European Network of
Transmission System Operators
for Electricity

All Continental Europe and Nordic TSOs' proposal for assumptions and a Cost Benefit Analysis methodology in accordance with Article 156(11) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

Date: __ ________ 2018

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Contents

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All Continental Europe and Nordic TSOs, taking into account the following,

Whereas

(1) This document is a common proposal jointly developed by all Transmission System Operators of the Continental Europe and the Nordic synchronous areas (hereafter referred to as the "TSOs") regarding the determination of assumptions and a methodology for a Cost Benefit Analysis (hereafter referred to as "CBA") to be conducted, in order to assess the time period required for frequency containment reserves (hereafter referred to as "FCR") providing units or groups (hereafter referred to as "FCR providers") with limited energy reservoirs to remain available during alert state, in accordance with Article 156(11) of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereafter referred to as "System Operation Guideline Regulation"). This proposal is hereafter referred to as "CBA methodology for FCR Proposal".

(2) The CBA methodology for FCR Proposal takes into account the general principles and goals set in the System Operation Guideline Regulation as well as Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity (hereafter referred to as "Regulation (EC) No 714/2009"). The goal of the System Operation Guideline Regulation is safeguarding operational security, frequency quality and the efficient use of the interconnected system and resources. It sets for this purpose requirements to FCR providers ensuring that their FCR providing units or groups with limited energy reservoirs are able to fully activate FCR continuously in alert state for a minimum time period to be defined pursuant to Article 156 (10) and (11) of the System Operation Guideline Regulation.

(3) Article 156(9) of the System Operation Guideline Regulation provides that, in case no time period has been determined pursuant to Article 156 (10) and (11) of the System Operation Guideline Regulation, each FCR provider shall ensure that its FCR providing units or groups with limited energy reservoirs are able to fully activate FCR continuously for at least 15 minutes or, in case of frequency deviations that are smaller than a frequency deviation requiring full FCR activation, for an equivalent length of time, or for a period defined by each TSO, which shall not be greater than 30 or smaller than 15 minutes. Furthermore, it provides that, if a time period has been determined pursuant to Article 156(10) and (11) of the System Operation Guideline Regulation, each FCR provider shall ensure that its FCR providing units or groups with limited energy reservoirs shall be able to fully activate FCR continuously in alert state for that time period assessed.

(4) Article 156(10) of the System Operation Guideline Regulation requires all Continental Europe and Nordic TSOs to develop a proposal concerning the minimum activation period to be ensured by FCR providers, and specifies that the period determined shall not be greater than 30 or smaller than 15 minutes. Such proposal shall take full account of the results of the CBA conducted pursuant to Article 156(11) of the System Operation Guideline Regulation.

(5) Article 156(11) of the System Operation Guideline Regulation requires the TSOs of the Continental Europe and Nordic synchronous areas to propose assumptions and methodology for a CBA to be conducted, in order to assess the time period required for FCR providing units or groups with limited energy reservoirs to remain available during alert state.

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The CBA shall take into account at least:

(a) experiences gathered with different timeframes and shares of emerging technologies in different LFC blocks;

(b) the impact of a defined time period on the total cost of FCR reserves in the synchronous area;

(c) the impact of a defined time period on system stability risks, in particular through prolonged or repeated frequency events;

(d) the impact on system stability risks and total cost of FCR in case of increasing total volume of FCR;

(e) the impact of technological developments on costs of availability periods for FCR from its FCR providing units or groups with limited energy reservoirs.

(6) This CBA methodology for FCR Proposal is exclusively related to FCR providing units or group with limited energy reservoirs.

