DRAFT:

Chapter 4.1.1. – Full Activation Time of the Explanatory Document to All TSOs' proposal for the implementation framework for a European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation in accordance with Article 21 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

31/10/2018

4.1.1. Full Activation Time (FAT) and Deactivation

The Full Activation Time ("FAT") defines the maximum allowed duration for the full activation or deactivation of a standard aFRR energy bid. The compliancy of each BSP with the FAT requirement is checked during the prequalification process and is later translated into local monitoring rules. In case of activation or deactivation of a bid of a BSP, the BSP has to deliver the requested volume at latest within the FAT to be compliant.

Currently, the aFRR FAT requirements of the European countries cover a wide range from 2 to 15 minutes and reflect the local generation structures and requirements. In the process of creating common European markets for balancing energy, these requirements must be harmonized to create a full level playing field for BSPs and ensure a comparable behaviour of BSP in case of imbalances, regardless of the structure of the Common Merit Order List. For the selection of a future harmonized FAT value and a harmonization roadmap, the following main aspects have been considered:

- The activation speed of balancing products has a direct impact on the resulting frequency restoration control error (FRCE) and the quality of the system frequency. Hence, the maximum FAT has to be short enough to fulfil the FRCE and frequency target parameters required by Commission Regulation (EU) 2017/1485 ("SOGL").
- The FAT has to be long enough to ensure the availability of the required capacities on the local capacity markets and facilitate liquid markets for aFRR capacity and energy.

From previous ENTSO-E discussions, the number of feasible candidates for FAT was limited to two: 5 and 7.5 minutes. These two candidates have been qualitatively and quantitatively assessed in detail, considering the abovementioned aspects of frequency quality and impact on capacity procurement.

Technical assessment

In order to qualitatively assess the impact of the aFRR FAT on the FRCE quality, TSOs simulated the aFRR activation process for the LFC blocks of Austria, Belgium, France, Germany and the Netherlands with different assumptions for the FAT. The resulting FRCE quality has been compared with the target parameters defined in the SOGL.

Since these LFC blocks constitute a large part of the interconnected network of Continental Europe (CE) and their generation structures reflect the heterogeneous generation in CE, the impact of the FAT on the combined FRCE of these LFC blocks is also a proxy for the impact on the CE system frequency. In this spirit, the impact of the FAT of these five control blocks on the CE frequency quality has also been simulated and compared to the frequency quality targets in SOGL.

The simulations have been performed on the basis of historical aFRR demands, available aFRR and energy exchanges due to imbalance netting of one complete year (April 2016 – March 2017). For the simulation, merit order activation has been assumed for all LFC blocks, since this activation scheme is a requirement from the EBGL. Moreover, it was assumed that the BSPs will react according to the FAT requirement. The sensitivity of the major results to the increase of the available aFRR band and to the change of controller settings has also been analyzed.

The major results of the assessment are:

- Under the given assumptions, at least one LFC block does not comply with the level 2 FRCE target parameters when choosing a FAT of 7.5 minutes.
- The global FRCE quality of the assessed control blocks (Figure 5) which is seen as a proxy for the frequency quality in the studied area would be better than the historical quality when choosing a FAT

of 5 min and worse when choosing a FAT of 7.5 min. This result is however strongly sensitive to the degree to which BSPs react faster than the minimum requirements.

