Explanatory document for the Nordic synchronous area proposal for additional properties of FCR in accordance with Article 154(2) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

1. Introduction

The Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereinafter **"SO Regulation"**) sets out rules on relevant subjects that should be coordinated between Transmission System Operators, as well as between TSOs and Distribution System Operators and with significant grid users, where applicable. The goal of the SO Regulation is to ensure provision of an efficient functioning of the interconnected transmission systems to support all market activities. In order to deliver these objectives, a number of steps are required.

One of these steps is to define the additional properties of Frequency Containment Reserves (FCR) for the Nordic synchronous area. Pursuant to Article 118(1)(b) of the SO Regulation, all Transmission System Operators in the Nordic Synchronous Area shall jointly develop common proposals for additional properties of FCR in accordance with Article 154(2) of the SO Regulation.

According to Article 6(3)(d)(iii) of the SO Regulation the proposal for additional properties of FCR in accordance with Article 154(2) (hereafter referred to as "**Proposal**") shall be submitted for approval by the relevant national regulatory authorities (hereinafter "NRAs") no later than 14 September, 2018. The Proposal is submitted for regulatory approval to all NRAs in the Nordic synchronous area. According to Article 6(6) of the SO Regulation the Proposal needs to be submitted to ACER as well, who may issue an opinion on the Proposal if requested by the NRAs.

This document contains an explanation of the Proposal from all TSOs of the Nordic synchronous area (hereinafter **"TSOs"**). It is structured as follows. The legal requirements for the Proposal are presented in Chapter 2. Chapter 3 starts with describing the objective of the additional properties of FCR. Chapter 4 provides an overview of the existing situation and Chapter 5 an outlook to future developments. The proposed additional properties of FCR are described in Chapter 6. Chapter 3 describes the expected impact on the relevant objectives of the SO Regulation. Finally, Chapter 8 provides the timeline for implementation and Chapter 9 describes the public consultation.

2. Legal requirements and interpretation

2.1 Legal references and requirements

Several articles in the SO Regulation set out requirements which the Proposal must take into account. These are cited below.

(1) Article 118(1)(b) and (2) of the SO Regulation constitutes the legal basis that the Proposal should take into account. Article 118 has the following content:

> *"1. By 12 months after entry into force of this Regulation, all TSOs of each synchronous area shall jointly develop common proposals for:[…]*
>
> *(b) additional properties of FCR in accordance with Article 154(2); […]*
>
> *2. All TSOs of each synchronous area shall submit the methodologies and conditions listed in Article 6(3)(d) for approval by all the regulatory authorities of the concerned synchronous area. Within 1 month after the approval of these methodologies and conditions, all TSOs of each synchronous area shall conclude a synchronous area operational agreement which shall enter into force within 3 months after the approval of the methodologies and conditions."*

(2) Article 154(2) of the SO Regulation has the following content:

> *" Article 154 FCR technical minimum requirements*
>
> *[...]*

2. All TSOs of a synchronous area shall have the right to specify, in the synchronous area operational agreement, common additional properties of the FCR required to ensure operational security in the synchronous area, by means of a set of technical parameters and within the ranges in Article 15(2)(d) of Commission Regulation No [000/2015 RfG] and Article 27 and 28 of Commission Regulation No [000/2015 DCC]. Those common additional properties of FCR shall take into account the installed capacity, structure and pattern of consumption and generation of the synchronous area. The TSOs shall apply a transitional period for the introduction of additional properties, defined in consultation with the affected FCR providers.

[...]"

(3) Article 154(1) and Annex V of the SO GL Regulation specify the minimum technical requirements for FCR that shall be ensured by each reserve connecting TSO:
"Article 154 FCR technical minimum requirements
1. Each reserve connecting TSO shall ensure that the FCR fulfils the properties listed for its synchronous area in Table 1 of Annex V.

[...]"

