Explanatory document for the amended Nordic synchronous area proposal for ramping restrictions for active power output in accordance with Article 137(3) and (4) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

Explanatory document to the proposal of 19 January 2021

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 ramping restrictions for active power output for the Nordic LFC Block. Pursuant to Article 119(1)(c) of the SO Regulation, all Transmission System Operators in the Nordic LFC Block shall jointly develop common proposals for ramping restrictions for active power output in accordance with Article 137(3) and (4).

According to Article 6(3)(e)(i) of the SO Regulation the proposal for ramping restrictions for active power output in accordance with Article 137(3) and (4) shall be submitted for approval by the relevant national regulatory authorities (hereinafter "NRAs").

The proposal that is accompanied by this explanatory document amends the methodology that has been approved by the NRAs in November 2020 and is a proposal from all TSOs of the Nordic synchronous area (hereinafter **"TSOs"**).

This explanatory document contains an explanation of the amendments. 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 ramping restrictions. Chapter 4 provides an overview of the existing situation and Chapter 5 describes and explains the amendments. An outlook to future developments is described in Chapter 6. Chapter 7 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 119(1)(c) and (2) of the SO Regulation constitutes the legal basis that the Proposal should take into account. Article 119 has the following content:

> *"1. By 12 months after entry into force of this Regulation, all TSOs of each LFC block shall jointly develop common proposals for:[…]*
>
> *(c) ramping restrictions for active power output in accordance with Article 137(3) and (4); […]*
>
> *2. All TSOs of each LFC block shall submit the methodologies and conditions listed in Article 6(3)(e) for approval by all the regulatory authorities of the concerned LFC block. Within 1 month after the approval of these methodologies and conditions, all TSOs of each LFC block shall conclude an LFC block operational agreement which shall enter into force within 3 months after the approval of the methodologies and conditions"*

(2) Article 137(3) and (4) of the SO Regulation has the following content:

> *"3. All connecting TSOs of an HVDC interconnector shall have the right to determine in the LFC block operational agreement common restrictions for the active power output of that HVDC interconnector to limit its influence on the fulfilment of the FRCE target parameter of the*

connected LFC blocks by agreeing on ramping periods and/or maximum ramping rates for this HVDC interconnector. Those common restrictions shall not apply for imbalance netting, frequency coupling as well as cross-border activation of FRR and RR over HVDC interconnectors. All TSOs of a synchronous area shall coordinate these measures within the synchronous area.

4. All TSOs of an LFC block shall have the right to determine in the LFC block operational agreement the following measures to support the fulfilment of the FRCE target parameter of the LFC block and to alleviate deterministic frequency deviations, taking into account the technological restrictions of power generating modules and demand units:

(a) obligations on ramping periods and/or maximum ramping rates for power generating modules and/or demand units;

(b) obligations on individual ramping starting times for power generating modules and/or demand units within the LFC block; and

(c) coordination of the ramping between power generating modules, demand units and active power consumption within the LFC block."

(3) Article 6(3)(e)(i) 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: […]
(e) methodologies and conditions included in the LFC block operational agreements in Article 119, concerning:
(i) ramping restrictions for active power output in accordance with Article 137(3) and (4);

2.2 Interpretation and scope of the Proposal

Article 137(3) of the SO Regulation provides the TSOs with the right to determine common restrictions for the active power output of that HVDC interconnector. These restrictions may impact both operation of the HVDC interconnectors and market exchanges over these interconnectors. Since Article 137(3) of the SO Regulation excludes applicability of the restrictions for imbalance netting, frequency coupling as well as cross-border activation of FRR and RR over HVDC interconnectors, the TSOs consider that only wholesale energy markets (day-ahead, intraday etc.) shall be affected by the restrictions.

Since the Nordic synchronous area only consists of one LFC block, the HVDC interconnectors to other LFC blocks are always HVDC interconnectors to other synchronous areas. The restrictions for the active power output of HVDC interconnectors between synchronous areas as referred to in Article 137(1) and (2) of the SO Regulation shall therefore be the same as the restrictions for the active power output of the HVDC interconnectors that are proposed in this Proposal.

Article 137(4) of the SO Regulation provides the TSOs with the right to determine ramping restrictions for power generating modules and demand units. Article 137(4)(a) and (b) allow defining obligations for power generating modules and/or demand units while Article 137(4)(c) allows the TSOs to actively coordinate between generating modules, demand units and active power consumption within the LFC block.

3. Objective of ramping restrictions for active power output

The objective of the ramping restrictions for active power output is to balance momentary generation, consumption and exchange over HVDC interconnectors and by that limit large FRCE and frequency deviations. This will contribute to that the frequency and FRCE quality target parameters for the LFC block are fulfilled.