According to Article 6(6) of the System Operation Guideline Regulation, the expected impact of the CBA methodology for FCR Proposal on the objectives of the System Operation Guideline Regulation (as listed in Article 4(1) of the System Operation Guideline Regulation) has to be described. The proposed CBA methodology for FCR Proposal generally contributes to the achievement of the objectives of Article 4(1) of the System Operation Guideline Regulation. Specifically, the CBA methodology for FCR Proposal provides the TSOs of the CE and Nordic synchronous areas with a methodology to assess and develop a proposal concerning the minimum activation period to be ensured by FCR providers. The determination of a minimum activation period to be ensured by FCR providers during alert state contributes to the determination of common operational security requirements and principles as set in the Article 4 (1) (a) of System Operation Guideline Regulation. It furthermore contributes to ensuring the conditions for maintaining operational security throughout the Union as set in Article 4 (1) (d) of System Operation Guideline Regulation. Finally it contributes to the efficient operation and development of the electricity transmission system and electricity sector in the Union as set in Article 4 (1) (h) of System Operation Guideline Regulation. The CBA methodology for FCR Proposal does not impact on the other objectives listed in Article 4(1) of the System Operation Guideline Regulation.

(7) In conclusion, the CBA methodology for FCR Proposal contributes to pursue the general objectives of the System Operation Guideline Regulation of safeguarding operational security by defining the proper time period for the full FCR activation in the alert state taking into account costs and benefits of the defined time period, to the benefit of all market participants and electricity end consumers.

SUBMIT THE FOLLOWING CBA METHODOLOGY FOR FCR PROPOSAL TO ALL REGULATORY AUTHORITIES OF THE CE AND NORDIC SYNCHRONOUS AREA:

Article 1
Subject matter and scope

The CBA assumptions and methodology as determined in this CBA methodology for FCR Proposal shall be considered as the common proposal of all Continental Europe and Nordic TSOs in accordance with Article 156(11) of the System Operation Guideline Regulation and shall form the basis on which the TSOs of the CE and Nordic synchronous areas shall assess the minimum activation period to be ensured by FCR providers in accordance with Article 156(10) of the System Operation Guideline Regulation.

This achievement is in accordance with the Article 4 (2) (c) of System Operation Guideline Regulation.

Article 2
Definitions and interpretation

1. For the purposes of the CBA methodology for FCR Proposal, terms used in this document shall have the meaning of the definitions included in Article 3 of the System Operation Guideline Regulation.

2. In addition, in this CBA methodology for FCR Proposal, unless the context requires otherwise, the following terms shall have the meaning below:
   a) 'LER' means 'FCR providing units or groups with limited energy reservoirs';
   FCR providing units or groups are deemed to have limited energy reservoirs in case a FCR full activation for the time frame contracted by the TSO might, even in case of an active energy reservoir management, lead to a limitation of their capability to provide the full FCR activation due to the depletion of their energy reservoir(s) taking into account the effective energy reservoir(s) available at the beginning of that time frame.
   b) 'LER Share' means the 'share of LER on the total FCR providers';
   c) 'Market induced imbalances' means the 'generation-load imbalance caused by the change in generation set points according to the results of the market scheduling'.
   d) 'System droop' means 'the ratio between frequency deviation and steady state power response provided by FCP';
   e) 'FCR cost curve' means 'the set of all the offered quantity of FCR with their corresponding cost';
   f) 'Time Period', according to Article 156 (9) of System Operation Guideline Regulation, means 'the time for which each FCR provider shall ensure that its FCR providing units or groups with limited energy reservoirs are able to fully activate FCR continuously, as of triggering the alert state and during the alert state';
   g) 'Long lasting frequency deviation' means an 'event with an average steady state frequency deviation larger than the standard frequency range over a period longer than the time to restore frequency'.
   h) 'FAT' means 'FRR Full Activation Time' as defined in Article 3 (101) of System Operation Guideline Regulation.
   i) 'Equivalent reservoir energy capacity' means the energy requirement for LER associated to the Time Period and shall amount to twice the energy provided by the full activation of LER for the Time Period.