ANNEX V

FCR technical minimum requirements referred to in Article 154:

Minimum accuracy of frequency measurement	CE, GB, IRE and NE	10 mHz or the industrial standard if better
Maximum combined effect of inherent frequency response insensitivity and possible intentional frequency response dead band of the governor of the FCR providing units or FCR providing groups.	CE	10 mHz
	GB	15 mHz
	IRE	15 mHz
	NE	10 mHz
FCR full activation time	CE	30 s
	GB	10 s
	IRE	15 s
	NE	30 s if system frequency is outside standard frequency range
FCR full activation frequency deviation.	CE	±200 mHz
	GB	±500 mHz
	IRE	Dynamic FCR ±500 mHz
		Static FCR ±1000 mHz
	NE	±500 mHz

Table 1 FCR properties in the different synchronous areas

(4) Article 15(2)(d) of Regulation (EU) 2016/631 (*"network code on requirements for grid connection of generators"*) provides a number of requirements (ranges) that shall be met by Type C and Type D power-generating modules *"when frequency sensitive mode ('FSM') is operating"*. These include ranges of the "*Active power range related to maximum capacity"*, *"Frequency response insensitivity"*, *"Frequency response deadband"*, *"Droop"*, *"Active power*

frequency response capability", *"initial activation of active power frequency response"* and the requirement that "*(v) the power-generating module shall be capable of providing full active power frequency response for a period of between 15 and 30 minutes as specified by the relevant TSO."*. Furthermore, *"(vi) within the time limits laid down in point (v) of paragraph 2(d), active power control must not have any adverse impact on the active power frequency response of power-generating modules;".*

(5) Articles 27 and 28 of Regulation (EU) 2016/1388 (*"network code on demand connection*") describe requirements for demand units to provide demand response services to system operators, including *"autonomously controlled demand response system frequency control"*. More specifically, Article 28 of Regulation (EU) 2016/1388 stipulates the *"specific provisions for demand units with demand response active power control, reactive power control and transmission constraint management"*. These provisions relate to operating capability across frequency ranges and voltage ranges, requirements related to receiving and executing instructions, controlling and adjusting power consumption, and requirements for maintaining the modification to power consumption.

(6) Article 6(3)(d)(iii) of the SO Regulation states:

"The proposals for the following terms and conditions or methodologies shall be subject to approval by all regulatory authorities of the concerned region, on which a Member State may provide an opinion to the concerned regulatory authority: […]
(d) methodologies, conditions and values included in the synchronous area operational agreements in Article 118 concerning:
(iii) additional properties of FCR in accordance with Article 154(2);

2.2 Interpretation and scope of the Proposal

The Nordic Frequency Containment Process (FCP) currently applies two types of Frequency Containment Reserves (FCR). FCR for normal operation (FCR-N) is used for continuous imbalances to keep the frequency within the ± 100mHz range. In conjunction with a rapid frequency change to 49.9/50.1 Hz, FCR-N shall be up regulated/down regulated within 2-3 minutes. FCR for disturbance situations (FCR-D) is only used in upward direction (upward FCR-D). The purpose of upward FCR-D is to mitigate the impact of incidental disturbances once the frequency is below 49.90Hz. Upward FCR-D shall be fully activated if the frequency stabilises at 49.50Hz. In the event of a frequency drop to 49.5 Hz caused by a momentary loss, FCR-D shall be fully activated within 30 seconds. It has to be noted that the *FCR full activation frequency deviation* of ±500mHz and *FCR full activation time* of 30s that are specified in Annex V of the SO GL Regulation only apply to FCR-D. Consequently, the TSOs specify the required FCR-N response as additional properties in this proposal. The other two requirements in Annex V of the SO GL Regulation apply to both FCR-N and FCR-D.

3. Objective of additional properties of FCR

The objective of the additional properties of FCR is to complete the set of minimum requirements in Annex V of the SO Regulation for both FCR-N and FCR-D as required for secure operation of the Nordic synchronous area.

4. The existing situation

In this chapter, the existing requirements for FCR are presented. Since the Nordic TSOs apply two types of FCR, section 4.1 addresses FCR-N and section 4.2 addressed FCR-D.

