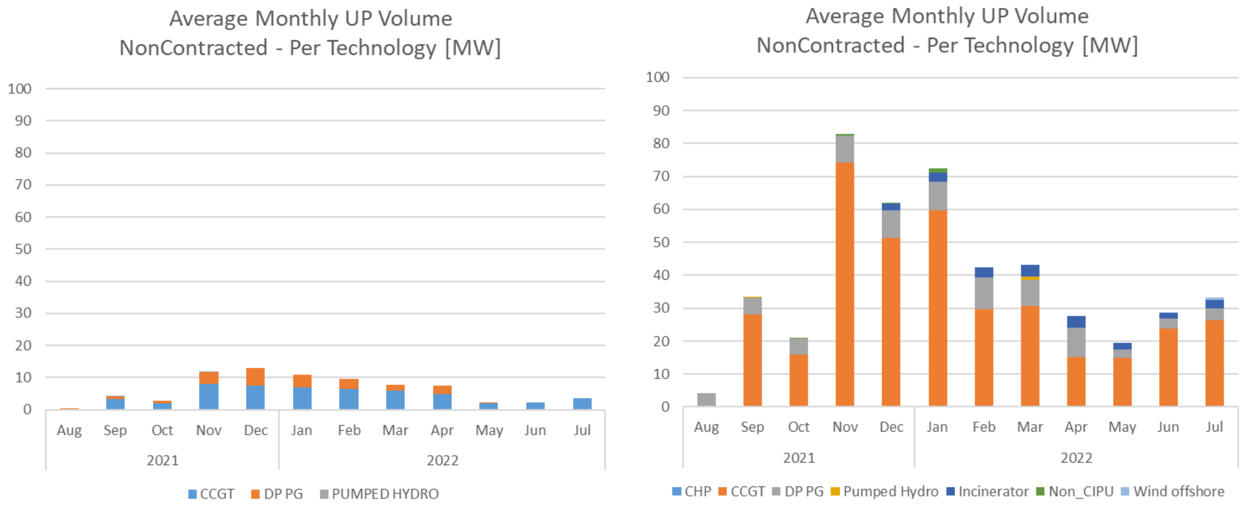


*Figure 5 : Evolution of monthly average of non-contracted balancing energy bid on aFRR per technology*

## 3.2. Relation with the contribution of cross-border flexibility

Besides non-contracted balancing energy bids expected to be available within the LFC block, Article 32 of the EBGL allows to take into account volume of non-contracted balancing energy bids which are expected to be available within the European platforms taking into account the available cross-zonal capacity. In other words, this could, on top of the contribution of the "local" non-contracted balancing energy bids discussed in this study, also allow the contribution of additional "cross-border" volumes following balancing energy bids submitted by other TSOs.

However, at this point in time, i.e. before the implementation of the balancing energy platforms and/or the connection thereto by a majority of TSOs, it is not clear which additional cross-border liquidity can be expected. A detailed analysis is obviously out of scope of this study due to lack of data but this section aims to already provide some reflections based on the available information.

First of all, it is, similar to the local non-contracted balancing energy bids, important that the volumes are sufficiently 'firm' which is likely to require a prediction before the procurement of balancing capacity. Developing such a prediction model would require sufficient data after the implementation of the platforms and is therefore subject for future investigations. One important element is that the balancing energy bids need to be available when requested by Elia, and therefore the prediction needs to somehow take into account the risk of simultaneous requests for activation by several TSOs.

Secondly, the availability of these volumes is related to the availability of transmission capacity. Today, available transmission capacity after the intra-day (which is considered available for balancing) is already relied on when assessing the potential contribution of reserve sharing in Elia's dimensioning. The contribution of additional cross-border flexibility in dimensioning requires additional transmission capacity after the intra-day time frame. Current volumes of reserve sharing are facilitated by observations of the available transmission capacity after intra-day (by means of statistical analysis based on four borders) and it is to be stressed that the future availability of these volumes are under no circumstances guaranteed as available transmission capacity after intra-day is a market variable, and depends on import and export positions of countries in a flow-based environment.