3. In this CBA methodology for FCR Proposal, unless the context requires otherwise:
   a) the singular indicates the plural and vice versa;
   b) unless otherwise provided, any reference to an Article means an article of this CBA methodology for FCR Proposal;
   c) the table of contents and headings are inserted for convenience only and do not affect the interpretation of this CBA methodology for FCR Proposal; and
   d) any reference to legislation, regulation, directive, order, instrument, code or any other enactment shall include any modification, extension or re-enactment of it then in force.

Article 3
CBA methodology outcomes and processes

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For each combination of LER Share and Time Period (as described in Article 6 (2)(a) and Article 6 (2)(b)), the outcomes of the CBA methodology are:

a) the FCR cost (as described in Article 4 and Article 5);
b) the acceptability of the combination against the most relevant real frequency events (as described in Article 7).

The FCR cost is calculated by means of two sequential processes.

The first process is a Probabilistic Simulation Model (described in Article 4) whose outcome is the amount of FCR.

The second process is an Assessment of cost of FCR (described in Article 5) which associates a cost to the required amount of FCR calculated by the Probabilistic Simulation Model.

The acceptability of the combination against the most relevant real frequency events is assessed by means of a dedicated process (described in Article 7).

Article 4
Probabilistic Simulation Model

1. All TSOs of a synchronous area shall develop a Probabilistic Simulation Model able to calculate the minimum amount of FCR needed to mantain the steady state frequency within maximum steady state frequency deviation.

2. The following sources of frequency disturbance are inputs of the Probabilistic Simulation Model:
   a. Deterministic frequency deviation.
      The TSOs shall consider the market induced imbalances, analyse frequency historical trend of each synchronous area over several years, and then statistically determine the typical trends and amplitudes of these frequency deviations in order to use them as an input of the Probabilistic Simulation Model.
      The TSOs shall take into account the possible mitigation actions that can be implemented in order to reduce the impact of deterministic frequency deviation as defined in Article 138 of System Operation Guideline Regulation.
   b. Long lasting frequency deviation.
      The TSOs shall take into account Long lasting frequency deviations.
      They shall analyse frequency historical trends in order to characterize the phenomena from a statistical point of view. The analysis shall determine:
      - the number of occurrences of these events;
      - the typical duration;
      - a representative frequency deviation trend;
      - typical time of occurrence, if highlighted by statistical analysis.
   c. Outages of relevant grid elements.
      The TSOs shall define a list of all the grid elements whose outages lead to relevant load or generation losses and indeed to relevant FCR activation.
      The grid elements outages to be investigated are at least: generation plants failure, critical busbar fault and critical substation blackout. For each outage a probability of failure shall be defined.

   All the available informations related to the dependence amongst the three sources of frequency disturbance shall be taken into account in order to avoid the double counting of phenomena.

3. The Probabilistic Simulation Model shall be used to calculate the requested FCR in each scenario described in Article 6. Therefore also the following variables represent inputs for the model:
   a. Time Period;
   b. LER Share;

   Moreover, also the average FAT of the synchronous area is an input parameter for the Probabilistic Simulation Model.

4. The Probabilistic Simulation Model calculates the required FCR using an iterative method. At every iteration the Probabilistic Simulation Model uses a Monte Carlo Simulation Process in order to verify if the steady state frequency is within maximum steady state frequency deviation. If the condition is not fulfilled, the Probabilistic Simulation Model increases gradually the FCR and calculates the next iteration. The iterations stop once the condition is fulfilled. The output of the Probabilistic Simulation Model is the FCR required to mantain the steady state frequency within maximum steady state frequency deviation.

5. The Monte Carlo Simulation Process shall be able to simulate several years of operation conditions of each synchronous area by means of random draws of long lasting frequency deviations and outages of relevant grid elements. It has the aim to generate a large number of random combinations of all the possible sources of frequency disturbance. Since the Monte Carlo Simulation Process works on the time domain, this approach requires to simulate a long system operation period.
   The operation period to be simulated shall be long enough to generate statistically significant results. The statistic significance of the results, and hence the length of the long system operation period, depends on the input data used (as defined in Article 4 (2)). Together with the Monte Carlo Simulation Process, all TSOs shall therefore evaluate the minimum length of the long system operation period needed to achieve statistically significant results, taking into account the input data actually used.

