Journal of Energy

VOLUME 72 Number 3 | 2023

journal homepage: http://journalofenergy.com/

Alignment of aFRR and mFRR prequalification process in Croatia with the target market design

Petra Sagrestano Štambuk, Dajana Vrbičić Tenđera, Nikolina Zovko, Tomislav Tenđera and Marin Uzelac

***Summary* — Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation defines a prequalification process as a process to verify the compliance of a reserve providing unit or a reserve providing group with the requirements set by the transmission system operator. Croatian Transmission System Operator Plc. (HOPS) carries out a prequalification process in order for (potential) ancillary service providers to prove their capability of providing ancillary services, which means that the prequalification process is a prerequisite for the provision of ancillary services. As part of the European Network of Transmission System Operators for Electricity, HOPS participates in the European implementation projects PICASSO and MARI, which aim is to establish a single European platform for aFRR and mFRR balancing services. Within the PICASSO and MARI projects, the technical characteristics of the products traded on unique European platforms were defined. This paper analyzes the difference between the requirements from the existing prequalification process rules and the technical requirements for products within the PICASSO and MARI projects, explores practice in Slovenia and Germany and suggests the required adoptions of aFRR and mFRR prequalification process in Croatia.**

***Keywords* — aFRR, MARI, mFRR, PICASSO, prequalification process**

I. Introduction

ANCILLARY services refer to a range of functions which transmission system operators (TSOs) contract so that they can guarantee system security. [1]

Croatian Transmission System Operator Plc. (HOPS) is the independent TSO in Croatia. HOPS determines the types, scope of supply, providers and period of supply of ancillary services. The Electricity Market Act (Official Gazette 111/2021) divides ancillary services into balancing services and non-frequency ancillary services. In European practice, balancing services are also called frequency ancillary services.

Frequency ancillary services in Europe are divided into four main reserve categories: Frequency Containment (FCR), automatic (aFRR) and manual (mFRR) Frequency Restoration, and Replacement Reserve (RR). The FCR and aFRR are automatically activated reserves (activated upon a frequency deviation) with fast response and short but more frequent activation events. The mFRR and RR are manually activated reserves with slower response, longer and less frequent activation events. FCR is used to intervene automatically within seconds in the entire synchronous area to restore the balance between the supply and the demand. A provider must be able to ramp up/down its generation/consumption to the full power within 30 seconds after a disturbance. After successful FCR activation, the frequency is at a stable value below or above the nominal value. The task of restoring the frequency to its nominal value is performed by aFRR and, if necessary, additionally by mFRR. The aFRR acts on a Load Frequency Control (LFC) area level where it replaces local FCR activations and mitigates power flow imbalances on the LFC interconnection lines. The activation time for aFRR provision is 30 seconds to 7.5 minutes in Europe (5 minutes after 2024). The mFRR is manually activated to release the activated aFRR capacity or to provide additional frequency restoration power [2]. At the time of writing the paper, full activation time of mFRR in HOPS control area is 15 minutes while in most European countries is 12.5 minutes. As the mFRR provision is gradually increasing, the aFRR is released and can be used for new imbalances. Additionally, a TSO can use RR, but is not obligatory. Full activation time of RR is 30 minutes.

In Table I the comparison between frequency ancillary services is shown. It should be noted that full activation time for aFRR and mFRR may vary within European countries. Harmonization of full activation times at the European level is expected in the framework of common implementation projects.

TABLE I

Comparison Between Frequency Ancillary Services

	Full activation time	Activation	Purpose
FCR	30 seconds	Automatically activated	Frequency containment
aFRR	5 minutes*	Automatically activated	Frequency restoration
mFRR	12,5 minutes*	Manually activated	Frequency restoration
RR	30 minutes	Manually activated	Frequency restoration

*may vary within European countries

FCR and RR are out of the scope of this paper. In Croatia, at the time of writing this paper, aFRR and mFRR are considered as balancing services. All individual network users and aggregators who have signed Balancing Service Agreement with HOPS can provide balancing services. A prerequisite for signing Balancing Service Agreement is successfully completion the prequalification process and proof of technical ability to provide balancing services.

