# Explanatory document for the amended Nordic LFC block methodology for FRR dimensioning in accordance with Article 157(1) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

13 February 2023

## 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 a methodology for FRR dimensioning. Pursuant to Article 119(1)(h) of the SO Regulation, all Transmission System Operators in the Nordic LFC Block shall jointly develop common proposals for the FRR dimensioning rules defined in accordance with Article 157(1).

This document contains an explanation of the common methodology developed by all Transmission System Operators within the Nordic synchronous area (hereinafter "**TSOs**") dated 06.09.2022. This methodology is hereafter referred to as '**Methodology**'.

This explanatory document is structured as follows: The legal requirements for the Methodology are presented in Chapter 2. Chapter 3 describes the objective of the Methodology. Chapter 4 provides an overview of the existing situation. The proposed FRR dimensioning rules are described and explained in Chapter 5. Chapter 6 describes the expected impact on the relevant objectives of the SO Regulation. Finally, Chapter 7 provides the timeline for implementation and Chapter 8 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 Methodology must take into account. These are cited below.

(1) Article 119(1)(h) and (2) of the SO Regulation constitutes the legal basis that the Methodology 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: […]*

*(h) the FRR dimensioning rules defined in accordance with Article 157(1); […]*

*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 157 of the SO Regulation has the following content:

*"1. All TSOs of a LFC Block shall set out FRR dimensioning rules in the LFC Block operational agreement.*

*2. The FRR dimensioning rules shall include at least the following:*

*(a) all TSOs of a LFC block in the CE and Nordic synchronous areas shall determine the required reserve capacity of FRR of the LFC block based on consecutive historical records comprising at least the historical LFC block imbalance values. The sampling of those historical records shall cover at least the time to restore frequency. The time period considered for those records shall be representative and include at least one full year period ending not earlier than6 months before the calculation date;*

*(b) all TSOs of a LFC block in the CE and Nordic synchronous areas shall determine the reserve capacity on FRR of the LFC block sufficient to respect the current FRCE target parameters in Article 128 for the time period referred to in point (a) based at least on a probabilistic methodology. In using that probabilistic methodology, the TSOs shall take into account the restrictions defined in the agreements for the sharing or exchange of reserves due to possible violations of operational security and the FRR availability requirements. All TSOs of a LFC block shall take into account any expected significant changes to the distribution of LFC block imbalances or take into account other relevant influencing factors relative to the time period considered;*

*(c) all TSOs of a LFC block shall determine the ratio of automatic FRR, manual FRR, the automatic FRR full activation time and manual FRR full activation time in order to comply with the requirement of paragraph (b). For that purpose, the automatic FRR full activation time of a LFC block and the manual FRR full activation time of the LFC block shall not be more than the time to restore frequency;*

*(d) the TSOs of a LFC block shall determine the size of the reference incident which shall be the largest imbalance that may result from an instantaneous change of active power of a single power generating module, single demand facility, or single HVDC interconnector or from a tripping of an AC line within the LFC block;*

*(e) all TSOs of a LFC block shall determine the positive reserve capacity on FRR, which shall not be less than the positive dimensioning incident of the LFC block;*

*(f) all TSOs of a LFC block shall determine the negative reserve capacity on FRR, which shall not be less than the negative dimensioning incident of the LFC block;*

*(g) all TSOs of a LFC block shall determine the reserve capacity on FRR of a LFC block, any possible geographical limitations for its distribution within the LFC block and any possible geographical limitations for any exchange of reserves or sharing of reserves with other LFC blocks to comply with the operational security limits;*

*(h) all TSOs of a LFC block shall ensure that the positive reserve capacity on FRR or a combination of reserve capacity on FRR and RR is sufficient to cover the positive LFC block imbalances for at least 99 % of the time, based on the historical records referred to in point (a);*

*(i) all TSOs of a LFC block shall ensure that the negative reserve capacity on FRR or a combination of reserve capacity on FRR and RR is sufficient to cover the negative LFC block imbalances for at least 99 % of the time, based on the historical record referred to in point (a);*

*(j) all TSOs of a LFC block may reduce the positive reserve capacity on FRR of the LFC block resulting from the FRR dimensioning process by concluding a FRR sharing agreement with other LFC blocks in accordance with provisions in Title 8. The following requirements shall apply to that sharing agreement:*

*(i) for the CE and Nordic synchronous areas, the reduction of the positive reserve capacity on FRR of a LFC block shall be limited to the difference, if positive, between the size of the positive dimensioning incident and the reserve capacity on FRR required to cover the positive LFC block imbalances during 99 % of the time, based on the historical records referred to in point (a). The reduction of the positive reserve capacity shall not exceed 30 % of the size of the positive dimensioning incident;*

