aFRR activation method

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Table of Contents

1. Introduction

A BSP offering an aFRR bid must be able to activate the entire volume within the Full Activation Time (FAT). In Belgium, the FAT is currently equal to 7.5 minutes[1].

The focus of the present study is the activation method for aFRR. Figure 1 illustrates the current process between the output of Elia's aFRR controller and the activation of the BSP.

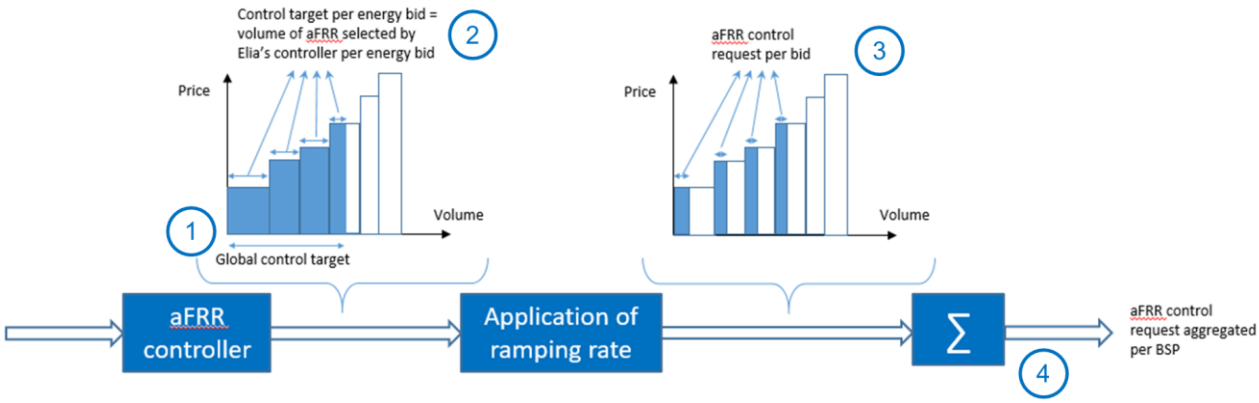

Figure 1: From the output of Elia's aFRR controller to the signal sent to the BSP

This process is repeated each 4 seconds time step[2]:

1. The aFRR controller calculates a "global control target". The global control target is expressed in MW and corresponds to the target aFRR volume to regulate the system during this time step.
2. The aFRR controller selects, according to a merit order activation mechanism, the aFRR energy bids that need to be activated and the control target (i.e. the selected volume) per aFRR energy bid.
3. The aFRR controller calculates the volume per aFRR energy bid to be activated (i.e. the aFRR Requested per bid), based a.o. on the ramping rate of the aFRR energy bids and the volume of the aFRR energy bids requested for activation during the previous time step. This is how the FAT is taken into account, by applying a ramping filter to the controller output corresponding to the FAT.
4. The aFRR Requested per bid are aggregated per BSP and sent to the BSP. Hence, the BSP receives one single "aFRR Requested" value, even when Elia activated more than one of its bids.

The BSP is expected to follow the signal it receives within a tolerance band. This activation method is said to be "control request" based and is further illustrated in Figure 2 below.

[1] According to the Implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation, the FAT of the standard aFRR balancing energy product will be reduced to 5 minutes by the 18th of December 2024

[2] A more detailed description of the functioning of the aFRR controller is provided in the Balancing Rules

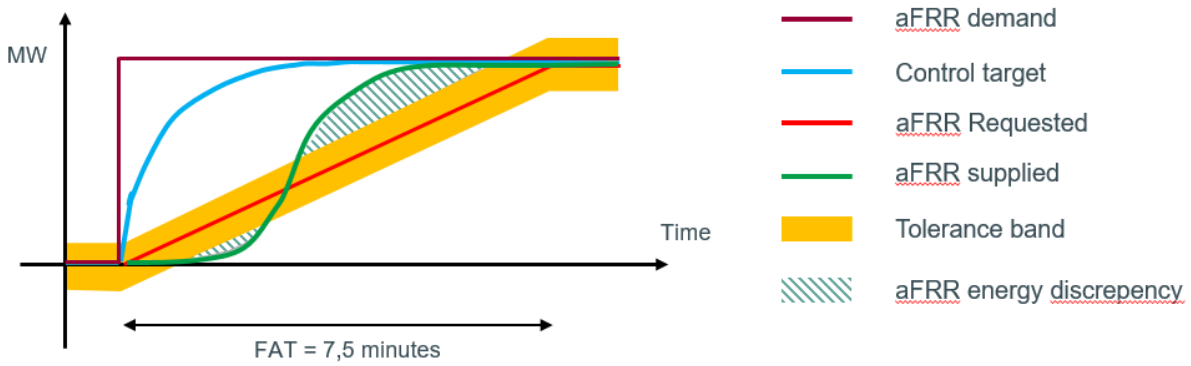

Figure 2: Activation method based on control request

Where, for each time step:

- The aFRR demand is the direct result of an imbalance[3].
- The control target corresponds to point 2 of Figure 1. For the sake of simplicity, the example assumes that the aFRR demand is to be covered by the activation of the full volume of one single aFRR energy bid.
- The aFRR Requested corresponds to point 4 of Figure 1 (same assumption) and is defined in the T&C BSP aFRR. The aFRR Requested is used for activation and remuneration of the BSP.
- aFRR supplied is the aggregated aFRR Power supplied by the BSP. It is transmitted in real-time by the BSP.
- The tolerance band refers to the permitted deviation $\delta_{perm(ts)}$ as defined in the T&C BSP aFRR. The BSP is expected to keep the aFRR supplied within the tolerance band defined around the aFRR Requested.
- The aFRR energy discrepancy is defined in the T&C BSP aFRR and will be used as a basis for the calculation of the activation control penalties.