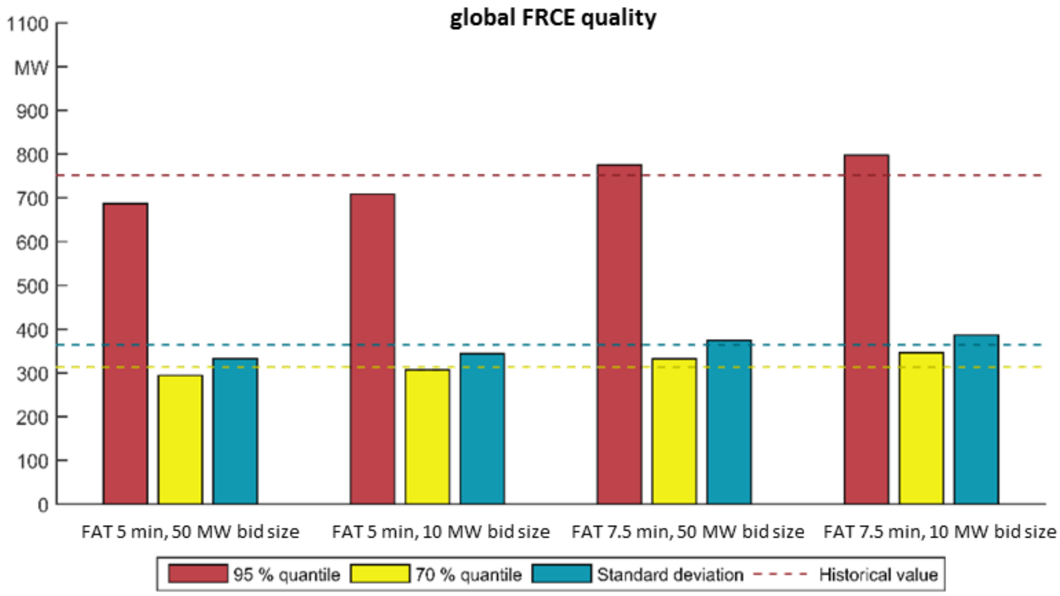

Figure 1: Simulation results for the global FRCE quality

- The frequency quality target of a maximum number of 15,000 minutes outside the standard frequency range of Continental Europe will be fulfilled with a FAT of 5 min but will not be fulfilled with a FAT of 7.5 min (see Figure 6).

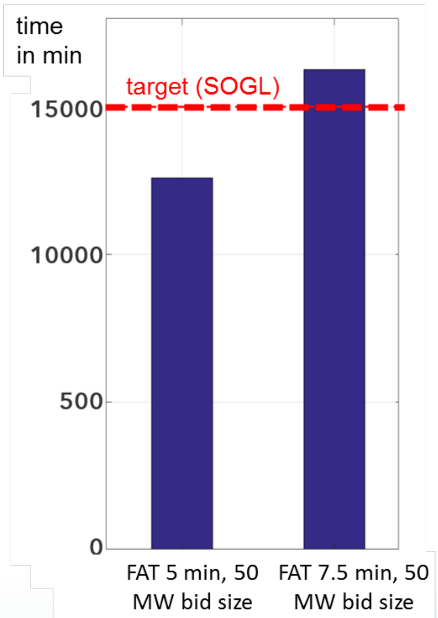

Figure 2: Simulated yearly minutes outside the standard frequency range of Continental Europe

- The increase of the available aFRR band, which could be achieved by an increased procurement of reserves or the availability of free bids, cannot compensate the impact of a slow FAT on the fulfilment of the frequency and FRCE quality targets. Particularly in LFC blocks with very volatile imbalances and frequent sign changes of the aFRR demand, an increased procured capacity does not increase the FRCE quality in case of a FAT of 7.5 min.

Economic assessment

In addition to the technical assessment, some TSOs (Elia and RTE) performed an economic assessment to identify the impact of a FAT reduction on volume of offered aFRR capacity bids and the impact on aFRR capacity procurement cost. This assessment aims to be generic and relatively easy to be applied by each TSO. Therefore, assumptions with a certain degree of simplifications were identified. PICASSO TSOs consider these assumptions as valid for a change of FAT in a range between 5 and 15 minutes.

- In case FAT is decreased compared to a TSO's current local standard, the aFRR capacity offered by thermal units (CCGT, coal fired, nuclear) connected on this TSO's grid is reduced linearly with the FAT decrease.
- A FAT change has no impact on offered aFRR capacity for non-thermal units (PV, demand side management, hydro, wind, batteries)
- Relative price effect due to expected setpoint changes of units and corresponding increase of opportunity costs, in particular when units are facing a must-run situation.
- Impact of setpoint changes on efficiency and corresponding impact on costs is neglected
- Any new providers and/or changes in bidding behaviour due to the potentially increased prices are neglected

The table below summarizes the main characteristics of the French and Belgian aFRR market:

	Belgium (Elia)	**France (RTE)**
Current FAT	7,5 minutes	6,7 minutes (400 seconds)
Dimensioned aFRR volume	≈ 140 MW	[500 MW – 1200 MW] (dynamic band) (≈ 660 MW on average)
Type of aFRR providers	Gas units (CCGT)	Nuclear, coal, gas, DSM, hydro