Thirdly, the implementation of the EU balancing energy platforms to which Elia intends to connect in 2022 (aFRR) and 2023 (mFRR) requires in principle to offer all available standard balancing energy bids on these platforms, and make them accessible to all participating TSOs.. This evolution requires particular attention to avoid double counting of energy via the sharing agreements on one hand and via non-contracted balancing energy bids observed in the platforms on the other hand.

Finally, there is no specific framework determining how non-contracted bids on EU balancing platforms can be taken into account in reserve dimensioning, contrary to reserve sharing for which Article 157 of the SOGL specifies certain rules and limitations. It is however clear that some level of regional coordination should be put in place to ensure operational security on the regional level to avoid that several TSOs are overly relying on the same energy volumes or network capacity. Such framework might be provided by the regional coordination centers in line with Article 37(1) of the Clean Energy Package (Energy Regulation), that specifies that *"each regional coordination center shall carry out at least all the following tasks of regional relevance in the entire system operation region where it is established: […]*

> *(j) regional sizing of reserve capacity;*
> *(k) facilitating the regional procurement of balancing capacity; […]"*

Elia is involved in above-mentioned discussions in order to support the development of a framework in which cross-border flexibility can be accounted in its reserve dimensioning and calculation of balancing capacity requirements, while taking operational security limits into account.

# 4. Conclusions and recommendations

## 4.1. Conclusions

This follow-up study on the on the daily prediction of non-contracted balancing energy bids investigates the feasibility of different dynamic procurement strategies for the allocation of non-contracted balancing energy bids in the calculation of the balancing capacity in line with Article 32 of the EBGL.

This study puts a partial procurement strategy forward as a feasible dynamic procurement strategy. Although no fundamental barriers are identified in the legal framework, attention needs to be paid to several risks including operational risk and market stability risks which need to be well managed including:

- Even if it is demonstrated that non-contracted bids available in the balancing market would likely be present as well in case of intermittent or partial procurement, it is shown that situations occur in which a reduced procurement induces changes in dispatch behavior and therefore also in the availability of non-contracted bids. This risk needs to be well covered in the algorithms used to make the predictions.

- It is recognized that forecasting the availability of non-contracted bids is not an easy task and it might be difficult to reach adequate volumes available at ‘firm’ availability level. Forecasting tools need to ensure a sufficient accuracy and to be able to anticipate sudden market evolutions.

- The absence of recurrent mFRR capacity auctions and the variability of volumes (in case of partial procurement) may affect the predictability of the market for market participants. The absence of clear patterns or trends could discourage market participation, or even result in operational errors at market side. It could be detrimental to the functioning of the balancing market in the short and long run and increase market power.

- In addition, reducing mFRR capacity procured could decrease mFRR energy market liquidity, leading to an increased risk of market power issues. Some generators could indeed gain a pivotal position more easily if fewer participants submit bids. This concern might be mitigated by the connection to the mFRR balancing energy platform, where local mFRR energy bids would compete against bids from other systems.

However, it is recognized that a partial procurement strategy may provide several economic gains. Firstly, the most obvious gain is the reduction of procurement costs following balancing capacity reductions. However, the effect should not be overestimated as periods with high volumes of non-contracted balancing bids are generally periods with large volumes of flexibility available, translating in lower balancing capacity prices. In addition, an indirect effect of lower balancing capacity requirements is that BSPs may downsize their investments following a decline in expected market revenues, which may counteract on the foreseen price reductions in the longer term.

Secondly, partial procurement will likely improve the dispatch efficiency in day-ahead and intraday energy markets. Freeing up capacity for participation in the wholesale energy market might also increase competition and drive prices down. It is to be understood that this effect should not be overestimated considering the limited balancing capacity in Belgium compared to the size of the European wholesale market. Also, previous analyses have shown that mFRR balancing capacity is mainly provided with units with large marginal costs such as turbojets, gas turbines and demand response. For this reason, these units are generally not dispatched in the energy market

Besides the expected economic gains, there are also some negative effects put forward. First of all, prediction issues will result in costly re-dispatch measures and economic inefficiency (as part of the initially available capacity might have become unavailable close-to real-time due to start-up times or other technical constraints). Secondly, a balancing capacity reduction may risk to increase balancing energy prices as less balancing energy bids might be available might be available and bids with higher energy prices at the end of the merit order would then be used more often. Thirdly, part of the cost for balancing capacity might be transferred to the capacity remuneration mechanism following increased missing money of units formerly counting on revenues from the balancing capacity market.