This “control request” activation method has the following advantages:

- The BSP response is predictable.
- The principles of settlement, based on requested value and tolerance band, are of limited complexity.

In addition, for assets which do not have the technical capability to react faster than the FAT, any method which would incentivize a faster reaction would not have any concrete benefits. From that point of view, the historical choice to use a “control request” approach is logic, as the aFRR service was primarily delivered with thermal units with a limited ramping rate.

However, as illustrated in Figure 2, the current control request approach prevents the assets that have the technical capability to react faster to do so. As the aFRR market has been opened to all technologies at the end of 2020 and that assets capable of reacting faster are progressively increasing their market share, the question of defining an activation method incentivizing a faster reaction arises. The main principle would be to request the BSP to react as fast as possible

[3] It is assumed that Elia’s aFRR demand is fully to be covered by Elia, i.e. no netting with the IN-Platform, nor aFRR-exchange with the aFRR-Platform

(which corresponds to the control target of its energy bids), with a minimum requirement set equal to the FAT. This is illustrated in Figure 3 below.

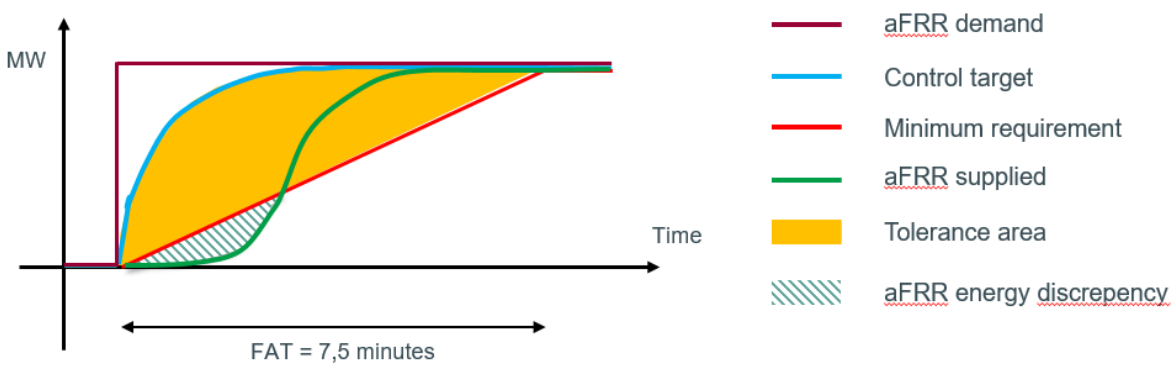

Figure 3: Activation method based on control target

Compared to the activation method based on control request illustrated in Figure 2, following differences are to be noted:

- The aFRR requested is replaced by a minimum requirement, in line with the 7.5 minutes FAT.
- The tolerance band is replaced by a tolerance area, which covers the zone between the control target and the minimum requirement.

Note that in practice, as some assets don't have the capability of reacting instantly (this is the case in the example illustrated: it takes some time before the aFRR supplied starts increasing), it could be considered to extend the tolerance area slightly below the minimum requirement.

This "control target" activation method is expected to have the following advantages:

- The BSP is not restrained to react faster. The control target approach allows to valorize the better reactivity of some assets, leading to an improved regulation, in particular to address the issues related to Deterministic Frequency Deviations (DFD)[4]. This is illustrated in Figure 3, where the BSP manages to reach the control target much sooner than the FAT.
- At the same time, the BSP benefits from additional flexibility in its reaction. This could be considered as a removal of an entry barrier to the participation to the aFRR service, in particular for assets not capable of following a ramped signal (even though pool-based activation already provides flexibility to the BSP in this).

It's to be noted that the activation method is not harmonized at European level.

The present study assumes that Elia will be connected to the aFRR-Platform before the activation method is modified. Should this not be the case, the incentives of the different methods described through the remuneration at the bid price instead of the Cross-Border Marginal Price (CBMP) during the activation phase may change.

[4] See Elia "Report on Deterministic Frequency Deviations: Lowering the contribution of the Belgian Control Block" (2020)

2. Scope of the study

The study consists of analysing the impacts for Elia and for the BSPs of an activation based on the "control target", defining the conditions under which this modification could be carried out and, in case of positive conclusions, proposing an implementation plan.

The following steps are foreseen in the study:

- Analysis of the impacts of an activation method based on the "control target" for Elia and for the BSPs in terms of:
    - Exchanges of data
    - Implementation in Elia's systems
    - Implementation in BSP's systems
- Definition of the conditions under which this modification could be carried out, in particular:
    - Impact on remuneration (which volume to use for settlement)
    - Impact on activation control
    - Impact on penalties
- In case of positive conclusions, proposal of an implementation plan

3. Activation methods based on control target

3.1. Introduction

The present section evaluates different options for designing a control target approach. Section 3.2 describes possible options on the volume to be considered for BSP remuneration, Section 3.3 describes the possible options in terms of activation control and Section 3.4 describes the impact on penalties for activation control. Those sections assume the activation of a one single aFRR energy bid. Section 3.5 describes the additional complexity and the consequences when multiple bids are activated. Finally, the side effects of changing from a control request to a control target approach on other processes are described in Section 3.6.