Table 1: French and Belgian aFRR markets

In order to estimate the impact of a FAT reduction to 5 minutes on available aFRR volumes and procurement costs, the two TSOs used two different approaches:

- RTE used a cost-based approach: the impact is estimated based on individual characteristics of the different aFRR providing technologies (available volumes, availabilities of production units, etc.) and assumptions on fuel costs.
- Elia used a market-based approach: based on historical records of aFRR bids, the volume and price effects caused by the FAT reduction are estimated. Besides this, a simplified cost-based assessment and a sensitivity analysis of the results on the clean spark spread were also performed.

From its analysis, RTE estimates that a FAT reduction from 6,7 minutes to 5 minutes would cause an aFRR procurement cost increase of approximately 26 Mio € per year (+ 54 %). This increase is mainly caused by the fact that the reduction of aFRR capacity offered by coal and gas power plants forces to reserve more aFRR on nuclear units. Since the opportunity cost is much higher on nuclear, aFRR capacity procurement cost increases accordingly.

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In the case of Elia, the FAT reduction from 7,5 minutes to 5 minutes would cause an increase of aFRR procurement cost between 8 to 20 Mio. € per year (between +20 % and +50 %). This increase is mainly caused by the fact that the reduction of aFRR capacity offered by gas units forces to reserve aFRR on a broader and/or less optimal set of production units; this leads to big increase of must-run costs for aFRR capacity procurement. As a consequence, this result is highly sensitive to the clean spark spread evolution. In the case of Belgium, liquidity issues were detected for 5 weeks out of the studied year.

It is interesting to note that despite the root cause of the cost increase being the same (FAT reduction), the mechanics behind it are very different: in France, the cost increase is driven by an increase of average opportunity cost for aFRR (more aFRR has to be reserved on units that would like to produce at full power), while in Belgium, it is driven by an increase of must-run costs (more / less optimal units have to be put in service in order to offer the required aFRR). PICASSO TSOs considered that this assessment was sufficiently diverse and representative enough of what could happen to "slower" TSOs if FAT of 5 minutes was chosen. Therefore, a detailed assessment was not performed for each participating country.

Considered options

When the results of the technical and economic assessments are brought together, it can be concluded that both FAT options have unacceptable impacts for some TSOs. This statement is globally confirmed by the stakeholders' consultation:

- On the one hand, many BSPs already displaying a FAT of 5 minutes (or even less) strongly emphasise their wish to keep a 5 min FAT, arguing that a longer FAT would be an issue for ensuring a level playing field and / or would reduce the differences in ramping requirements between aFRR and mFRR products by too much.
- On the other hand, some BSPs displaying a longer FAT confirmed that the FAT reduction to 5 minutes would have a significant impact on the volumes that they could bid on the aFRR capacity market.

Facing this scenario, TSOs investigated multiple options, which are not limited to plain values of the FAT but also include combinations with measures to mitigate the technical or economic shortcomings that might result for some TSOs. These measures include the use of specific products according to Article 26 of the EBGL for a limited timeframe after the start of the platform. Additionally, different combinations of the FAT and the maximal cross-border ramping period have been analyzed. The maximal cross-border ramping period is used by the FRCE Adjustment Process (FAP) for the division of the responsibility for the FRCE resulting from slow aFRR activation between the exporting and the importing TSO (see Chapter 5.5). TSOs only studied mitigation measures which could be taken in the scope of the project, excluding local mitigation measures and other measure specifically targeting Deterministic Frequency Deviations (DFDs).

The following options have been considered:

Option 1: aFRR standard product FAT of 5 minutes, local specific products with longer FAT

With this option, the FAT of aFRR standard products and the maximum cross-border ramping period are equally set to 5 minutes. If the liquidity on a local market for aFRR capacity is not sufficient, TSOs have the choice to procure additional capacity using specific products with a longer FAT. However, these specific products are only used locally: they are not forwarded to the Common Merit Order List (CMOL). As shown on Figure 7 and Figure 8, this can be done in two different ways, depending on whether the conversion of specific aFRR bids with longer FAT into standard aFRR bids is performed or not. This conversion can be done by asking BSPs to communicate which part of the volume of each specific bid can be delivered within the harmonized FAT. The rest of the volume of the bid can be activated only if the standard part is already fully activated.