*(ii) for the GB and IE/NI synchronous areas, the positive reserve capacity on FRR and the risk of non-delivery due to sharing shall be assessed continually by the TSOs of the LFC block;*

*(k) all TSOs of a LFC block may reduce the negative reserve capacity on FRR of the LFC block, resulting from the FRR dimensioning process by concluding a FRR sharing agreement with other LFC blocks in accordance with the provisions of Title 8. The following requirements shall apply to that sharing agreement:*

*(i) for the CE and Nordic synchronous areas, the reduction of the negative reserve capacity on FRR of a LFC block shall be limited to the difference, if positive, between the size of the negative dimensioning incident and the reserve capacity on FRR required to cover the negative LFC block imbalances during 99 % of the time, based on the historical records referred to in point (a);*

*(ii) for the GB and IE/NI synchronous areas, the negative reserve capacity on FRR and the risk of non-delivery due to sharing shall be assessed continually by the TSOs of the LFC block.*

*3. All TSOs of a LFC block where the LFC block comprises more than one TSO shall set out, in the LFC block operational agreement, the specific allocation of responsibilities between the TSOs of the LFC areas for the implementation of the obligations established in paragraph 2.*

*4. All TSOs of a LFC block shall have sufficient reserve capacity on FRR at any time in accordance with the FRR dimensioning rules. The TSOs of a LFC block shall specify in the LFC block* *operational agreement an escalation procedure for cases of severe risk of insufficient reserve capacity on FRR in the LFC block."*

(3) Article 6(3)(e)(iv) 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: […]*

*(iv) the FRR dimensioning rules in accordance with Article 157(1);"*

(4) Article 152(1) of the SO Regulation has the following content:

*"1. Each TSO shall operate its control area with sufficient upward and downward active power reserve, which may include shared or exchanged reserves, to face imbalances between demand and supply within its control area. Each TSO shall control the FRCE as defined in the Article 143 in order to reach the required frequency quality within the synchronous area in cooperation with all TSOs in the same synchronous area."*

### 2.2 Interpretation and scope of the Methodology

The SO Regulation requires NRA approval for the FRR dimensioning rules in accordance with Article 157(1). Article 157(1) requires that all TSOs of a LFC block shall set out FRR dimensioning rules in the LFC block operational agreement. Article 157(2) further specifies the minimum requirements to the FRR dimensioning rules. The TSOs therefore consider that Article 157(1) and (2) of the SO Regulation set out the scope for this Methodology. These articles can however not be seen completely separate from Article 152(1) which requires each TSO to operate its control area with sufficient upward and downward FRR, which may include shared and exchanged reserves, to face imbalances between demand and supply within its control area. In accordance with Article 157(1) and (2) of the SO Regulation, the scope of this Methodology shall include the dimensioning of both manual FRR (mFRR) and automatic FRR (aFRR) for the Nordic LFC Block. The results of the dimensioning are the required amounts of upward and downward mFRR and aFRR for the Nordic LFC Block, including the geographical distribution.

Article 157(2)(j) and (k) refer to reducing the result of the FRR dimensioning by sharing of FRR with other LFC blocks. The TSOs consider that this reduction will take place after FRR dimensioning and shall therefore be outside the scope of this Methodology. The conditions specified in article 157(2)(j) and (k) are taken into account in the TSOs' proposal for the methodology to determine limits on the amount of exchange of FRR between synchronous areas in accordance with article 118(1)(z) of the SO Regulation.

Although Articles 119(1)(j)/157(3) and 119(1)(k)/157(4) require proposals that need to be included in the LFC block operational agreement, these proposals do not require NRA approval and are not part of the scope of this Methodology. Similarly, outside the scope of this Methodology is how the TSOs of the Nordic LFC block will ensure that sufficient FRR will be available in practice as referred to in Article 157(4) of the SO Regulation. Consequently, outside the scope of this Methodology are issues like procurement, pricing, acceptance of bids, settlement and (other) issues regulated in the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (EBGL).

# 3. Objective of FRR dimensioning

The main purpose of FRR is restoring FRCE in the Nordic LFC block and consequently to replace activations of FCR. mFRR can also be pro-actively activated to prevent for FRCE deviations, e.g. in case of (expected) deterministic frequency deviations. FRR shall be sufficiently available to maintain the FRCE quality, and to be within system security limits. The objective of FRR dimensioning is to determine a volume of aFRR and mFRR that shall be available in the Nordic LFC block. As the Nordic LFC block experiences frequent congestions in the grid, the dimensioning shall take the geographical requirements for distribution of FRR into account.