4.1 Frequency Containment Reserves for normal operation (FCR-N)

FCR-N is the momentarily available active power available for frequency regulation in the range of 49.9 – 50.1Hz and which is activated automatically by the system frequency. Currently, FCR-N reserves shall be at least 600MW at 50.0Hz in the synchronous system. It shall be fully activated at f = 49.9/50.1Hz (Δf = ±0.1Hz). In conjunction with a rapid frequency change to 49.9/50.1 Hz, the reserve shall be up regulated/down regulated within 2-3 minutes.

4.2 Frequency Containment Reserves for disturbance situations (FCR-D)

Currently, the TSOs only apply FCR-D in upward direction (upward FCR-D). Upward FCR-D is the momentarily available active power available for frequency regulation in the range of 49.9 – 49.5 Hz and which is activated automatically by the system frequency.

Upward FCR-D shall be activated at 49.9 Hz and shall be fully activated at 49.5 Hz. It shall increase virtually linearly within a frequency range of 49.9-49.5 Hz.

Agreed automatic load reduction could be delivered by e.g. industrial, district heating and electric boiler consumption. If load is reduced automatically when the frequency drops to 49.5 Hz it can be counted as part of the upward FCR-D. Load reduction can be used as upward FCR-D in the frequency range of 49.9 Hz to 49.5 Hz, when load reduction meets the same technical requirements set below for generators.

In the event of a frequency drop to 49.5 Hz:

- 50 % of the upward FCR-D frequency controlled disturbance reserve in each subsystem shall be regulated upwards within 5 seconds;
- 100 % of the upward FCR-D frequency controlled disturbance reserve shall be regulated upwards within 30 seconds.

5. Outlook

The TSOs foresee in the near future that changes and additions to the additional FCR properties are required. When the required changes are fully clear, the TSOs will start an amendment process. The following issues may be addressed:

- *Effectiveness of FCR:* After intensive analysis and measurement programs, the TSOs concluded that the existing requirements for both FCR-N and FCR-D do not necessarily meet the needs of the Nordic power system anymore. For this reason, the TSOs are in the process of defining more appropriate requirements that shall improve the effectiveness of both FCR-N and FCR-D.
- *Adding downward FCR-D:* Mainly caused by the increasing number of HVDC interconnectors to other synchronous areas, the Nordic synchronous area faces more and more large disturbances that result in an over frequency (i.e. generation surplus due to e.g. trip of an exporting HVDC interconnector). Since these incidents also affect the operational security, the TSOs will introduce downward FCR-D in accordance with the SO Regulation by 2021.

6. Proposal for additional FCR properties

Together with the requirements in Annex V of the SO Regulation, the proposed additional properties for FCR-N and upward FCR-D in section 6.1 and 6.2 form the same set of requirements as currently applied (see section 4.1 and 4.2). As discussed in chapter 5, these requirements do not necessarily meet the needs of the Nordic power system anymore and may need to be modified. Since the new requirements need to be defined carefully and in close cooperation with potential providers of FCR-N and upward FCR-D, the TSOs decided not to rush the implementation of new requirements. Furthermore, the TSOs did not opt for partly changing the requirements because that could mean that FCR providers should adapt their FCR providing units and/or FCR providing groups twice. For this reason, the additional properties for FCR-N and upward FCR-D below only include the existing requirements that are not covered by the requirements specified in the SO Regulation. It may be noted that the reasons for the existing requirements are largely historical and may – as suggested above – be outdated.

6.1 Additional FCR-N properties

As discussed in section 2.2, for FCR-N, Annex V of the SO GL Regulation specifies the *Minimum accuracy of frequency measurement* and the *Maximum combined effect of inherent frequency response insensitivity and possible intentional frequency response dead band of the governor of the FCR providing units or FCR providing groups*. Conversely, for FCR-N, SO GL Regulation does not specify the *FCR full activation frequency deviation* and the *FCR-N full activation time*. These two properties will be deducted from existing requirements in section 6.1.1 and 6.1.2.

6.1.1 FCR full activation frequency deviation

Since FCR-N is used for continuous imbalances to keep the frequency within the ± 100mHz range, FCR-N shall be fully activated at f = 49.9/50.1Hz ($\Delta f = \pm 0.1$Hz). This implicitly means that the *FCR full activation frequency deviation* for FCR-N is ±100mHz, which is proposed in Article 3(1) of the Proposal.