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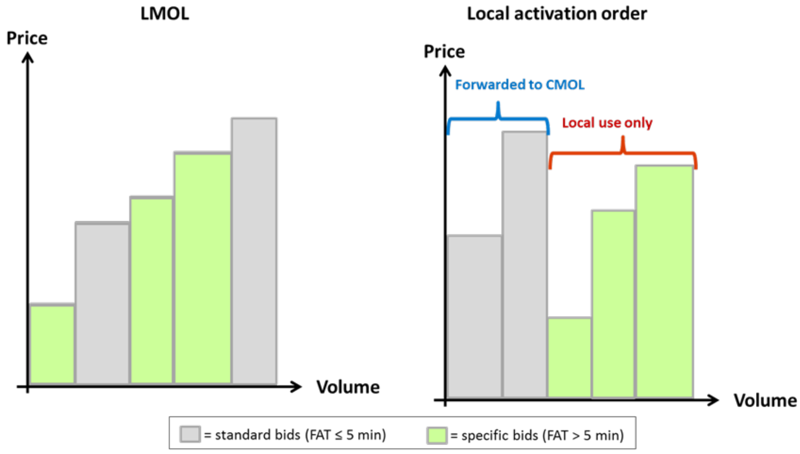

Figure 3: Local implementation of option 1, without conversion of specific products

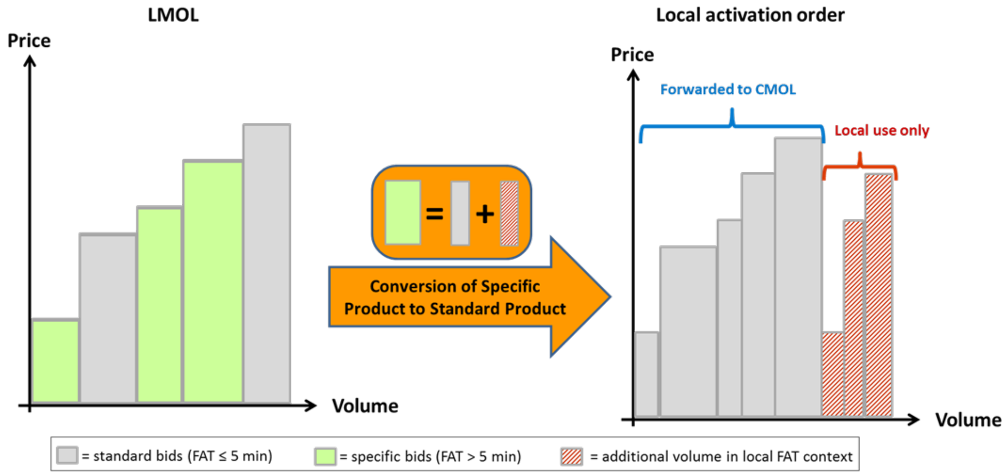

Figure 4: Local implementation of option 1, with conversion of specific products

Each LFC area needs to keep a single controller to activate all aFRR bids, regardless of whether they are standard or specific. Since the activation of slower specific bids for cross-border exchange is not foreseen in this option, specific bids or additional volumes of specific bids therefore need to be placed at the end of the local merit order in order to avoid undue activation by the AOF. Hence, the local activation order has to differ from the local price ranking of bids, which leads to local economic inefficiencies during activation. The compliance with the merit-order activation required by EBGL is also questionable. A possible consequence of these inefficiencies could be an increase of capacity price of specific products: because they are placed at the end of the LMOL, specific products will be activated less often; therefore, BSPs might want to increase their aFRR capacity prices in order to compensate a lack of revenue on the aFRR energy market.

The conversion of specific products allows to increase the total volume that is forwarded to the CMOL, increasing the liquidity on the common aFRR energy market and reducing the local economic inefficiencies described above. However, this comes at the expense of a major complexity increase for local implementation, especially for TSOs currently sending an aggregated activation signal per BSP. Indeed, in this sub option, separate targets for standard and specific volumes need to be communicated to each BSP.