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https://doi.org/10.37798/2023723472

II. Prequalification Process Rules

In accordance with Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation, HOPS has developed document Rules for conducting prequalification process (Verification process for provision of aFRR and mFRR balancing services) that was valid at the time of writing this paper. The document defines the procedure for performing aFRR and mFRR prequalification process, the steps of which are listed below. The first step in prequalification process is the application process. When applying for the prequalification process, the candidate submits a completed Application form for aFRR or mFRR balancing service. HOPS checks submitted forms and if the criteria are met, informs the candidate about the possibility of continuing the prequalification process. The second step is testing the communication systems, which needs to be completed before proceeding to the final step, which is testing the technical capability to provide aFRR or mFRR balancing services. The requirements that are tested in the last step are listed in the documents Test profiles for aFRR service and Test profiles for mFRR service which are available on HOPS' website. After the completion of the last step, HOPS evaluates the results of the prequalification process [4].

A. aFRR operating test

Operating test for aFRR balancing service includes the following steps:

1) upper and lower limits of control range check,
2) verifying declared gradient (ramping) for positive and negative direction,
3) dead band between two opposite requests check and
4) checking operation in the middle of the control range and response to small changes check.

In coordination with a candidate, HOPS creates a detailed test program for each test. Requirements regarding a candidate's response are shown in Figure 1. Reaction time needs to be less or equal to 30 seconds and full activation time up to 5 minutes [5].

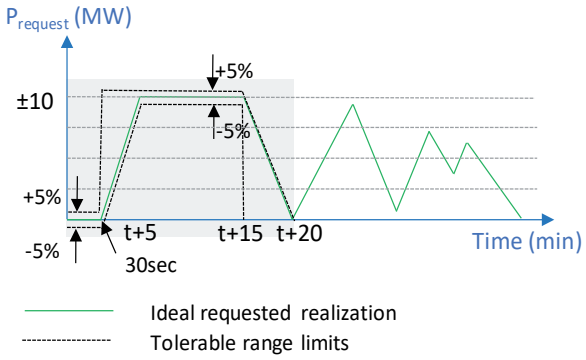

Fig. 1. aFRR operating test [5]

B. mFRR operating test

When testing the technical ability to provide the mFRR balancing service, the candidate proves his ability by responding to two activation requests. Activation requests and allowable response limits are shown in Figure 2. The first activation request lasts 30 minutes, while the second activation request lasts 75 minutes. The interval between activation requests is arbitrarily determined by HOPS during testing, respecting the minimum period between activation requests of 15 minutes and taking into account the deactivation time of the previous activation request. The maximum time between activation requests is 300 minutes.

Requirements regarding response are shown in Figure 2. [6]

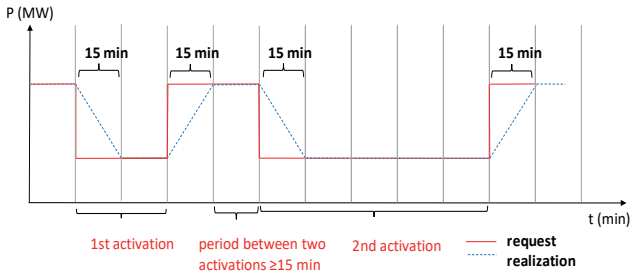

Fig. 2. mFRR operating test [6]

As it is shown in Figure 2, the criteria for full activation time is 15 minutes.

III. European Implementation Projects MARI and PICASSO

The Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO) and Manually Activated Reserves Initiative (MARI) are implementation projects of European transmission system operators whose goal is the establishment of European aFRR and mFRR platforms, two key objectives of Commission Regulation (EU) 2017/2195 of November 23, 2017 on the establishment of guidelines for balancing electricity. The purpose of the joint platforms is to improve the efficiency of the balancing process at the European level and integrate the balancing energy market, promote the possibility of exchanging aFRR and mFRR balancing energy while contributing to maintaining operational security. According to the projects' timelines, the connection of HOPS' internal balancing platform with the European aFRR and mFRR platforms is planned for July 2024.