6.1.2 FCR-N full activation time

FCR-N shall – in conjunction with a rapid frequency change to 49.9/50.1 Hz - be up regulated/down regulated within 3 minutes which is proposed in Article 3(2) of the Proposal.

Both the full activation frequency deviation and the full activation time are within the ranges in Article 15(2)(d) of Commission Regulation No [000/2015 RfG] and Article 27 and 28 of Commission Regulation No [000/2015 DCC].

6.2 Additional upward FCR-D properties

For FCR-D, Annex V of the SO GL Regulation specifies the *full activation frequency deviation* (±500mHz) and the *full activation time* (30s). However, SO GL Regulation does not specify other requirements that are important for the Nordic synchronous area. These issues are addressed in section 6.2.1, 6.2.2 and 6.2.3.

6.2.1 virtual linear increase between 49.9 and 49.5Hz

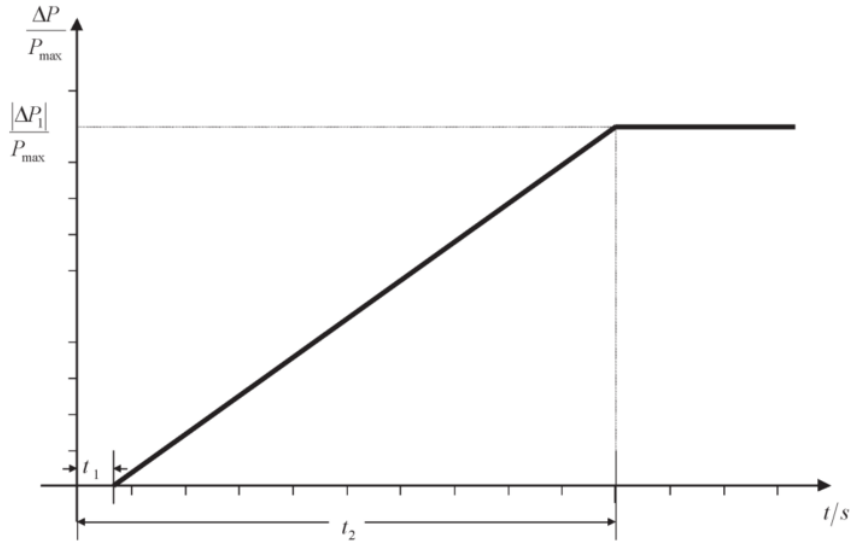
The existing rules for upward FCR-D include the requirement that activation shall increase virtually linearly within a system frequency range of 49.9-49.5Hz. This should give the most stable control. This requirement is proposed in Article 4(1) of the Proposal.

6.2.2 50% of the FCR-D response shall be available within 5s

The existing rules for FCR-D require that in the event of a frequency drop to 49.5 Hz caused by a momentary loss of production 50 % of the upward FCR-D shall be regulated upwards within 5 seconds. This requires a faster response than required by Article 15(2)(d)(iii) of Commission Regulation No [000/2015 RfG] which states that *"in the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response, at or above the full line shown in Figure 6 [..]."*.

Figure 6

Active power frequency response capability



This Figure 6 shows that it is only required to reach 50% of the activation far later than the current requirement of 50% within 5s. Since especially at times of low inertia in the Nordic synchronous area a fast FCR-D response is required[1], the TSOs consider relaxing the current requirement unacceptable for operational security reasons. For that reason, the TSOs propose keeping the existing requirement that *"50% of the upward FCR-D in each subsystem shall be regulated upwards within 5 seconds;"*. Article 4(2) of the Proposal reflects this position.

6.2.3 Load reduction can be used as upward FCR-D

In some cases, automatic load reduction is applied in the Nordic synchronous area as part of the upward FCR-D. This load reduction may be delivered by e.g. industrial load, district heating and electric boiler consumption. For upward FCR-D provided by load reduction in principle the same requirements apply as for upward FCR-D provided by generation units. This means that upward FCR-D provided by load reduction shall operate in the frequency range of 49.9 Hz to 49.5 Hz and that the same *FCR full activation time* and response requirements (see section 6.2.2) apply. This is reflected by article 4(3) of the Proposal.