Currently the Nordic frequency restoration process is based on frequency deviation in the synchronous area. The Nordic LFC block is however divided in several LFC areas corresponding to the bidding zones. In balancing, the potential congestions between these bidding zones and sometimes within the bidding zones will have to be considered and controlled. Ramping restrictions on LFC area level will contribute to both safeguarding the Nordic FRCE quality and controlling these congestions. Consequently, these ramping restrictions ensure secure and efficient operation of the total electricity transmission system. The TSOs will define FRCE quality target parameters also for LFC areas to be used when ACE based balancing is implemented.

4. The existing situation

In this chapter, the existing ramping restrictions for active power output are presented. Section 4.1 describes the existing ramping restrictions for HVDC interconnectors and section 4.2 describes the existing ramping restrictions for production plans. Section 4.3 describes the existing possibilities for the TSOs to coordinate ramping between production plans. Ramping of consumption is currently not restricted nor coordinated.

The TSOs have investigated the efficiency of the existing ramping restrictions based on figures and simulations of 2019. Section 4.4 provides a summary of the results.

4.1 Existing restrictions for HVDC interconnectors

The trading plans on the HVDC interconnectors between the Nordic LFC block and other LFC blocks can potentially change so much from one hour to the next that the changes in power flows at the change of hours must be restricted to manage balance regulation and to stay within system security limits. For this reason, since 2007 the Nordic TSOs apply ramping restrictions on HVDC interconnectors in a harmonised way. These ramping restrictions limit the ramping rate and the ramping speed (see explanation of this terminology in Textbox 1). The maximum ramping rate limits the increase or decrease of the commercial interconnector flow to 600 MW from one hour to the next. In addition, there is a combined restriction on Skagerrak and Konti-Skan of 600 MW. The maximum ramping speed limits the physical change in the flows on minute-to-minute basis to 30 MW/minute per interconnector.

After the first introduction of these ramping restrictions, new HVDC interconnectors have been commissioned. For all these new interconnectors the same ramping restriction was applied as for the already existing interconnectors resulting in an increasing aggregated ramping rate for the Nordic LFC block.

Table 1 provides an overview of these restrictions for the existing bidding zone borders. The TSOs apply different ramping periods on the HVDC interconnectors.

Textbox 1: Explanation of different aspects of ramping restrictions: ramping rate, ramping period and ramping speed

In this document different aspects of ramping restrictions are discussed. Figure 1 shows a commercial flow which may change every hour (hour is the current Imbalance Settlement Period - ISP). The figure shows that the 'ramping rate' incidates the change from one hour to the next.

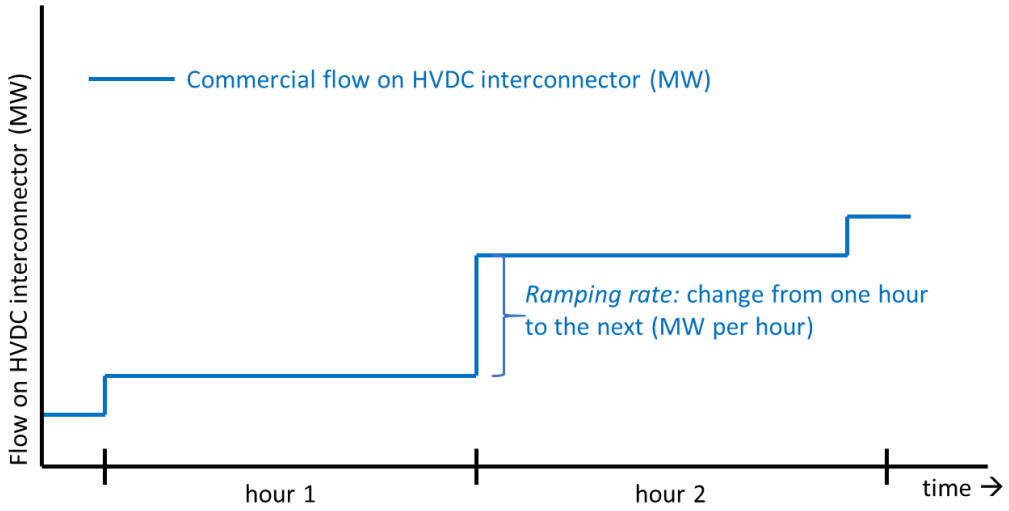

Figure 1: Explanation of ramping rate based on a commercial flow on an HVDC interconnector

Figure 2 shows a physical minute-by-minute schedule on an HVDC interconnector indicating a change of the flow every minute. The figure provides an explanation for the 'ramping period' which is the period (in minutes) that the ramping on the interconnector takes place. The 'ramping speed' defines the gradient of the change in the flow.