In the context of alignment of the prequalification process with the requirements of European platforms, it is necessary to analyze the products offered on the platforms.

A. aFRR product within PICASSO project

PICASSO project was designed with the aim of connecting the AGC systems of individual TSOs and achieving maximum social benefit at the European level, taking into account the network topology and the balance of bids of aFRR balancing service providers. The AGC system, i.e. the system for automatic regulation of production, is the basic system for carrying out the frequency restoration process using the aFRR balancing service. The network topology is modeled with constraints for each boundary of load-frequency control area. These limits are called Available Transmission Capacities and they are determined by predefined processes. The AGC system of each individual OPS within the PICASSO project should always be connected to the central optimizer (Activation Optimization Function) of the aFRR platform, i.e. with a common priority list. The activation itself takes place in cycles that are activated at intervals of every 4 seconds. Each cycle consists of three steps. The first step is the calculation of the value for the unsatisfied demand (surplus or shortage of energy) of an individual TSO according to the common priority list, the second step is the netting TSO's deviation, and the third step is the recalculation of the value for the unsatisfied demand according to the common priority list. After these three steps, the total prices are calculated depending on the prices of the offers and the limitations of transmission capacities. Activation according to the aFRR platform takes place after each cycle, while the TSO – balancing service provider (BSP) delivery shape is subject to definition at the national level. [7]

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Standard aFRR product has the following characteristics:

1) by December 2024, the full activation time is harmonized to 5 minutes,
2) minimum bid size and the bid granularity are harmonized to 1 MW,
3) the validity period for aFRR bids is harmonized to 15 minutes,
4) all bids are divisible,
5) complex bids/linked bids are not supported by the aFRR platform.

B. mFRR PRODUCT WITHIN MARI PROJECT

Optimization algorithm developed within MARI is formulated as Mixed Integer Linear Programming Problem. The primary objective of the Activation Optimization Function is to maximize social welfare and the secondary objective is the minimization of cross-border exchanges. On the mFRR platform, the standard mFRR product can be ordered either through scheduled activation or direct activation with a minimum quantity of 1 MW. Direct and scheduled activations use the same Activation Optimization Function with different input data. Balancing service providers may choose if their bids are available for direct activations. The exchange shape for scheduled and direct activation between two TSOs is shown in Figure 3. TSO – BSP delivery is defined in the national terms and conditions. Optimization for scheduled activation runs every 15 minutes, once for each 15-minute interval, with delivery for the next 15-minute interval [8].

The full activation time is the same for both scheduled and direct activations and is 12.5 minutes, while 2.5 minutes is the time required for communication between the central and national platforms. The key data for the prequalification process is the full activa

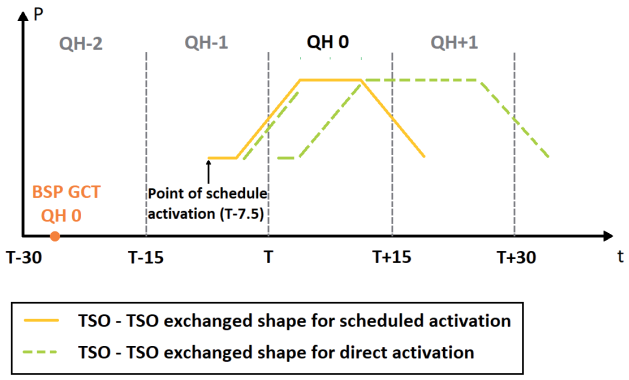

Fig. 3. Scheduled and direct activation within MARI [8]

IV. EXAMPLES OF PREQUALIFICATION PROCESSES OF SOME EUROPEAN TSOS

In order to gain a broader overview of the prequalification processes in Europe, two examples of prequalification processes are presented in this chapter: Slovenian TSO's (ELES) and German TSOs' (Amprion GmbH, TransnetBW GmbH, TenneT TSO GmbH and 50Hertz Transmission GmbH) process.