3.2. Volume considered for BSP remuneration

Figure 4 illustrates the activation and deactivation phases of an aFRR energy bid in the positive direction. As assumed in previous examples, the aFRR demand is considered to be covered by the activation of the full volume of one single aFRR energy bid.

Based on this, one could consider 3 options for the volume to be remunerated.

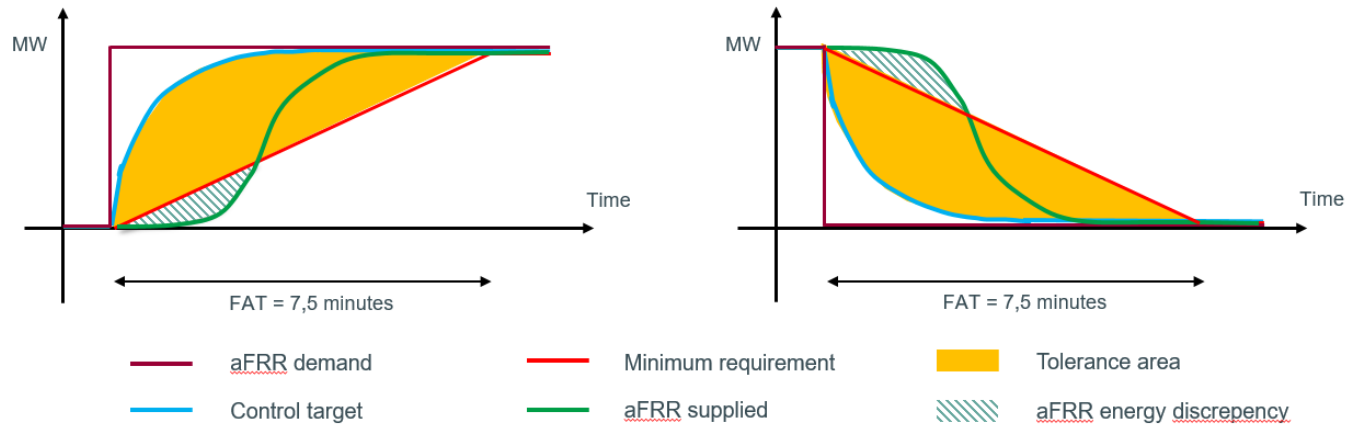

Figure 4: Activation based on control target – volume to be remunerated

It's to be noted that the examples used in the reasoning developed in the study are based on energy bids in the positive direction. Conclusions are also valid for energy bids in the negative direction.

3.2.1. Option 1: Remunerate minimum requirement

Compared to a control request approach, applying a control target approach and remunerating the minimum requirement (red curve) would allow to avoid penalizing the BSP when it delivers a volume which better satisfies Elia's needs (close to control target). However, the financial incentive for the BSP would not be to react faster, but to deliver less aFRR energy. As a result:

- In the activation phase, the BSP is incentivized to follow the minimum requirement. A faster reaction, closer to the control target, will induce additional costs to the BSP but will not be remunerated.

- In the deactivation phase, the BSP is incentivized to follow the control target, which is positive for the regulation quality. However, aFRR energy that was not delivered would have to be remunerated to the BSP.

Therefore, this option is not retained.

3.2.2. Option 2: Remunerate control target

A 2nd option would be to remunerate the control target (blue curve). In order to provide appropriate incentives, a tolerance band should be defined around the control target and deviations from this control band should be subject to penalties. This means that BSPs respecting the minimum requirement but not able to react faster would be penalized, which is not acceptable.

Therefore, this option is not retained.

3.2.3. Option 3: Remunerate aFRR supplied

The 3rd option is to remunerate the aFRR supplied (green curve). The impact on the incentives to react faster is the following:

- The method provides appropriate incentives in the activation phase, as the more volumes are delivered by the BSP, the more remuneration it receives. In addition, the remuneration during the activation phase is set to the CBMP, providing an additional margin to the BSP compared to the bid price.
- The method does not provide an incentive to react faster in the deactivation phase, as the BSP is still remunerated at its bid price and unpenalized as long as it remains within the tolerance area.

As a result, while we can't consider the incentives as optimal, remunerating aFRR supplied can potentially bring benefits to regulation quality, in addition to allow more flexibility to the BSPs in its reaction. Therefore, this 3rd option is evaluated more in detail in the next part of this Section.

3.3. Activation control

The activation control will be based on the tolerance area, which covers the zone between the control target and the minimum requirement. This is illustrated in Figure 5, in a situation where the control target remains stable after the activation phase.

Note: in practice, one observes that the tolerance area is reduced to 0 when the minimum requirement reaches the control target, leading to penalties as soon as the BSP is not delivering the very precise volume expected. Therefore, a detailed design of the activation control could include the definition of additional tolerance bands. For the activation phase of a bid in the positive direction, the tolerance bands would be defined below the minimum requirement and above the control target. This would also provide an answer to the constraint of some assets that don't have the capability of reacting instantly (see Figure 3). For the sake of simplicity, this is not taken into account in the illustrations from the present Section.