6.3 Summary

The arguments in section 6.1 result in the additional properties for FCR-N in Article 3 of the Proposal:

1. FCR-N shall be fully activated at f = 49.9/50.1Hz (Δf = ±0.1Hz). FCR full activation frequency deviation for FCR-N is ± 100mHz.

2. In conjunction with a rapid system frequency change to 49.9/50.1 Hz, FCR-N shall be up regulated/ down regulated within 3 minutes.

The arguments in section 6.2 result in the additional properties for FCR-D in Article 4 of the Proposal:

1. Upward FCR-D shall be activated at 49.9 Hz and shall be fully activated at 49.5 Hz. It shall increase virtually linearly within a system frequency range of 49.9-49.5 Hz.

[1] to prevent for automatic Under Frequency Load Shedding in case of large instantaneous imbalances.

2. In the event of a system frequency drop to 49.5 Hz:
    - 50 % of the upward FCR-D shall be regulated upwards within 5 seconds;
    - 100 % of the upward FCR-D shall be regulated upwards within 30 seconds.
3. Agreed automatic load reduction in the event of frequency drops to 49.5 Hz can be counted as part of the upward FCR-D reserve. However: Load reduction can only be used as upward FCR-D in the frequency range of 49.9 Hz to 49.5 Hz, when load reduction meets the same technical requirements set under item 1 of this article.

7. Expected impact of the Proposal on the relevant objectives of the SO Regulation

The Proposal generally contributes to and does not in any way hamper the achievement of the objectives of Article 4 of the SO Regulation. In particular, the Proposal serves the objectives to:

- Article 4(1)(c) determining common load-frequency control processes and control structures;
- Article 4(1)(d) ensuring the conditions for maintaining operational security throughout the Union;
- Article 4(1)(e) ensuring the conditions for maintaining a frequency quality level of all synchronous areas throughout the Union; and
- Article 4(1)(h) contributing to the efficient operation and development of the electricity transmission system and electricity sector in the Union.

The Proposal contributes to these objectives by specifying the additional rules for FCR-N and upward FCR-D, which are key reserves that are used in the common Nordic load-frequency control processes. The additional properties are required to maintain the operational security by reducing the risk for automatic Under Frequency Load Shedding (UFLS) and for system blackouts due to under or over frequency. The additional properties balance the impact of both cost for FCR and outage risk and therefore ensure efficient operation of the electricity transmission system.

8. Timescale for the implementation

For proposed additional properties for both FCR-N and FCR-D currently apply in the Nordic synchronous area. Therefore, the TSOs shall implement the proposed additional properties for both FCR-N and FCR-D not later than when Nordic synchronous area operational agreement enters into force in accordance with Article 118 of the SO Regulation.

9. Public consultation

Article 11 of the SO Regulation states that: *"TSOs responsible for submitting proposals for terms and conditions or methodologies or their amendments in accordance with this Regulation shall consult stakeholders, including the relevant authorities of each Member State, on the draft proposals for terms and conditions or methodologies listed in Article 6(2) and (3). The consultation shall last for a period of not less than one month."*

This proposal has been consulted in the period 1 June to 1 July 2018. The appendix to this document includes the views of stakeholders resulting from the consultations and explains if and how these views have been taken into account in the proposal.

Appendix: Results of Public Consultation

Article 11(3) of the SO Regulation states that: *"The TSOs responsible for developing the proposal for terms and conditions or methodologies shall duly take into account the views of stakeholders resulting from the consultations prior to its submission for regulatory approval. In all cases, a sound justification for including or not including the views resulting from the consultation shall be provided together with the submission of the proposal and published in a timely manner before, or simultaneously with the publication of the proposal for terms and conditions or methodologies."*. Table 1 lists the views of stakeholders on this proposal resulting from the consultations and explains if and how these views have been taken into account in the Proposal.