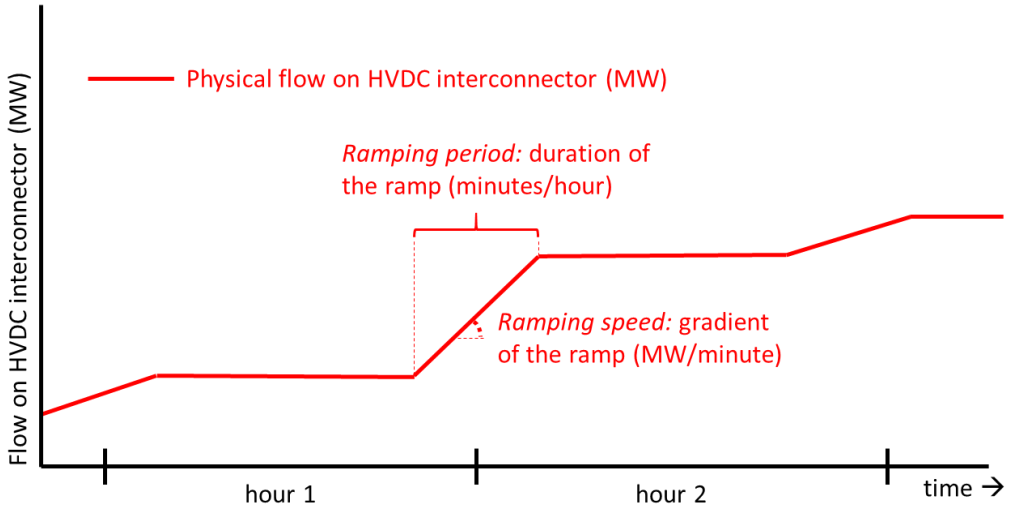

Figure 2: Explanation of 'ramping period' and 'ramping speed' based on the physical flow on an HVDC interconnector

The defined terms in this textbox may be used on individual HVDC interconnectors or in a combined way for a set of interconnectors. Where this is not obvious, 'individual' or 'combined' is used before the term.

Table 1: Existing restrictions between bidding zones

from	to	HVDC link	maximum ramping speed for change in flow (MW/min)	maximum ramping rate: changes to the trading plans from one hour to the next(MW)	
Sweden (SE4)	Germany (DE/LU)	Baltic Cable	30	600	
Finland (FI)	Estonia (EE)	Estlink 1	30	600	
		Estlink 2	30		
Denmark (DK2)	Denmark (DK1)	Great Belt	30	600	
Denmark (DK2)	Germany (DE/LU)	Kontek	30	600	
Sweden (SE3)	Denmark (DK1)	Konti-Skan 1	30	600	600
		Konti-Skan 2			
Norway (NO2)	Denmark (DK1)	Skagerrak 1	30	600	
		Skagerrak 2			
		Skagerrak 3			
		Skagerrak 4			
Sweden (SE4)	Lithuania (LT)	NordBalt	30	600	
Norway (NO2)	Germany (DE/LU)	NordLink	30	600	
Norway (NO2)	Netherlands (NL)	NorNed	30	600	
Sweden (SE4)	Poland (PL)	SwePol	30	600	
Finland (FI)	Russia (RU)	Vyborg	30	600	

4.2 Existing ramping restrictions for production plans

The TSOs apply a ramping restriction on BRPs representing power generating modules in Finland, Norway and Sweden when their hourly production plan changes more than 200 MW at hour shift. In this case BRPs need to reschedule their plan with quarterly steps 15 minutes before hour shift, at hour shift and 15 minutes after hour shift in order to adjust the plans to better correspond to the consumption pattern. In Norway, the steps can be applied 30 minutes before the hour shift until 30 minutes after the hour shift. The detailed terms and conditions are specified on national level. This obligation is not relevant in Denmark East due to the physical characteristics for production.

4.3 Coordinate ramping of production plans

Based on the planning information and real-time information, each TSO assesses the impact of ramping around hour shifts from a national perspective. In addition, Svenska kraftnät and Statnett assess whether the changes in production plans in the Nordic area and the HVDC exchange around hour shift will impact the system frequency in a way that cannot be entirely handled by control centres in the minutes before and after hour shift. If so, there is a need to advance or delay parts of planned production steps at the hour shift. The power schedules may be changed from 30 minutes before hour shift till 30 minutes after the hour shift.

This coordination is mainly important during morning and evening hours and also around day shift. If the changes in the production plans are deemed to be too high, the TSOs make a coordinated plan on how to level out these changes by an agreement with BRPs that represent power generating modules to reschedule the production. In situations with congestions, there is also a need to decide in which order the rescheduling should take place. E.g. in case of close to congestion on Hasle from Norway to Sweden it may be wise to start with increased production in Sweden/Finland 15 minutes before hour shift and decreased production in Norway in the first 15 minutes after the hour shift[1]. The volumes to be shifted after the hour shift might be reassessed closer to real time if something unplanned occurs that would interfere with the initial plan.