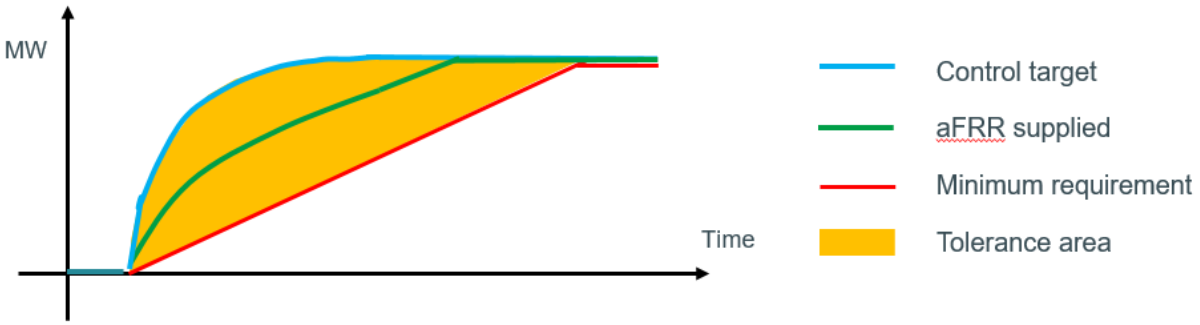

Figure 5: Activation control in a control target approach

When defining the borders of the tolerance area, different options can be considered in case the control target starts to decrease before the minimum requirement has reached the control target.

3.3.1. Option 1: Define minimum requirement based on the minimum requirement from previous time step

A 1st option is to start from the minimum requirement during the previous time step, as illustrated in Figure 6.

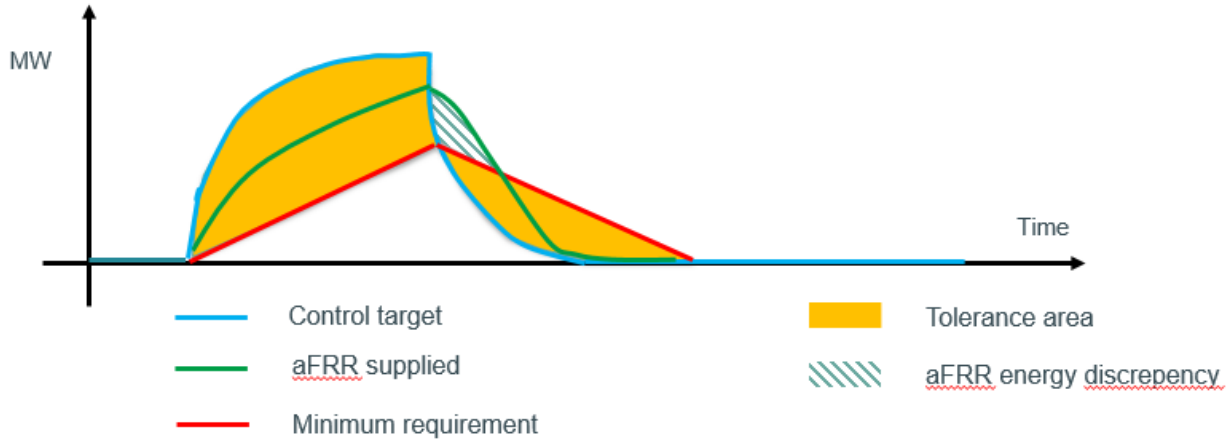

Figure 6: Activation control in a control target approach – option 1

In this configuration, a BSP who reacts faster than the minimum requirement in the activation phase would be penalized in the deactivation phase if he's not capable of reacting instantly to follow the control request, which is unfair and doesn't provide the right incentives in the activation phase.

Therefore, this option is not retained.

3.3.2. Option 2: Define minimum requirement based on the control target from previous time step

A 2nd option would be to start from the control target of previous time step, as illustrated in Figure 7.

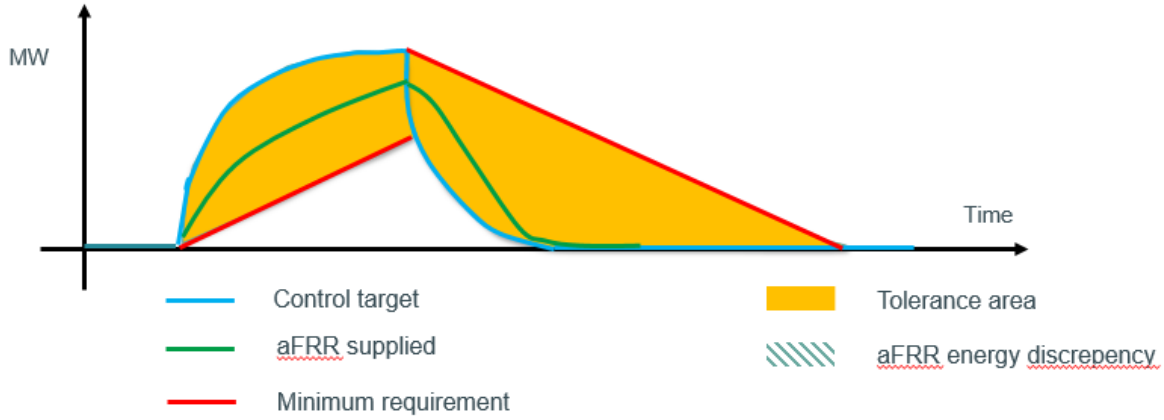

Figure 7: Activation control in a control target approach – option 3

In terms of incentives given to the BSP to react fast, Section 3.2.3 already identified that the control target approach does not provide an incentive to react fast in the deactivation phase. The present case shows that there's even a possibility for the BSP to react slower than with the current control request approach, without being penalized. In this situation, one observes that the tolerance band can become very large, with incentives in the deactivation phase that are significantly degraded compared to the current control request approach.