In any case, specific products can only be used for an intermediate timeframe until local capacity markets have evolved and provide more liquidity.

To summarize, this first option guarantees a good FRCE quality and mitigate the impact on the procurement costs, but show some serious drawbacks for slower TSOs: use of specific products, local economic inefficiencies, major implementation changes, and uncertain benefits in terms of capacity procurement costs.

Option 2: aFRR standard product FAT of 5 minutes, specific products allowed in CMOL

As in option 1, the FAT of aFRR standard products and the maximal cross-border ramping period are equally set to 5 minutes. If specific products with longer FAT are locally required, the specific bids are also forwarded to the CMOL and are thus also activated in a cross-border context. However, the total volume of non-standard bids that each TSO can forward to the CMOL is limited to the dimensioned volume. In this case, this option does not affect the level playing field on the energy market, since energy pricing depends on marginal costs and is therefore independent of the FAT.

With this approach, the adjusted FRCE quality of exporting TSOs with specific bids at the beginning of the CMOL will be impacted. This effect incentives TSOs to minimize their amount of procured specific bids and foster the development of local markets for fast reserves. The resulting frequency quality depends on the share of specific bids in the CMOL but is generally worse than with option 1. The implementation effort is lower than with option 1, as no local separation between standard and specific products in the real-time processes is necessary.

The option presents the drawback of an inconsistency of the cross-border ramping period and local FAT requirements in markets that use specific products. Moreover it does not ensure the creation of a proper level-playing field with similar requirements for all BSPs, without distinguishing resources participating in balancing capacity market and in balancing energy market.

Option 3: aFRR standard product FAT of 7.5 min, shorter cross-border ramping period

With this option, the FAT of aFRR standard products is set to 7.5 minutes. However, the maximum cross-border ramping period is set to a shorter value (e.g. 5 minutes). This means that connecting TSOs of BSPs with a FAT longer than the cross-border ramping period are considered as responsible for this slow reaction and the resulting FRCE. Therefore, they are incentivized to influence the BSPs in their LFC area(s) to react faster (e.g. by implementing incentives for a faster reaction in the local TSO-BSP settlement scheme).

Regarding the short-term effects, option 3 is comparable to option 2. In the long-term however, option 3 strives to achieve fast reaction through sustainable incentives while option 2 is based on more stringent FAT requirements. However, this incentive is strongly depending on the structure of the CMOL. With option 3, connecting TSOs of slow BSPs with low generation costs would have to bear a high risk of an increasing FRCE.

Option 4: aFRR standard product of 7.5 min, equal cross-border ramping period

As in option 3, the FAT of aFRR standard product is set to 7.5 minutes. However, the cross-border ramping period is equally set to 7.5 minutes. Since a faster effective reaction of the BSPs than 7.5 minutes is most probably needed in the long term to fulfil all frequency and FRCE quality requirements, local incentives for a faster reaction will have to be implemented with this option. The fulfilment of the frequency and FRCE targets depends on the effectiveness of these incentives. However, the incentives cannot be harmonized without harmonization of the TSO-BSP settlement including the determination of the settled volume. Thus, it cannot be guaranteed that these incentives are equally strong in all participating LFC blocks.

Option 5: Intermediate value of FAT between 5 minutes and 7.5 minutes

From previous ENTSO-E discussions, the number of feasible candidates for FAT was limited to 5 and 7.5 minutes, so PICASSO TSOs focused their assessments on these two options. An intermediate value would be possible, but the result of the assessments provided no indication that an intermediate value would provide a more optimal solution considering the technical and economic aspects and would thus just be an arbitrary choice. An intermediate value would not solve the technical or economic shortcomings of the two values that have been assessed in detail. Therefore, none of the TSOs favored to select an intermediate value.

Option 6: CMOL filtering based on ramp rate

Respecting ramping speeds in the process of bid selection (filtering the CMOL in real-time according to the current ramp rates of BSPs) could lead to a faster effective activation of aFRR without stringent FAT requirements. This approach could in theory allow to fulfil the FRCE and frequency quality targets with a FAT of 7.5 minutes. A similar approach is currently applied in Hungary. However, due to incompatibilities with the concept for the interaction between controller and optimizer (control concept) and with the optimization algorithm, this model cannot be implemented in a cross-border context with distributed activation of BSP.