4.4 Assessment of the efficiency of ramping restrictions

Steps in electricity trade have increased over the last decades due to tighter market integration and an increasing number of interconnections between countries and synchronous areas. As a result of this, increasing steps in production make it more and more difficult to ensure the security of supply in the Nordic synchronous area in general and the Nordic system frequency quality in particular. To mitigate this, the Nordic TSOs developed a 'package of measures' which include – among other measures – ramping restrictions on both HVDC interconnectors and production plans. Both ramping restrictions aim for reducing the deterministic steps in minute-by-minute plans. While the ramping restrictions on HVDC interconnectors limit the size of the steps from one hour to the next, ramping restrictions for production aim for splitting-up the steps at the hour shift to smaller quarterly steps. Together, these ramping restrictions limit the minute-by-minute imbalances and help the TSOs to maintain the system frequency.

The TSOs assessed these ramping restrictions in 2020. The assessment covered the ramping arrangements described in sections 4.1 to 4.3 and assesses operational and market issues with a focus on the Nordic synchronous area in 2019.

To evaluate the efficiency of the ramping restrictions on HVDC interconnectors (as described in in section 4.1), the Nordic TSOs assessed the socioeconomic cost of ramping restrictions and compared them with the cost of alternatives, while keeping the current frequency quality at today's level. For this, the TSOs performed market simulations, using the Euphemia algorithm: Both the situation with the existing ramping restrictions on HVDC interconnectors and the hypothetical situation without ramping restrictions have been simulated for January, March, June and October 2019, using historical grid situations and historical bids.

The simulation results in Figure 3 show that ramping restrictions on HVDC interconnectors are most effective when they are most needed: In the approx. 1% of the hours that without ramping restrictions the steps would have been the largest, ramping restrictions reduce the total step on all Nordic HVDC interconnectors to other synchronous areas by 570 to 2200 MWh/h (830 MWh/h on average) and prevent for situations with a step of more than 4300 MWh/h. In the other 99% of the hours, ramping restrictions reduce the steps by up to 630 MWh/h (33 MWh/h on average). The simulation results show that the steps on restricted HVDC interconnectors are either shifted to other hours or to other HVDC interconnectors. This results in only minor changes in average Nordic bidding zone prices. The impact of the restrictions on the socioeconomic welfare is limited to less than 1 million Euro per year.

[1] In Norway and Sweden, it is sometimes possible to reschedule production steps within the hour if there are available production changes to reschedule.