Therefore, this option is not retained.

3.3.3. Option 3: Define minimum requirement based on aFRR supplied from previous time step

A 3rd option is to start from the aFRR supplied during the previous time step, as illustrated in Figure 8.

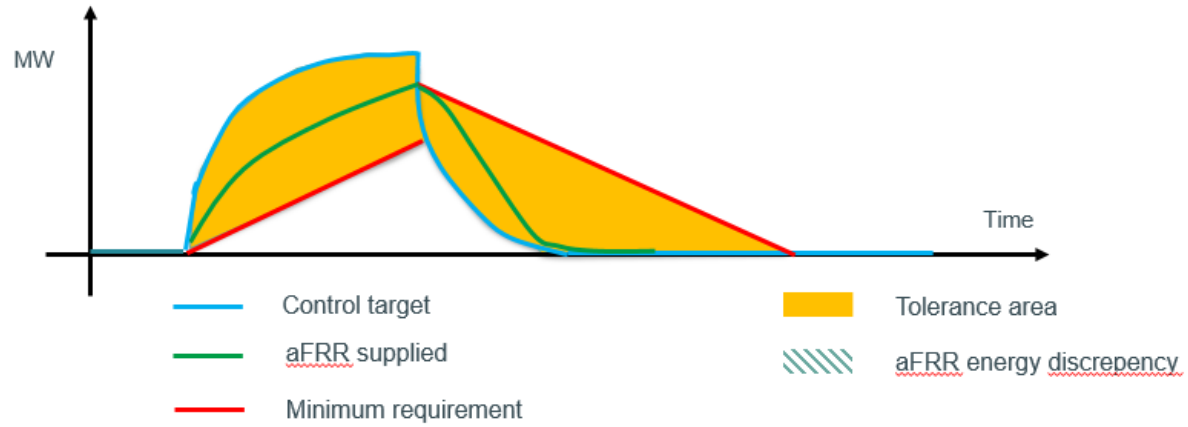

Figure 8: Activation control in a control target approach – option 3

In this case, the conclusion drawn in Section 0 is still correct but less pronounced, as the tolerance area is not as large. Therefore, among the options presented, this 3rd option is the one which will be further evaluated. The global impact on regulation quality, taking into account the benefits in the activation phase and the drawbacks in the deactivation phase, will depend on the aFRR activation dynamics and on the behaviour of the BSPs. At this stage, it's not possible to conclude that the change to a control target approach has a positive impact on regulation quality.

In addition, a specific calculation would be needed to determine the minimum requirement when the control target starts to decrease before the minimum requirement has reached the control target. For this calculation, the aFRR supplied would have to be computed in Elia's SCADA in order to calculate the minimum requirement and send it in real-time to the BSP.

Note that to cover the situation where aFRR supplied is below the minimum requirement at the moment the control target crosses the minimum requirement, the minimum requirement at the start of the deactivation phase should be based on the maximum (minimum in case of activation in the negative direction) between the aFRR supplied and the minimum requirement of previous time step. This is illustrated in Figure 9.

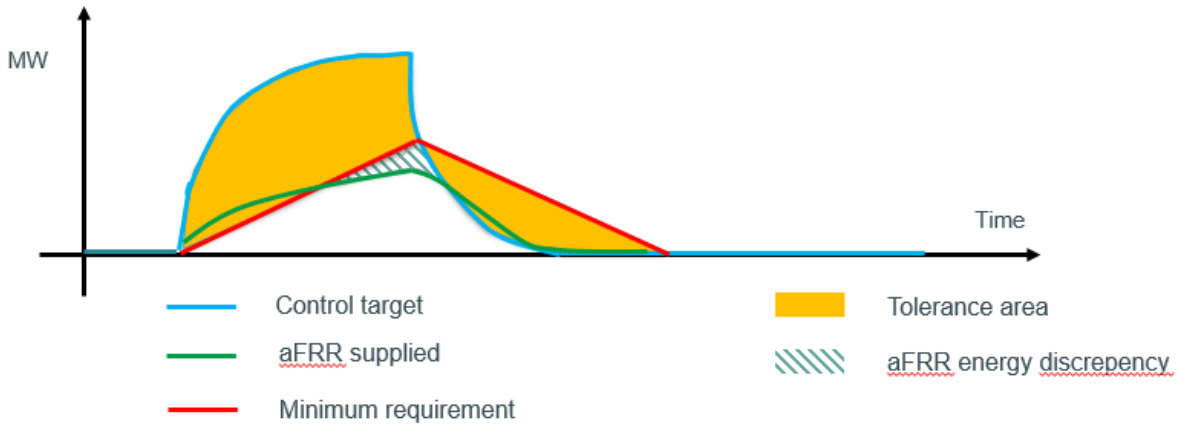

Figure 9: Activation control in a control target approach – option 3 – case of aFRR supplied below the minimum requirement

3.4. Penalties

Currently, the BSP is remunerated for the aFRR Requested, even in case of underdelivery. The financial penalty for activation control is higher than the remuneration, which is necessary to avoid incentives to not deliver the service.