6. The Monte Carlo Simulation Process uses a Dynamic Simulation Model in order to calculate the frequency deviation. The Dynamic Simulation Model uses as input the sources of frequency disturbance as randomly generated by Monte Carlo Simulation Process and simulates the FCP and FRP.

7. The Dynamic Simulation Model shall be able to simulate the depletion of LER and its effects on the frequency deviation, taking into account the LER Share and the Time Period.

Article 5
Assessment of cost of FCR

1. The minimum amount of FCR needed to mantain the steady state frequency within maximum steady state frequency deviation calculated by the Probabilistic Simulation Model shall be used to assess the FCR cost associated to each scenario by means of a FCR cost curve.

2. All TSOs of a synchronous area shall define a FCR cost curve which includes both LER and non-LER FCR providers.

   The FCR cost for non-LER FCR providers shall be calculated at least by comparing the marginal cost of the FCR provider with the day-ahead energy marginal price of the bidding zone. The comparison allows to estimate the cost of reserving capacity for FCR provision.

The FCR cost for future installed LER shall be calculated considering: investment, OPEX and opportunity costs (if any). These contributions shall be considered only if they are sustained in order to qualify for FCR provision.
The capacity of future installed LER is related to the LER share assumption in each scenario (as defined in Article 6 (2)(a)). To each LER share corresponds a value of future installed LER, regardless of the year of installation.

The FCR cost for already existing LER shall be calculated considering: OPEX and opportunity costs (if any). These contributions shall be considered only if they are sustained in order to qualify for FCR provision.

The impact on FCR cost for LER due to variations of energy reservoir requirement (associated to the Time Period) shall be taken into account.

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Article 6
Simulation scenarios

1. The analyses and processes described in Articles 4 and 5 shall be performed considering different scenarios and allow to calculate both FCR dimensioning and cost of FCR taking into account different assumptions. Scenarios are aimed to address uncertainties and assess the impact of different hypotheses which can affect the results of the CBA.

2. The set of scenarios shall include all the combinations of the following assumptions:
   a) Time Period. In order to evaluate the best solution in terms of minimum activation period which is not greater than 30 or smaller than 15 minutes, the interval of possible solutions have to be explored adopting an opportune discretization. When implementing the CBA methodology for FCR Proposal, the TSOs shall consider a discretization of 5 minutes, thus the results considering Time Periods of 15, 20, 25 and 30 minutes shall be assessed.
   b) LER Share. The share of the LER can be affected by the cost effectiveness of LER but also by other factors, such as the presence of a market based procurement of FCR, or other technical and regulatory impacts on LER deployment. For this reason, different LER Shares shall be analysed in the 10-100% range with 10% discretization.
   c) Mitigation actions on Deterministic frequency deviations. Two different scenarios shall be considered. In the first scenario the Deterministic frequency deviations are considered without the implementation of mitigation actions. In the second scenario the mitigation actions shall be taken into account, considering a proper filter that reduce the amplitude of Deterministic frequency deviations according to the expected effects of these mitigation actions.

   All the analyses shall be performed considering potential future developments of the energy system and regulations in the short term.

3. The elaboration of the results obtained performing the analyses described in Articles 4 and 5 to the whole set of scenarios shall allow to obtain FCR dimensioning and costs of FCR for each combination of Time Period and LER Share.

Article 7
Simulation of the most relevant real frequency events in presence of LER

1. The most relevant frequency disturbances occurred in the past shall be simulated modelling the presence of LER and assessing how the potential energy depletion would have affected the system stability.