It is clear that a partial procurement strategy would impact the allocation to the grid users of costs incurred to ensure system security. While balancing procurement costs and energy market costs are expected to be reduced, the balancing energy costs, re-dispatching costs and capacity remuneration market costs are expected to increase. Note that these benefits and costs may impact grid users in a different way as some costs are socialized via grid tariffs or surcharges (balancing procurement costs, re-dispatching costs and capacity remuneration costs), while others are accounted to the user of the service (energy costs).  While a net benefit is likely to be realized, this is difficult to quantify due to the lack of tools which allow to capture the benefits and costs over the entire electricity system. This would require complex simulation techniques which are not available in the framework of this study.

## 4.2. Recommendations

Elia confirms its commitment to the implementation roadmap presented in the previous study but recommends an update of the implementation planning. Considering the postponement of the connection to the European balancing platform for mFRR, the robustness check of the algorithms and results can only be conducted in 2025 (instead of 2023-24), i.e. when disposing of sufficient reliable data after the implementation of the balancing platform, explicit bidding and the shorter full activation period. Note that :

- the local go live of the new mFRR bidding and iCAROS phase 1 is currently foreseen for late Q3 2023 while the connection to MARI (EU mFRR balancing energy platform) is currently foreseen in Q4 2023 ;
- the data in the first months after the 'go lives' end 2023 might not be representative as the market will likely need to adapt to these new evolutions ;
- at least one year (and preferably even two years) of representative data (so the entire year of 2024) is needed as input to train the machine learning model which explains that the analyses cannot be started before 2025.

The updated implementation planning is presented in Figure 6.

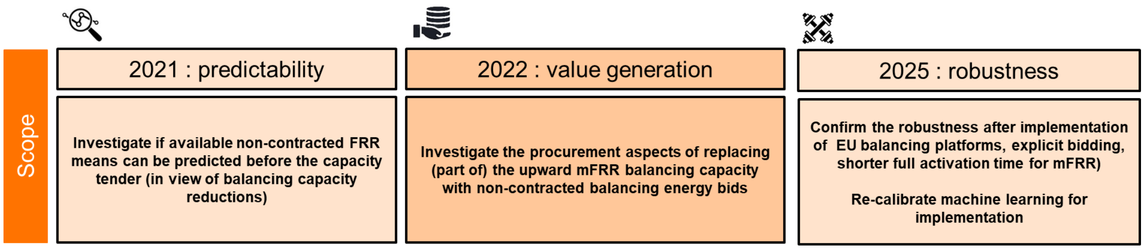


*Figure 6: Proposed update of the roadmap before starting implementation*

If after a positive outcome of this robustness check, sufficient reliability and volumes justify to implement a partial procurement strategy, an implementation can be realized towards 2027. Note that :

- the results of the robustness check have to be discussed first with the market (foreseen in 2025 after obtaining the results of the analyses in that same year);
- the implementation requires one year (including a proof of concept) and can be started begin 2026 after the discussions with the market which explains that the implementation cannot be finished before 2027.

Elia wants to stress that this implementation roadmap fits in its strategy to limit mFRR procurements to the extent possible as soon as there is sufficient guaranteed flexibility in the system following the integration of decentral flexibility (except during particular periods such as for instance near scarcity events). It therefore refers to its CCMD value model (presented in the WG Balancing) and its biannual flexibility study (as part of the adequacy and flexibility study). Meanwhile, Elia continues to focus on:

- Facilitating market access for all technologies
- Managing expected system imbalance increase
- Benefitting to the extent possible from cross-border flexibility

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# ANNEX

**Compass Lexecon, 2022, Procurement strategies for a dynamic allocation of FRR means - a report for Elia (31/08/2022)**