Following the control demand model (see Chapter 5.1.1), the aFRR optimisation according to the CMOL is performed on the central platform while the LFC and activation logic including any ramping of output signals remains on the local TSO side. The central platform does not technically interfere with the individual control loops of each TSO but translates the imbalances into real-time energy exchange schedules between the LFC areas.

This separation has multiple advantages:

- The stability of the process is independent of the BSP behavior and imperfections or possible errors in the IT-process and can be proven mathematically
- The concept does not affect the performance of the individual control loops
- The concept allows to tune the settings of each LFC to the dynamic behavior of the local BSPs and thus allows to efficiently combine BSPs with different dynamic behavior (e.g. pumped storage plants and gas fired plants) in a common market

However, due to the dynamics of the LFC, it is not possible to synchronize the processes of aFRR optimization (based on the CMOL) and the local BSP activation (based on the local MOL) when using dynamic constraints.

This is illustrated with an example shown in Figure 9. In this example, bid 1 covers 80 MW but only 50 MW can be activated within 5 min. In a case of a stepwise demand of 100 MW, the AOF determines that 50 MW of both bids must be activated simultaneously in order to fully compensate the imbalance within 5 minutes. The local activation of bids is however not based on the aFRR demand but on the control target (P_{Target}), which is the output of the local LFC (with proportional-integral dynamic behavior). The integral term of the controller leads to a delay of the control target. Due to this delay, parts of bid 1 are already activated when control target reaches the 50 MW threshold and a larger share of the total volume of bid 1 is "unlocked". Therefore, a larger share of bid 1 and a smaller share of bid 2 is activated than foreseen by the AOF

MOL

	Volume	Volume avail. within 5 min	Price
Bid 1	80 MW	50 MW	10 €/MWh
Bid 2	50 MW	50 MW	20 €/MWh

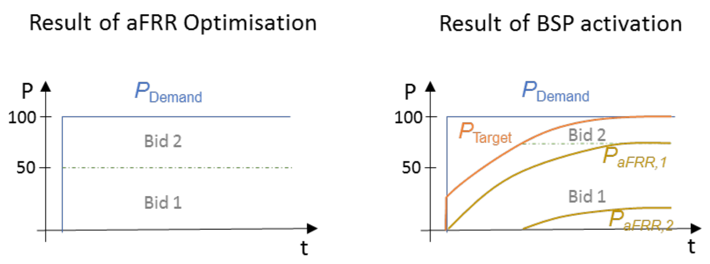

Figure 5: Example of MOL deviations due to dynamic constraints

This type of CMOL deviations can only be prevented by some kind of real-time synchronization between the AOF and the local activation logic. However, any real-time synchronization of both processes would undermine the separation between the AOF and the feedback LFCs, which is the key to the stability of the process. Hence, the implementation is not only an IT problem but is generally incompatible with the planned control concept.

Example of MOL deviations due to dynamic constraints

This issue could only be solved by a complete change of the control concept e.g. towards the "control request" concept which is not practically proven and is much more complex with regards to the stability of the process. Changing the control concept would also massively increase the implementation effort and costs because it requires the harmonization of all controllers. See also Section 5.1.1 for more elaboration on the reason of the choice of the control demand concept.

At the same time, the consideration of ramp rates in the AOF adds additional constraints to the optimization. Respecting these constraints while at the same time satisfying all demands leads to an optimization problem that can only be solved by deviating from the CMOL (additional bids are selected to respect the ramp rate constraints).

As an example, let us assume that bid 1 of the MOL in Figure 9 is completely activated in LFC area A for an imbalance in LFC area B. Now, the imbalance completely disappears. Normally, the optimizer would correct the demands so that the bid is fully deactivated, however, only 50 MW of the bid can be deactivated within 5 minutes and the optimizer has no access to the remaining 30 MW of the bid. In order to maintain the system balance, the optimizer will activate downward aFRR of 30 MW, leading to counteracting aFRR bids. This negative aFRR is activated regardless of its price, as the AOF is trying to avoid to increase the FRCE.