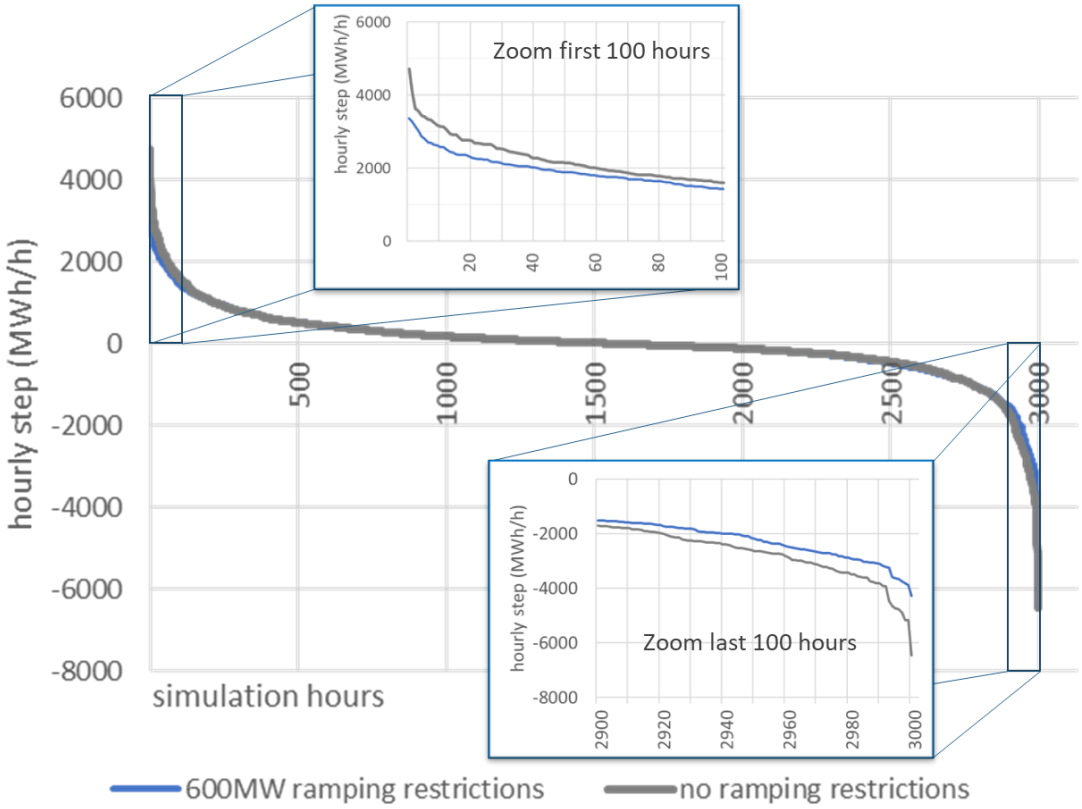

Figure 3: Total hourly steps for all Nordic HVDC interconnectors (except Vyborg), ranked to the simulation results, for January, March, June and October 2019.

The second type of ramping restrictions aim at minimising minute-by-minute imbalance by distributing hourly steps in production plans over different quarters (as described in section 4.2). The rules require that when the hourly production plan of a BRP changes more than 200 MWh/h at hour shift, the BRP is obliged to send in a quarterly production plan. BRPs ramping above 200 MWh/h usually have a larger number and mix of production units, which can be reoptimized across hours without deviating from the optimal setpoints of production units. In contrast, applying these rules to smaller steps than 200 MWh/h would also affect BRPs with less production units. If they cannot reoptimize across production units, this would result in a deviation from operating at optimal setpoints and, thus, a reduction in production efficiency. This would harm the level playing field and results in energy losses in the Nordic power system.

In practice, these rules mainly affect BRPs that operate hydro units with storage since these BRPs are able to quickly ramp at hour shift. This does not mean that the rules are not applicable to other types of production. However, due to their technical restrictions these other units implicitly follow the requirements (thermal units) or are hardly able to adjust (e.g. intermittent generation and run-of-river hydro generation). Consequently, the rules mainly impact Norway and Sweden, have limited impact in Finland (limited hydro with storage) and are not applied at all in Denmark (no hydro with storage).

The rules further allow the TSOs to adjust the production plans in order to minimise the minute-by-minute imbalance in the Nordic synchronous area (as described in section 4.3). The TSOs mainly adjust the plans during morning ramp hours and the day shift. But also during the evening there is quite significant quarterly adjustment. During these hours the TSOs shift up to 480 MW on average weekdays. In total, the TSOs shifted 403 GWh in 2019, which is less than 0,1% of the total Nordic production in 2019. For these adjustments the TSOs paid a compensation payment of 2.8 million Euros to mainly Norwegian and Swedish BRPs.

The restrictions above reduce the Nordic imbalance around the hour shift. To further reduce the minute-by-minute imbalance, the Nordic TSOs procure 600 MW of FCR-N around the clock and 300 MW aFRR (upward and downward) for the hours with the largest ramps. This is however not sufficient to meet the aimed frequency quality of 10.000 minutes outside the standard frequency range , but meets the target frequency quality parameter of 15.000 minutes outside the standard frequency range as specified in SOGL.

It can be argued that if more automatic reserves would be available, the ramping restrictions could be relaxed. However, this comes at a far larger cost: Contracting aFRR in order to slightly relax the ramping restrictions (from 600 MWh/h to 700 MWh/h) would cost 10 to 20 million Euros/year while the socioeconomic benefit in terms of avoided ramping restrictions would be less than 1 million Euro/year (resulting from the simulations described above). A reason for the big difference is that ramping restrictions only reduce socioeconomic welfare in hours that they are effective. Conversely, aFRR capacity needs to be procured for all the hours that large steps on interconnectors could be the result of the energy market clearing. It has to be further noted that – at least in the short term – this alternative is only a theoretical one since insufficient aFRR capability would be available to relax the potential ramping restrictions. Furthermore, it may be operationally challenging to operate with very large amounts of aFRR with current setup since these may also create additional flows and bottlenecks in the system. Additional aFRR is therefore not considered more efficient and effective than ramping restrictions.

Counter trading may also be considered as an alternative to mitigate ramping issues after the market results are known. The assessment shows that this alternative does not result in higher socioeconomic welfare than ramping restrictions while increasing the complexity in operations and the risk of market power abuse. Furthermore, an important challenge of the use of counter trade is that the prices in the spot market will not reflect the real value of power in the different bidding zones with detrimental consequences for use of hydro power storage as well as investments in consumer flexibility or generation capability. The TSOs therefore do not consider counter trading as a more efficient solution for ramping restrictions either.

To sum up, the TSOs consider ramping restrictions on HVDC interconnectors and production BRPs an efficient tool for mitigating large minute-by-minute imbalances at hour shifts, at least until the introduction of the new Nordic Balancing Model and the 15 minutes ISP. However, the assessment also provides some indication that ramping restrictions may be improved and better adapted to the increasing number of HVDC interconnectors.