When changing to a control target approach where remuneration is based on aFRR supplied, a BSP who would underdeliver would not be remunerated for the non delivered volumes and be penalized in the activation control. Therefore, the financial penalty for activation control in case of underdelivery should be calibrated accordingly.

Considering the other hurdles for changing to a control target approach identified in the present study and the alternative proposal, Elia has not worked out an adapted proposal of penalties for activation control.

3.5. Activation of multiple bids

The analyses done in Sections 3.2 and 3.3 consider the activation of a single bid from the BSP. Additional questions arise when considering the activation of multiple bids. The present Section considers the choices made above: remuneration based on aFRR supplied (Section 3.2.3) and minimum requirement in case of deactivation based on the aFRR supplied during the previous time step (Section 3.3.3).

The aFRR service is portfolio based: the BSP has the possibility to include a same Delivery Point in several bids and it can choose the Delivery Points it uses to perform the activations. As a result, Elia does not have the possibility to distinguish which volume is delivered by each bid, which raises the following questions as soon as one of the bids activated is not anymore selected by Elia's controller:

- When connected to the aFRR-Platform, the volumes in the activation phase are remunerated at the CBMP, while the volumes in the deactivation phase are remunerated at the bid price. Without the information of the aFRR delived per bid, the settlement process can't be performed. This is illustrated in following example:
    - Bid 1 has a volume of 15MW and a bid price of 150€/MWh.
    - Bid 2 has a volume of 15MW and a bid price of 250€/MWh.
    - The CBMP at a given time step is 200€/MWh. As a result, bid 1 is selected by Elia's controller and should be remunerated at the 200€/MWh (CBMP).
    - Bid 2 has been activated in previous time steps and is in the deactivation phase. It should be remunerated at 150€/MWh (bid price).
    - aFRR supplied is equal to 20MW. With the information available to Elia, it's not possible to distinguish which part of the 20MW is to be remunerated at 200€/MWh, and which part is to be remunerated at 150€/MWh.

  In a control request approach, this is solved by using the aFRR Requested per bid (aFRR $\text{Requested}_{\text{bid}}$) for remuneration.
- In case the control target starts to decrease before the minimum requirement has reached the control target, the ramping rate of the minimum requirement needs to be determined. The ramping rate will depend on which bid has already reached its control target and which bid is still ramping down, and hence on the aFRR supplied per bid. The same situation occurs when a bid in the positive and in the negative direction are linked: the information of when the 1st bid is fully deactivated is necessary to define the ramping rate.

Therefore, rules would need to be defined to assign the aFRR supplied to the different bids in order to calculate the remuneration and to define the minimum requirement. These rules would need to be implemented in Elia's real time processes.

3.6. Impact on related processes

When changing from a control request approach to a control target approach, the use of the aFRR Requested in several processes should be re-evaluated, for example:

- The calculation of the System Imbalance, of the aFRR demand sent to the IN-Platform and aFRR-Platform and of the input provided to the aFRR-Platform for the ACE calculation. These calculations are part of critical operational real-time processes. However, the Flexhub, which would be needed to access data reflecting the aFRR supplied, is designed to store and structure real-time data, but not to be integrated into critical operational real-time processes. This is potentially a blocking point for the implementation of a control target approach.
- The correction of the perimeter of the BRP_{BSP}. Currently, the perimeter correction is based on requested values. When changing to a control target approach, using the ramped signal would lead to imbalances from the BRP_{BSP} in case the BSP is delivering the service in a compliant way but more rapidly than the minimum requirement. This could also lead to a double payment of the energy delivered in excess of the aFRR requested.

Regarding the jumps in the activation signals as described in annexes 10 and 13.A of the T&C BSP aFRR, changing to a control target approach appears not to solve the issue for the BSP. Indeed, a specific handling of the settlement, as the one described in annex 13.A of the T&C BSP aFRR, would still be necessary when the bid is not anymore selected at the beginning of the quarter-hour.

4. Alternative proposal

Considering the conclusions of Section 3, Elia has worked out a pragmatic alternative proposal. The objective is to combine the advantages of the control target approach with those of the ramping approach:

- Allow BSPs capable of reacting faster to do so
- Maintain the efficiency and robustness of the use of aFRR requested in the activation, settlement and other operational processes

This proposal is described in the present Section.

4.1. Principles

The principles would be the following:

- The BSP has the possibility to specify an alternative FAT for an energy bid ($FAT_{energy\ bid}$) which is shorter than the 7.5 minutes FAT.
- The information is provided in each aFRR energy bid individually. The BSP may decide on a quarter hourly basis what the $FAT_{energy\ bid}$ of the aFRR energy bid is and this may vary each quarter hour. No prequalification is needed to demonstrate that the BSP can provide an aFRR delivery within a $FAT_{energy\ bid}$ shorter than 7,5 minutes.
- The $FAT_{energy\ bid}$ is the same in the activation and in the deactivation phases. Therefore, there is maximum one additional value to be provided per aFRR energy bid (an alternative is considered below).
- The information is optional. A BSP who doesn't use the opportunity for a shorter $FAT_{energy\ bid}$ doesn't have to change anything compared to the current bid submission process.
- The activation method is still based on a ramping approach, however:
    - The specified $FAT_{energy\ bid}$ is taken into account by Elia when calculating the aFRR Requested, leading to a faster regulation.
    - The tolerance band is computed around the calculated aFRR Requested. Note that the permitted deviation is unaffected (calculation according to annex 13.B of the T&C BSP aFRR).