A. ELES - SLOVENIA

In the document Terms and conditions for balancing service providers on the ELES balancing market aFRR and mFRR, available in English, prequalification processes are defined. The steps of ELES' prequalification process are shown in Figure 4 [9].

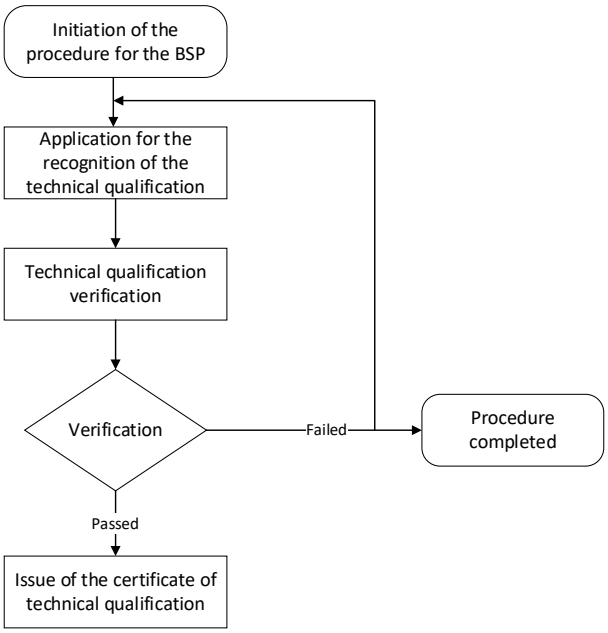

Fig. 4. The steps of ELES' prequalification process [9]

1) TEST ACTIVATION FOR AFRR

The prerequisite for conducting the qualification test is a successful application by sending the "Application for technical qualification of the balance service provider" form and successful testing of communication and information system. In the Article 49 of Terms and conditions for balancing service providers on the ELES balancing market technical requirements for providing aFRR service are stated:

1. The BSP shall be capable of activating or deactivating the total volume of the aFRR balancing energy bid, i.e. they shall be capable of implementing the change of active power from the value of the operating point up to the limit of the offered aFRR volume in no more than five minutes;
2. After a certain time delay (a reaction time of 30 seconds), the activated value shall start following set point, and in no more than five minutes, shall achieve the requested value with an imbalance of 5% of the sum of all aFRR balancing bids submitted by individual BSP being allowed. For a short period of time a single overshoot is allowed in the direction of the activation, namely up to 10 % of the value of the activated balancing capacity with the maximum allowed value of the overshoot being limited to 10 MW.

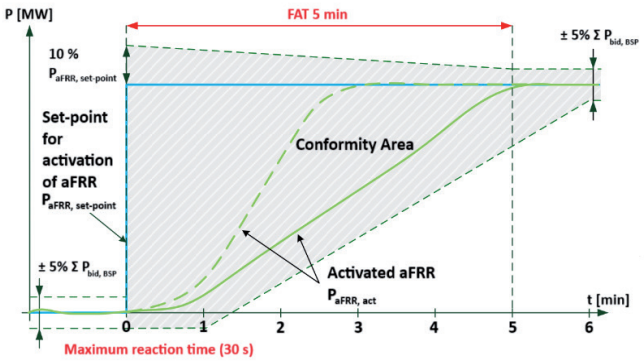

Fig. 5. The range of the response adequacy in the event of a step change of the required balancing capacity [9]

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2) Test activation for mFRR

Just like for the aFRR balancing service, the prerequisite for the performing qualification test for mFRR is a successful application by sending the "Application for technical qualification of the balance service provider" form and successful testing of communication and information system. In article 97. of Terms and conditions for balancing service providers on the ELES balancing market technical requirements for providing aFRR service are stated. The BSP shall be capable of activating the control group or the portfolio which they use to provide the mFRR service, i.e. they shall be capable of changing the active power in accordance with the TSO's requirement, so that they:

1) reach the required value of the capacity within 12,5 minutes of the request being submitted by the TSO and

2) implement the change of the required capacity or end the activation within 12.5 minutes of the request being submitted by the TSO.