5. Proposal for Ramping Restrictions

5.1 Overview

Momentary imbalances result from the momentary difference between generation and import on one side, and export and demand on the other side. It shall be noted that a balanced ISP does not mean that system balance exists in every moment. A major reason for this is the difference in behaviour between generation and demand: Generation units tend to ramp quickly to their new set-point at the beginning of the ISP and keep their generation stable over the ISP. Conversely, demand increases linearly. The difference between the generation ramp and the consumption increase creates the momentary imbalance within the ISP and accordingly results in a FRCE. The effect is similar for import/export vs. generation. Also here there may be a mismatch between the quickly changing generation units and the gradually ramping HVDC interconnectors. It must be noted that these imbalances represent substantial volumes.

The mechanism that is described above is particularly present in the Nordic synchronous area because of the abundance of fast ramping hydro generators that increase their production in large steps during the morning hours to catch up with the increasing demand and increasing export (or decreasing import) on HVDC interconnectors with large aggregated exchange capacity. The opposite happens in the evening. It is clearly the size of the steps between the ISPs that are important.

In order to limit the momentary imbalance (and FRCE), the Nordic TSOs apply a number of measures. Some of these measures intend to mitigate consequences of the momentary imbalance (e.g. aFRR) and others try to prevent for them. Two of the latter ones are included in this proposal.

All TSOs' measures together result in the Nordic LFC's FRCE quality and consequently the Nordic synchronous area's frequency quality. Since all measures affect each other and measures cannot be seen independently from each other, identifying the individual effect of one of the measures is difficult, if possible. The Nordic TSOs consider that – at this moment – they do not have another choice than applying all the measures. By relying on all these measures, the Nordic frequency quality during the previous decade was in between the Nordic aim (not more than 10,000 minutes per year outside the standard frequency range) and the limit set by the SO Regulation (15,000 minutes per year outside the standard frequency range). There seems to be an improvement in this trend in 2020 but then it must be noted that this year is characterised by an operational situation with large reductions in exchange capacity and very high hydro reservoir levels. The consequence has been small ramping volumes on HVDC interconnectors.

The TSOs have earlier informed about the increased operational challenges from increased volumes of renewables, increased exchange capacity and further market integration in a specific report[2]. This development will continue and the TSOs must safeguard system security as a first priority. However, the TSOs foresee that development in some of the measures, like expected larger aFRR volumes related to implementation of the mACE balancing, will contribute to an improved FRCE quality. The substantial increase in aFRR volumes will however take some time to be realised. Consequently, the TSOs propose to be careful with relaxing the existing ramping restrictions now. I.e. the proposed ramping restrictions are determined as per current operational conditions (see section 6 for outlook).

The existing ramping restrictions for HVDC interconnectors and production plans (see sections 3, 4.1 and 4.2) and the existing possibilities for the TSOs to coordinate ramping between production plans (see section 4.3) limit large FRCE and frequency deviations and contributes to that the frequency and FRCE quality target parameters will be fulfilled. Consequently, the TSOs conclude that it is required to keep the existing ramping restrictions and coordination possibilities. Therefore, the TSOs only propose minor adjustments in the ramping restrictions and coordination possibilities to increase efficiency.

5.2 Amendments to the proposal

The connection of new HVDC interconnectors NordLink (in 2020) and North Sea Link (NSL) (in 2021) are the trigger for the proposed amendments to the methodology. Without additional measures, starting the operation of these HVDC interconnectors will result in increased ramping on the HVDC interconnectors to the Nordic synchronous area and accordingly harm the frequency quality and operational security.

Also in 2021, the 'Kriegers Flak combined grid solution' will start operation. This interconnector will operate in parallel to the existing Kontek HVDC cable that already connects bidding zone DK2 (Eastern Denmark) to Germany. The existing ramping rate between DK2 and Germany will consequently be used by both the Kontek cable and the Kriegers Flak combined grid solution.

As argued above, the TSOs need to avoid further deterioration of the freqeuncy quality. This means that the TSOs need to ensure that the very large steps from one hour to the next are avoided.

Although the new HVDC interconnectors affect the entire Nordic LFC block, the biggest impact will be on bidding zone NO2, to which both NordLink and NSL connect. Due to very quick changes in the flow in the grid over potentially congested corridores in southern Norway and towards Sweden in the Hasle corridor, additional measures are needed to be able to handle the increased ramping from these two new interconnectors without breaching operational securitiy limits.