In practice, an additional field would be added for energy bid submission in BIPLE. When no value is specified, the standard 7.5 minutes FAT will be used.

A distinction can be made between the $FAT_{energy\ bid}$ in the activation phase and in the deactivation phase. The advantage for the BSP is to provide additional flexibility for assets with Limited Energy Reservoir (LER) to manage their State of Charge (SoC), as further explained in Section 4.3. However, as it cannot be the objective that an artificial volume of aFRR is delivered and remunerated in the deactivation phase, the constraint would be to have the $FAT_{energy\ bid}$ in the deactivation phase at least as short as the $FAT_{energy\ bid}$ in the activation phase. Table 1 shows examples of combinations which would be allowed and not allowed.

$FAT_{energy\ bid}$ activation phase	$FAT_{energy\ bid}$ deactivation phase	Allowed?
7.5 minutes	2 minutes	✓
2 minutes	2 minutes	✓
2 minutes	7.5 minutes	✗

Table 1: allowed combinations of $FAT_{energy\ bid}$ when making the distinction between activation and deactivation phases

4.2. Implementation efforts

The alternative proposal entails limited efforts both from Elia and from the BSPs:

- Elia would need to amend the T&C BSP aFRR: currently, Annex 9.A (Specifications for aFRR Energy Bids) specifies that the ramping rate is based on a 7.5 minutes FAT. This would need to be adapted to describe that the BSP has the possibility, on a voluntary basis, to specify a shorter $FAT_{energy\ bid}$.
- IT developments are required at Elia side in order to:
  - Be able to distinguish the FAT between bids in the bidding tool
  - Consider this difference in the computation of the aFRR requested
  - Consider this difference in the activation control
- On BSP's side, developments would be needed to be able to specify the $FAT_{energy\ bid}$. It's to be noted however that the information will be optional, meaning that BSPs which don't intend to use this possibility, don't need to make any development.

4.3. Incentives for the BSP

As the use of a shorter $FAT_{energy\ bid}$ is optional, it's important to evaluate whether the possibility provides an incentive to the BSPs to actually use it. This is described in the present Section.

4.3.1. Financial incentive

There is a financial incentive for the BSP to specify a shorter $FAT_{energy\ bid}$, which is illustrated in the 2 cases below. The examples also show how a shorter $FAT_{energy\ bid}$ improves regulation quality. For the sake of simplicity, the reaction time of the aFRR controller is not taken into account in the examples.

The 1st case is illustrated in Figure 10, where following assumptions are made:

- Bid 1 and bid 2 have the same volume and price, bid 2 has specified a shorter $FAT_{energy\ bid}$.
- The bid volume is 10MW and the bid price is 150€/MWh.
- The CBMP during the 1st half of the quarter hour is 250€/MWh. As a result, the full volume of the bids is selected for activation.

- The CBMP during the 2nd half of the quarter hour is 100€/MWh. As a result, the bids are not anymore selected for activation.

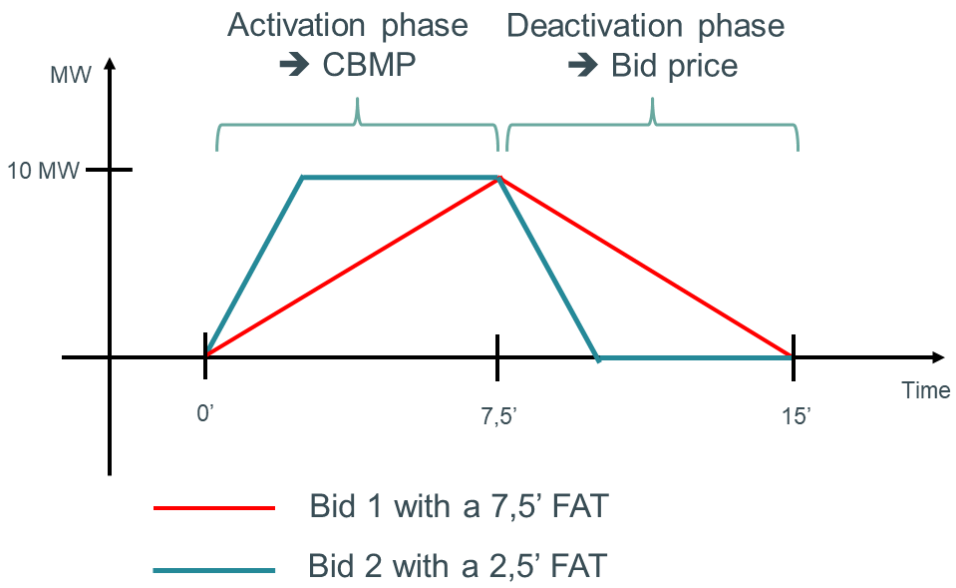

Figure 10: impact of defining a shorter $FAT_{energy\ bid}$ – case 1

This results in the following remuneration:

- Remuneration Bid 1 = 250€
- Remuneration Bid 2 = 292€

The total requested volumes are identical. The higher remuneration for bid 2 is explained by the higher volume requested in the activation phase, remunerated at the CBMP, while the lower volumes requested in the deactivation phase are remunerated at the bid price.