As with the aFRR service, two activation tests are performed when testing the mFRR balancing service. Activation test example is in the Figure 6 [9].

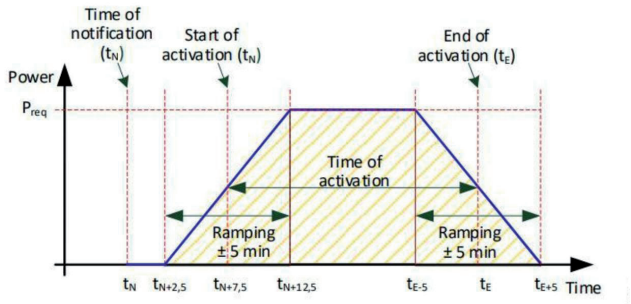

Fig. 6. An example of test activation for mFRR in the framework of the qualification procedure [9]

B. German TSOs

Four TSOs operate in the German control area: Amprion GmbH, TransnetBW GmbH, TenneT TSO GmbH and 50Hertz Transmission GmbH. The document Prequalification Process for Balancing Service Providers (FCR, aFRR, mFRR) in Germany ("PQ conditions"), available in English, defines the requirements that must be fulfilled within the prequalification process, which apply to all four German TSOs.

In the document is stated that prequalification process and prequalification application are carried out via PQ portal. As a part of the application documents, the candidate needs to deliver the required data and results of the carried operating test. The required information technology configuration is described in the separate document that can be found on the official website. The operating test is normally carried out independently by the BSP. Coordination with the reserve connecting TSO is however requested in cases in which a BSP intends to prequalify 150 MW of power or more. However, in the case of prequalification of a power reserve of more than 150 MW, coordination with the competent TSO is required.

The prequalifiable power (actual balancing reserve value of the stationary period) is determined by evaluating the results of the performed operating test according to defined formulas. In addition to the operating test, a control system test is carried out. In contrast to the operating test, which the BSP carries out without the participation of the reserve connecting TSO, the control system test is carried out in close coordination with the TSO. The control system test has two primary elements: The BSP must show that its pool is connected correctly to the control system of the TSO and the BSP must verify the robustness of the providing by the pool [10].

Within the document, all steps within the prequalification process are comprehensively defined, as well as certain specifics that are not included in this paper.

1) aFRR operating test

Within aFRR operating test, the response time up to 30 seconds, the power change period of 5 minutes and a deactivation time of 5 minutes are defined. A stationary period, which starts 5 minutes after the set point change and lasts at least 10 minutes is also defined. Typically, three reservation and two activation phases are carried out during an operating test. Figure 7 shows the permissible and acceptable fluctuations as part of the aFRR operating test [10].

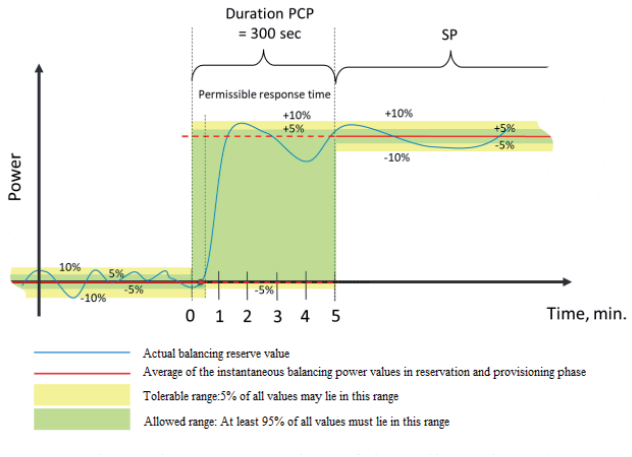

Fig. 7. Schematic representation of the "allowed" and "acceptable" intervals (aFRR) [10]