2. Simulation of the most relevant real frequency events shall be performed for each combination of Time Period and LER Share defined in Article 6 (2a) and (2b). If a combination of Time Period and LER Share worsens operational security potentially leading to a blackout state, the combination shall be considered not acceptable.

Article 8
Determination of Time Period

1. According to Article 156 (11) the TSOs of the CE and Nordic synchronous areas shall submit the results of their cost-benefit analysis to the concerned regulatory authorities, suggesting a Time Period for CE synchronous area and a Time Period for Nordic Synchronous area.

2. If the required input parameters defined in Article 1 (2), Article 5 (2) and Article 7 will significantly change after entering into force of the Time Period, all TSOs shall submit the results of an updated cost-benefit analysis to the concerned regulatory authorities, suggesting an updated Time Period. The update of the cost-benefit analysis results shall be performed also as a consequence of changes in the assumptions due to additional requirements derived from SOGL art. 118.

   In case of significant changes in the assumptions of the methodology, which may make the methodology unreliable, all TSOs shall submit an amended methodology for approval to NRAs. Following the approval, the TSOs shall run the cost benefit analysis based on the amended methodology and take full account of the results for the definition of a new Time Period that shall not be greater than 30 or smaller than 15 minutes.

Article 9
CBA assumptions

1. The Probabilistic Simulation Model described in Article 4(1)(2)(3)(4), the Monte Carlo Simulation Process described in Article 4(1)(5)(6) and the Dynamic Simulation Model described in Article 4(6)(7) shall be referred to a whole synchronous area.
2. The Dynamic Simulation Model shall simulate the FRP with a single FRP controller without FRR limitations. The single FRP controller shall use a FAT calculated as an average of the FAT of all the LFC areas belonging to the synchronous area weighted on FRR K-factor.
3. The Dynamic Simulation Model can neglect the entire Cross-Border Load-Frequency Control Process.
4. The Dynamic Simulation Model can neglect both system inertia and FCP deployment dynamic.
5. The Dynamic Simulation Model shall simulate at least the FRP deployment dynamic, the system droop and the self-regulation of load.
6. If a continuous exceeding of the standard frequency range includes the triggering of an alert state, the activated energy and the residual energy in the reservoir is calculated from the first exceeding of the standard frequency range limits.
7. At the full availability of the reservoir, the energy level will be considered equal to half of the Equivalent reservoir energy capacity.
8. The annual review of FRP K-factors (Article 156 (2) of System Operation Guideline Regulation) can be neglected as long as the review does not affect signicantly the average FAT as defined in Article 9 (2).

Article 10
Publication and implementation of the CBA methodology for FCR Proposal

1. Each Continental Europe and Nordic TSO shall publish the CBA methodology for FCR Proposal without undue delay after all NRAs have approved the proposed CBA methodology for FCR Proposal, in accordance with Article 8 of the System Operation Guideline Regulation.

2. The Continental Europe and Nordic TSOs shall have implemented the adopted CBA methodology for FCR Proposal by 12 months after its approval by all regulatory authorities of the CE and Nordic synchronous areas. The implementation shall take place by submitting the results of the CBA conducted by the TSOs of the CE and Nordic synchronous areas according to the adopted CBA methodology for FCR Proposal to the concerned regulatory authorities suggesting a time period for

FCR providers with limited energy reservoirs during which they shall be able to fully activate FCR continuously in alert state, whereas this time period shall not be greater than 30 or smaller than 15 minutes.

Article 11
Language

The reference language for this CBA methodology for FCR Proposal shall be English. For the avoidance of doubt, where TSOs need to translate this CBA methodology for FCR Proposal into their national language(s), in the event of inconsistencies between the English version published by TSOs in accordance with Article 8(1) of the System Operation Guideline Regulation and any version in another language, the relevant TSOs shall, in accordance with national legislation, provide the relevant national regulatory authorities with an updated translation of the CBA methodology for FCR Proposal.

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