The 2nd case is illustrated in Figure 11, where following assumptions are made:

- Bid 1 and bid 2 have the same volume and price, bid 2 has specified a shorter $FAT_{energy\ bid}$.
- The bid volume is 15MW and the bid price is 150€/MWh.
- The CBMP during the 1st 2.5 minutes of the quarter hour is 250€/MWh. As a result, the full volume of the bids is selected for activation.
- The CBMP during after 2.5 minutes is 100€/MWh. As a result, the bids are not anymore selected for activation.

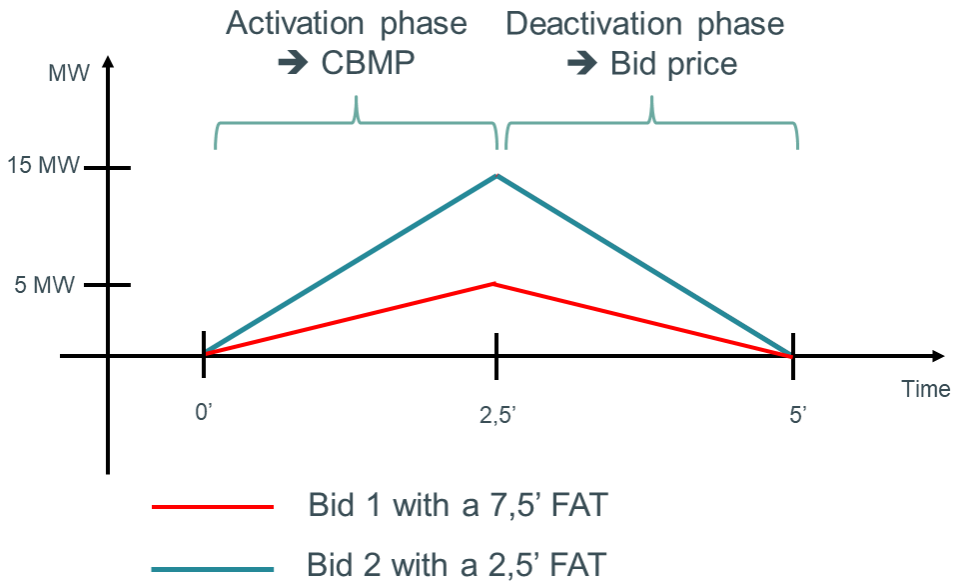

Figure 11: impact of defining a shorter $FAT_{energy\ bid}$ – case 2

This results in the following remuneration:

- Remuneration Bid 1 = 42€
- Remuneration Bid 2 = 125€

In this case, the difference is explained by the higher volume requested to bid 2.

4.3.2. SoC management

Assets with LER can use the functionality to support the management of their SoC. For example, if the SoC is getting close to 100% while the BSP is offering aFRR energy bids in both directions, it could specify a shorter $FAT_{energy\ bid}$ for its bid in the upwards direction. By doing this:

- The volumes requested / activated in the upwards direction will be higher, recovering a more optimal SoC.
- The BSP provides a better answer to a need for aFRR from Elia, improving regulation quality.
- The BSP has the possibility to limit the use of back-up assets and ID trades, hence reducing its costs.

5. Conclusions

The analysis of the control target approach leads to the following conclusions:

- Remunerating the minimum requirement or the control target are unsuitable designs
- Hence, the only suitable option would be to remunerate the aFRR Supplied. This would allow more flexibility to the BSPs in the reaction of its pool. However:
    - While it would improve incentives in some situations, the evaluation highlights that this is not always the case. At this stage, it's not possible to conclude it would have a global positive impact on regulation quality
    - It would imply a significant design and implementation impact, namely:
        - The design and implementation of rules to assign the aFRR supplied to the different bids in order to calculate the remuneration and to define the minimum requirement
        - The implementation of a specific calculation in Elia's EMS to determine the minimum requirement when the control target starts to decrease before the minimum requirement has reached the control target
        - The implementation of additional signals to exchange between Elia and the BSP (at least the control target and the minimum requirement)
        - The implementation at the BSP's side to steer assets based on a control target and a tolerance band instead of the aFRR Requested
        - The re-calibration of the penalties for activation control
        - The definition and implementation of alternatives to the use of aFRR Requested in real-time operational processes. The feasibility of these alternatives would have to be confirmed.

Based on these findings, an alternative approach is proposed, as described in Section 4.1, which combines:

- The expected advantages of the control target approach in terms of incentive for the BSP to react faster; and
- The advantages of the ramping approach in terms of simplicity of the design. The alternative approach has the advantage also to be relatively simple to implement on BSP and Elia side.

6. Implementation plan

The implementation of this recommendation requires amendments to the T&C BSP aFRR. Currently, Annex 9.A (Specifications for aFRR Energy Bids) specifies that the ramping rate is based on a 7.5 minutes FAT. This would need to be adapted to describe that the BSP has the possibility, on a voluntary basis, to specify a shorter $FAT_{energy\ bid}$ (and deactivation time, if applicable).

In addition, as described in Section 4.2, IT developments are required at Elia's side. Those developments are expected to be feasible in parallel of the amendment process of the T&C BSP aFRR.

On BSP's side, developments are necessary to be able to specify the $FAT_{energy\ bid}$. It's to be noted however that the information will be optional, meaning that BSPs which don't plan to use this possibility don't need to make any development.

Based on this, Elia proposes to include this modification during the next proposal for amendment of the T&C BSP aFRR. The timing of this future amendment is still to be determined based on a general roadmap of projects related to balancing.