2) mFRR operating test

In the case of mFRR, the power change period starts with the set point change and ends 12.5 minutes after the set point change. The stationary period starts 12.5 minutes after the set point change. It lasts at least 10 minutes Typically, three reservation and two activation phases are carried out during an operating test. Figure 8 shows the permissible and acceptable fluctuations as part of the aFRR operating test. [9]

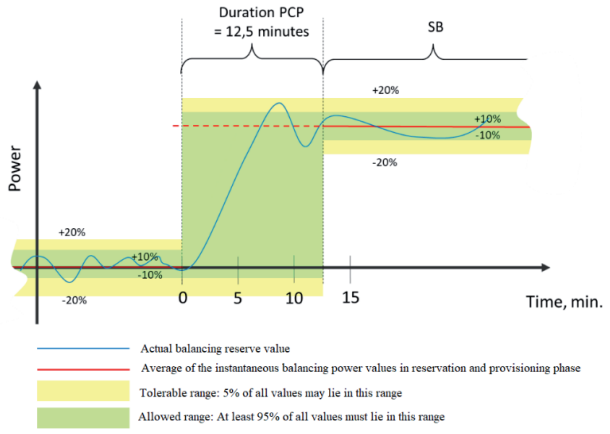

Fig. 8. Schematic representation of the "allowed" and "acceptable" intervals (mFRR) [10]

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C. Compliance of ELES and German TSOs' prequalification process with PICASSO and MARI

When comparing the requirements of the PICASSO and MARI projects with the prequalification processes of ELES and German TSOs, it can be concluded that the prequalification processes are adapted to European implementation projects. This is supported by the fact that German TSOs are already connected to European aFRR and mFRR platforms.

V. Adopting aFRR and mFRR Prequalification Process in Croatia

HOPS is currently adopting the aFRR and mFRR prequalification process. The planned completion and publication of the document is at the beginning of 2024. Unlike the existing version, the new version of the document will be improved in the form of terminology standardization and a clearer structure, in addition, it will be adapted to the requirements of target market design (PICASSO and MARI). During the creation of the new document, the requirements of European implementation projects as well as the existing European practice were analyzed. It was found that mFRR operating test needs to be adjusted. With regard to the performed analyses, it was concluded that the full activation time (time to reach full declared reserved power) must be changed from 15 minutes to 12.5 minutes.

Table II

Comparison Between Full Activation Time in Existing and New aFRR and mFRR Prequalification Process

	Full activation time	
	Existing prequalification process	New prequalification process
aFRR	5 minutes	5 minutes
mFRR	15 minutes	12,5 minutes

Additionally, HOPS considers shortening the duration of the activation, defining the amount of the tolerance threshold and validating the deactivation time. Additionally, given the different requirements compared to current practice, it is necessary to decide which providers must repeat the prequalification process. The considered example of mFRR operating test profile is shown in Figure 9.

The requirements of the aFRR operating test do not need to be changed.

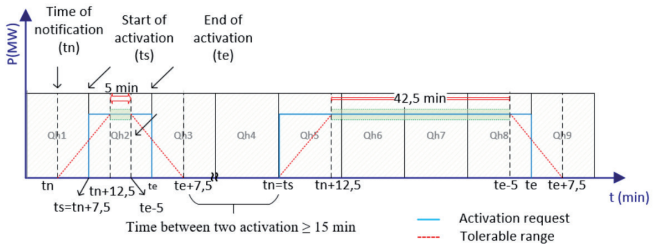

Fig. 9. Potential profile of mFRR operating test

V. Conclusion

PICASSO and MARI projects represent the target market design for aFRR and mFRR balancing services. In order to be able to participate in PICASSO and MARI, some TSOs need to adjust local processes. One of the processes that potentially need to be adopted is the prequalification process for providing aFRR and mFRR balancing services. The paper provides an overview of the existing HOPS' practice of performing aFRR and mFRR prequalification process and in order to determine the necessary changes, it analyses PICASSO and MARI standard products and prequalification processes of Slovenian TSO and German TSOs. To conclude, the mFRR operating test needs to be adopted.

The identified changes, together with other improvements, will be included in a new document which is expected to be finalized and published in early 2024.

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