Table 1: Views of stakeholders resulting from the consultations and explains if and how these views have been taken into account in the Proposal.

no.	organisation	comment	response TSOs
3	Nordenergi	We have the following comments regarding the proposal for additional properties of FCR in accordance with Article 154(2) of the Commission Regulation (EU) 2017/1485 of 2 August 2017: In the explanatory document for Nordic FCR additional properties proposal it is raised that the existing additional FCR properties do not necessarily meet the needs of the Nordic power system anymore. The TSOs foresee in the near future that changes and additions to the additional FCR properties are required and it is stated that: "Since the new requirements need to be defined carefully and in close cooperation with potential providers of FCR-N and upward FCR-D, the TSOs decided not to rush the implementation of new requirements". Nordenergi regards that stronger efforts could have been made to address some of the issues raised by the TSOs already in the consulted proposal. We have the understanding that a separate consultation on downward FCR-D will be performed shortly and supports this effort to make the portfolio of reserves more complete.	Comment acknowledged and did not result in changes to the proposal. The TSOs recognise that some changes could have been included in the proposal. However - as stated in chapter 6 of the explanatory document - *'the TSOs did not opt for partly changing the requirements because that could mean that FCR providers should adapt their FCR providing units and/or FCR providing groups twice. For this reason, the additional properties for FCR-N and upward FCR-D below only include the existing requirements that are not covered by the requirements specified in the SO Regulation.'*. The amendment process to this proposal will include a public consultation process.
4	Nordenergi	Given both the expected changes in the Nordic power system, the TSOs quarterly monitoring of the frequency quality and possible changes in product and settlement routines, it is crucial with deeper stakeholder involvement in the process going forward. In the monitoring process, it is important that new requirements are tested during a period to study/analyse any improvement to the frequency in the Nordic synchronous area before requirements enter into force on a permanent basis. Hence, new requirements etc. should be developed together with a	Comment acknowledged and did not result in a change of the proposal. Providers have already been involved in discussions and tests of new requirements and will also be involved in future. The focus in near future will be on the evaluation of the ability of providers to pre-qualify their assets. Furthermore, the need for the new FCR requirements from a system perspective will be analysed using simulation models. The TSOs will start the FCR implementation feasibility study shortly (proposed to be executed Q3'18-Q1'19). The TSOs will

no.	organisation	comment	response TSOs
		reference group from the industry. We further encourage the TSOs to publish an implementation plan for the FCR in the Nordic region containing milestones like pre-qualifications, product roll-out, frequency monitoring periods and expected stakeholder involvement including future consultations.	share an implementation plan for the new FCR requirements with their stakeholders as soon as this plan has been agreed between the TSOs.
7	Fortum Oyj	Given both the coming changes in the Nordic power system and possible changes in balancing products and settlement routines, it is crucial with deeper stakeholder involvement in the process going forward. In the monitoring process, it is important that new requirements are tested during a period to study/analyse any improvement to the frequency in the Nordic synchronous area before requirements enter into force on a permanent basis. Hence, new requirements etc. should be developed together with a reference group from the industry.	Comment acknowledged, see response to comment no. 4
8	Fortum Oyj	We further encourage the TSOs to publish an implementation plan for the FCR in the Nordic region containing milestones like pre-qualifications, product roll-out, frequency monitoring periods and expected stakeholder involvement including future consultations.	Comment acknowledged, see response to comment no. 4
9	Fortum Oyj	Specifically the Article 4, – Upward FCR-D additional properties of the "Nordic synchronous area proposal for additional properties of FCR in accordance with Article 154(2) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation", can be problematic given the fact that the frequency is too often below the standard frequency range, even with no major disturbance. It could be valuable to consider either to loosen the demand on virtual linearity or an introduction of a deadband (example: between 49,9 and 49,80) of the activation of FCR-D, or other measures to ensure FCR-D reserves are not used in vain.	Comment acknowledged and did not result in changes to the proposal. The TSOs recognise the issue that is raised by the respondent and aim for implementing resolutions in both the development of the new requirements for FCR and the new Nordic balancing model.