# 4. The existing situation

In this chapter, the existing FRR dimensioning rules at the time of the submission of this amended methodology are described. The Manual Frequency Restoration Process (mFRP) and the Automatic Frequency Restoration Process (aFRP) are under development in the Nordics, migrating from frequency based to ACE based activation. The manual frequency restoration process (mFRP) is currently the dominant process for balancing, Section 4.1 describes mFRR dimensioning, while section 4.2 elaborates on aFRR.

## 4.1 mFRR dimensioning

mFRR shall exist in order to restore the faster reserves FCR-N, FCR-D and aFRR when these reserves have been activated and to control flows in the grid within applicable limits. mFRR is also pro-actively activated to prevent frequency deviations, e.g. in case of expected frequency deviations. The mFRR shall in normal operation exist and be localized to the extent that the synchronous system can be balanced at any time. mFRR is dimensioned by the individual TSOs based on their control area assessment of local requirements. Bottlenecks in the network, reference incident and similar are included when assessing this.

The requirements for mFRR volumes in upward direction are currently defined by large national N-1 incidents: Each control area shall have mFRR volumes available equivalent to or greater than the reference incident in the subsystem.

In addition, the TSOs must also have reserves or other measures available to handle other imbalances which are correlated with N-1 incidents or two or more simultaneous faults, if they are likely to occur at the same time, within the TSOs control area and on the borders to other control areas.

In practice, all four TSOs dimension the mFRR volumes for their control area and determine the required distribution within the control area. The mFRR volumes are based on the reference incident in the control area, as described above. However, some mFRR capacity is shared between Sweden and Denmark. mFRR that shall be available for handling of ‘normal’ BRP imbalances are not explicitly dimensioned for in Denmark East, Finland and Sweden. For this, these TSOs rely on voluntary mFRR energy bids that are available in the Nordic Regulating Power market. Statnett relies on voluntary mFRR energy bids when recent experience shows that such bids are delivered with sufficient volume. However, if the probability for availability of sufficient mFRR up or down is too low, Statnett contracts upward mFRR or downward mFRR reserves as required.

The TSOs see that there is sometimes a lack of reserves based on the voluntary bids, the plan is to resolve this using the mFRR capacity mechanism.

## 4.2 aFRR dimensioning

aFRR was introduced in the Nordic synchronous area in January 2013. The background for implementing and developing aFRR in the Nordics was the deteriorating frequency quality and aFRR was identified and agreed on as one of the main measures to stop the weakening of the frequency quality.

The aFRR product shall be seen as an automatic "complement" to mFRR in the Frequency Restoration process. The Nordic LFC block centrally activates aFRR from a single Load Frequency Controller (LFC). Based on the measured frequency, this LFC calculates the required activation of aFRR and distributes the activation requests to the Nordic TSOs pro-rata. Consequently, each Nordic TSO distributes the requests to the contracted aFRR providers in its control area.

Currently, only procured aFRR capacity can be activated and therefore the complete dimensioned amount shall be procured. Each quarter of a year, all Nordic TSOs determine the hours for which aFRR shall be dimensioned. These hours include the hours where the frequency variations are most challenging. Likewise, the required total aFRR in the Nordic LFC block is updated quarterly, the update is based on the targeted frequency quality and FRCE quality. The total volume is shared between the TSO's using a sharing key, which the Nordic TSOs have agreed upon.

# 5. Proposal for FRR dimensioning rules

On a high level, the goal for the FRR dimensioning rules is to have access to sufficient FRR in the LFC block to handle imbalances in all LFC areas at least 99% of time and respect the FRCE targets for the LFC block. In addition, each TSO is responsible for being able to handle potential reference incidents in their LFC areas. Different measures may be used to handle reference incidents, but each TSO shall have access to sufficient FRR to handle the Control area Reference Incident as a minimum.

The Methodology reflects this goal as it will be applied in the new Nordic Balancing Model. Below, the articles in the Methodology have been explained individually.

## 5.1 Article 2(2): Definitions

For the purpose of the Methodology, the TSOs distinguish two types of imbalances: normal imbalances (defined in section 5.1.1) and reference incidents (defined in section 5.1.2).