[2] Report 'Challenges and Opportunities for the Nordic Power System' (by Energinet, Fingrid, Statnett and Svenska Kraftnät), available on https://www.fingrid.fi/globalassets/dokumentit/fi/yhtio/tki-toiminta/report-challenges-and-opportunities-for-the-nordic-power-system.pdf

The connection of the new HVDC interconnectors NordLink and NSL requires reinforcements in the AC grid in Southern Norway. Although these works are done in parallel to the completion of these HVDC lines, the completion will take three more years. During this time, some existing lines will need to be disconnected in the summer and spring periods and reduction of ramping rates may be needed in a similar way as reduction of ATC for the energy markets. The proposed amendments allow for this flexibility which requires transparency and timely information to the market.

Within the operational limits described above, the TSOs want to maximise Nordic socioeconomic welfare, and relax the ramping restrictions where possible. This needs to be done carefully to safeguard system operation. Therefore, it requires a gradual approach and some flexibility for TSOs to optimize between the objectives.

The assessment of the ramping restriction (see section 4.4) showed that ramping restrictions on HVDC interconnectors are an efficient tool with rather low socio-economic cost. The main reason is that the ramping restrictions are only active when they are needed, i.e. when the steps would otherwise be very large. The proposed amendments therefore use ramping restrictions on HVDC interconnectors for mitigating the issues described above. At the same time the proposed amendments intend to increase the efficiency of these ramping restrictions by introducing a combined restriction on bidding zone NO2 and by that making it possible to increase the ramping rates on individual HVDC interconnectors.

In summary, the TSOs therefore propose the following amendments:

- Keep the exisiting ramping restrictions as a starting point and make them applicable to new HVDC interconnectors (implemented in Article 3(1) and 3(2));
- Introduce a combined ramping restriction for NorNed, NordLink and Skagerrak of at least 1200 MW from one hour to the next; and allow for increasing the individual ramping speed in MW/minute and the individual ramping rates in MW/hour on these three HVDC interconnectors. It is noted that NSL cannot be included because this interconnector is not part of the Internal Energy Market and its exchange is settled before the IEM (implemented in Article 3(3), 3(4) and 3(5)). For NSL only the ramping rate of 600 MW from one hour to the next and the maximum ramping speed of 30MW/minute apply (implemented in Article 3(1) and 3(2));
- Make it possible for the TSOs to restrict the steps temporarily under specific network conditions (implemented in Article 3(2)). This flexibility requires transparency and timely information to the market;
- After implementation of the combined restriction for NO2, the TSOs consider that the existing combined ramping restriction on Konti-Skan and Skagerrak is not required anymore (implemented in Article 3(6));

5.3 Amendments to the proposal per amended Article.

This section repeats the amendments proposed in section 5.2, but now per article.

5.3.1 Article 2(2)

For clarification reasons and without the intention to change the meaning, the definition of the HVDC interconnector has been changed from *'a HVDC interconnector means one or more cables between two synchronous areas connected to the transmission grid in the same connection point on both sides'* to *'a HVDC interconnector means one or more HVDC cables between a bidding zone in the Nordic synchronous area and a bidding zone in another synchronous area.*

5.3.2 Article 3 (first sentence)

Article 3 has been completely revised. To the first sentence *"In order to fulfil the FRCE target parameters for the LFC block as referred to in article 128 of the SO Regulation"* the following text has been added *"and prevent for breaching operational security limits while maximising Nordic socioeconomic welfare".* The additions refer to the network issues that should be resolved by the implementation of a combined

ramping restriction for bidding zone NO2 (in paragraph 3 and 4) and the possibility to increase the individual ramping rates (in paragraph 5).

5.3.3 Article 3(1)

Article 3.1 reflects the existing maximum ramping speed of 30 MW/minute as included in the existing methodology that was approved by the NRAs in November 2020. This maximum ramping speed has now been made applicable to all HVDC interconnectors which means that the ramping speed of '30 MW/minute' automatically applies to all new HVDC interconnectors.

While Article 3(1) of the existing methodology firmly determines a maximum gradient for change in flow to be 30 MW/min, this limitation cannot be kept if it shall be possible to increase individual ramping rates as explained in paragraph 5.

5.3.4 Article 3(2)

Article 3.2 reflects the existing ramping rate of '+/- 600 MW from one hour to the next' as included in the existing methodology that was approved by the NRAs in November 2020. This ramping rate has now been made applicable to all HVDC interconnectors which means that the ramping rate of '+/- 600 MW from one hour to the next' automatically applies to all new HVDC interconnectors.

Furthermore, article 3(2) adds that the *'The TSOs may however reduce the maximum individual ramping rates temporarily under specific network conditions and for a period in time less than 8 consecutive months'* as explained in 5.2.