The physical impact depends on the location of these downward bids. If they are located in the same LFC area than the upward bids, they will not be activated and the intended ramp rate will not be achieved, leading to an increasing FRCE. If they are located in another LFC area, there will be counteracting aFRR bids in violation of the principles stated in Chapter 5.4.

Option 7: Two aFRR standard products in CMOL, selective activation

Two standard products with different FAT (e.g. 5 minutes and 7.5 minutes) are procured; the bids of both products are forwarded to the CMOL. However, TSOs can chose to cover their demand only with fast bids if they require a fast reaction to fulfill the FRCE quality targets. The AOF selects the bids that are activated for each TSO accordingly.

This option implies a vast complexity increase it would cause at AOF level (algorithm), for the communication between AOF and local LFC (AOF should specify how to split the control target between fast and slow products), and for local activation and calculation of the setpoint towards BSPs (each BSP would need to know how much volume of "slow" bids and "fast" bids he needs to activate). Additionally, this option leads to a market split and thus has detrimental effects on the liquidity on the aFRR energy markets.

Selected option

After careful consideration of all abovementioned options in the light of the technical and economic assessments, the TSOs came to the conclusion that a compromise solution is necessary. They acknowledged that due to the FRCE and frequency quality requirements, a FAT of 5 minutes is the superior long term option, because of its advantages in terms of system response. By this, they take into account that:

- The frequency quality targets for Continental Europe are currently already hard to fulfil with an average FAT of 6.5 minutes and a majority of LFC blocks using pro-rata activation. The changes on the aFRR market will render these requirements even more challenging. Additionally, the frequency quality in Continental Europe has been decreasing during the recent years and the future development is subject to major uncertainties (more volatile generation due to development of markets and generation structure, reducing system inertia). Stringent FAT requirement are needed to fulfil these requirements in the future.
- European balancing markets are currently evolving and many new BSPs are entering the market (renewables, batteries, power to heat, demand response). For most of these technologies, the FAT is

not the factor that limits the capacity they can offer on the aFRR market. Shorter FAT requirements help to utilize the flexibility of these units for the improvement of the system response and thus for the fulfilment of the FRCE and frequency quality targets.

- The European aFRR platform will also include the smaller Nordic synchronous area, which currently has effective FAT values of 2 to 3 minutes. A FAT of 7.5 minutes would significantly impact the Nordic system frequency. The Nordic TSOs indicated that extensive mitigation measures (e.g. local specific products) would be necessary in such a case, which would undermine the concept of a common European aFRR market.

However, it was also clear that the move to a FAT of 5 minutes could not be overtaken too quickly, because time is needed in countries with longer FAT to prequalify the current capacities and to develop a faster, broader local aFRR market in order to avoid (or at least largely mitigate) cost increase of aFRR capacity. Due to complexity and possible local ineffectiveness, the use of local specific products (option 1) has also been discarded as short-term solution.

Therefore, the best option that all TSOs could agree on was a stepwise approach:

- No harmonization of FAT at go-live of the platform until 18 December 2025: in this first step, each BSP has to comply with the FAT requirements of its connecting TSO, and all standard aFRR bids will be merged in the same CMOL regardless of their FAT. The FRCE adjustment process will have a maximum cross-border ramping period of 7.5 minutes. This creates an incentive for TSOs that currently have a longer FAT to foster a fast reaction of their local BSPs.
- As of 18 December 2025 the FAT is to be set at 5 minutes and as a result the FRCE adjustment process will have a maximum ramping period of 5 minutes also starting from 18 December 2025.

With this solution, the FAT will remain a local choice until 18th of December 2025. It is expected, that TSOs with a FAT of 5 minutes or less will not increase their local FAT beyond 5 minutes in this phase, therefore a significant deterioration of the FRCE and system frequency quality is not expected. Even though a full harmonization of the markets is not given in this transitory phase, a major distortion of the level playing field is not expected as TSOs will already have to start the transformation of the local aFRR markets and BSPs will have to develop their portfolios in the light of the full harmonization of the FAT.

In the consultation, stakeholders have expressed different views on the proposal. Many stakeholders were requesting immediate harmonisation, but the values towards which they were willing to harmonise were different (and mostly in line with the current value they have to comply with). No better compromise than the one described here above has been identified, hence TSOs favour keeping this stepwise approach.

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