5.3.5 Article 3(3)

To allow for a more efficient allocation of the ramping (see paragraph 5) and also based on the response of the stakeholders to the public consultation on the previous proposal, Article 3(3) adds the obligation for the TSOs to implement a combined maximum ramping rate in the energy markets in bidding zone NO2 of at least 1200 MW from one hour to the next. This combined maximum ramping rate will cover three of the four HVDC interconnectors connected to bidding zone NO2: NordLink, NorNed and Skagerrak. The reason to exclude NSL is that this HVDC interconnector does not participate in the Internal Energy Market (IEM).

The combined restriction for NO2 provide two additional opportunities:

- The individual ramping rates on NorNed, NordLink and Skagerrak may be increased (see Article 3(5));
- The existing combined restriction for Skagerrak and Konti-Skan will be removed.

A quarterly evaluation and potentially increased ramping rate shall be based on impact on 'minutes outside the standard frequency range' and potential excursions of operational security limits.

5.3.6 Article 3(4)

Since the combined restriction of Article 3(3) limits the total step of the NordLink, NorNed and Skagerrak, it is a possibility to increase the maximum individual ramping rates and ramping speeds on these HVDC interconnectors, without increasing the total step for the Nordic LFC block and bidding zone NO2. This would allow the market algorithm to better optimise the allocation of the flows to the HVDC interconnectors. Article 3(4)(a) opens for this. However, some conditions need to be fulfilled, including the technical feasibiliy of the HVDC interconnector (Article 3(4)(b)). Furthermore, increasing the ramping rate and ramping speed must not result in network issues on both ends of the HVDC interconnector (Article 3(4)(c)+(d)).

5.3.7 Article 3(5)

The TSOs consider that the existing sum restrictions for Skagerrak and Konti-Skan of 600MW/hour can be removed after the implementation of the combined ramping rate in Article 3(3).

5.3.8 Article 3(6)

The TSOs consider that market participants shall be informed timely about any change on ramping restrictions.

5.3.9 Article 3(7)

Article 3(7) is a copy of text in Article 137(3) of the SO Regulation which reminds that the ramping restrictions shall only apply wholesale energy markets (day-ahead, intraday etc.) and consequently not to imbalance netting, frequency coupling as well as cross-border activation of FRR and RR over HVDC interconnectors.

6. Outlook

The restrictions for HVDC ramping discussed in section 4.1 above were determined on the basis that the total change for the Nordic synchronous system at one hour shift should not exceed an acceptable maximum level and this total level was evenly distributed on individual HVDC interconnectors.

The ramping restrictions have not been changed after they were first introduced in 2007 even if new interconnectors, increased volumes of renewables and further market integration have led to that the potential change above have increased. This has been possible by improvements in other operational measures like e.g. introduction of Nordic aFRR as well as the fact that the increase in the total ramping so far have shown not to effectuate the full potential.

By adding ramping rates of 600 MW/hour for the new NordLink (in 2020) and NSL (in 2021) HVDC interconnectors, the addition of a combined restriction on NordLink, NorNed and Skagerrak and the removal of the sum restriction on Skagerrak and Konti-Skan, the aggregated maximum ramping rate on all Nordic HVDC interconnectors will increase with at least 1200 MW/hour from 2020. This may have a negative impact on the FRCE / frequency quality of the Nordic LFC Block/Synchronous Area and will therefore be monitored carefully. The TSOs evaluated the possibility to also propose a cap on the total ramping on all Nordic HVDC interconnectors towards other synchronous areas, as suggested by stakeholders in accordance with article 137 of SOGL. The TSOs will propose an amendment to this methodology including a combined Nordic ramping restriction by the introduction of an ISP of 15 minutes in 2023.

Future development with changed flow pattern, the mACE concept and the introduction of an ISP of 15 minutes requires that the limits, ramping periods and the methodology to determine these limits are re-evaluated in the new Nordic balancing model development process. In the same process, the restrictions and coordination of production plans discussed in section 4.2 and 4.3, will be assessed.

It is envisaged that the ramping restrictions on both HVDC and production plans will have to be modified before the implementation of the 15 min ISP.

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.

The Proposal contributes to these objectives by specifying ramping restrictions for HVDC interconnectors and production plans. These ramping restrictions are required to maintain the operational security by reducing

the risk for automatic Low Frequency Demand Disconnection (LFDD) and for system blackouts due to under or over frequency. Furthermore, the ramping restrictions are required to maintain the frequency quality level of the synchronous areas involved.

8. Timescale for the implementation

Since paragraphs 1, 2, 7 and 8 of Article 3 and Article 1, 2, and 4 represent the existing situations following the previously NRA approved methodologies, these articles do not require implementation time.

The new rules that are specified in paragraphs 3, 4, 5 and 6 require some implementation time required for changing IT systems at both the TSOs and the market operator and can be implemented within August 2021, subject to NRA approval.

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 will be consulted in the period 21 January 2021 to 22 February 2021 .