### *5.1.1 Normal imbalances*

Normal imbalances are the imbalances that continuously happen in power systems. They are caused by stochastic deviations in load and generation, deterministic events at given times (e.g. shifts of hours) and forecast errors. Usually, normal imbalances consist of many small and large imbalances which partly compensate for each other since they are in the opposite direction. The aggregated normal imbalances changes continuously and results in a frequency deviation. The challenge for the TSOs is to keep the frequency within the standard frequency range (± 100 mHz).

### *5.1.2 Reference incidents*

Imbalances can be caused by contingencies, including faults in a power generating module, a demand facility, a HVDC interconnector or from a tripping of an AC line. These imbalances are different from normal imbalances (which occur constantly) as large power deviations of this kind occur only occasionally and result in an instantaneous (within seconds) power surplus or deficit. An instantaneous power surplus or deficit produces an instantaneous frequency deviation, and may result in a frequency outside the standard frequency range. In these situations, the TSOs shall restore the frequency to the frequency restoration range (± 100 mHz) within time to restore frequency (15 minutes).

Article 3(1)(58) of the SO Regulation defines the term reference incident as "*the maximum positive or negative power deviation occurring instantaneously between generation and demand in a synchronous area, considered in the FCR dimensioning*". In a Nordic context, this would then be the maximum power deviation resulting from a contingency in the synchronous area that can occur in the time period for which the FRR dimensioning applies. The Nordic synchronous area and LFC block encompass the same bidding zones which means that in the context of reference incident they are interchangeable.

The Methodology sometimes refer to “reference incident for the LFC area” or “reference incident for the control area”. This should be understood as the maximum positive or negative power deviation occurring instantaneously from generation, demand or an Interconnector in a LFC area or control area respectively. To make the distinction clear to the reader the Methodology always specifies the area which is evaluated for its possible maximum power deviation, even in the case of the synchronous area.

#### *5.1.3 Dimensioning incident*

Article 3(1)(109) of the SO Regulation defines the term dimensioning incident as *“the highest expected instantaneously occurring active power imbalance within a LFC block in both positive and negative direction*”. In a Nordic terminology, this would be the maximum imbalance for the LFC Block, regardless of what is the cause(s) of the imbalance.

#### *5.1.4 Available transmission capacity (ATC)*

Balancing energy may be transferred between LFC areas but, as previously mentioned, the Nordic LFC block experiences frequent congestions in the grid. When FRR is activated the power lines between LFC areas already transmit the power exchanged on the day ahead- and intraday markets, only the capacity not used by the market will be available for transmission of reserves. This remaining unused transmission capacity after day ahead- and intraday markets is referred to as ATC in this Methodology.

### 5.2 Article 3: FRR dimensioning for the LFC block

The rules in this Methodology will result in the dimensioning of the automatic and manual FRR products. All together, the ratio of aFRR and mFRR, as referred to in article 157(2)(c), results from these individual components, as explained in paragraph 2 of this article. This means that firstly the reserve requirements for each LFC area on FRR and aFRR are calculated. When the volumes are known the part of the total FRR consisting of aFRR will give the ratio. The reserve requirement on aFRR is thus not calculated using the ratio, rather the ratio is calculated based on the reserve requirement on aFRR. The ratio is dynamic (it will change each time the dimensioning is repeated) and varies between LFC areas. The rules on the determination of this ratio are implicitly explained in Article 7(7) and 8(5).

Paragraph 4 of this article describes the general objective of FRR dimensioning which tries to find the optimal balance between efficiency and security of supply. I.e. the amount of FRR shall be sufficient to meet the rules that ensure a sufficient level of security of supply, but not more than that. The dimensioning shall have the objective to minimise the total amount of reserve capacity on FRR for the LFC block, within the geographical constraints (see Textbox 1) and without breaching the rules referred to in paragraph 4.

Textbox 1: FRR dimensioning in constrained Nordic LFC block

The Nordic LFC block consists of 11 LFC areas, which are equal to the 11 bidding zones. Since cross zonal capacity (CZC) is limited, day-ahead and intraday trading between the LFC areas/bidding zones is only possible up to a certain limit. The CZC that is used by the day-ahead and intraday markets, cannot be used by FRR. Consequently, considering these constraints in the Nordic system, TSOs shall make sure that FRR shall be distributed to the LFC areas in a way that supports FRR activation without breaching the constraints. In order to safeguard these conditions, the TSOs start the FRR dimensioning process by determining the required FRR for each LFC area (this gives the upper bound of the sizing) and for the LFC block (this gives the lower bound of the sizing) respectively. Based on the available grid capacity, the TSOs will accordingly aggregate their reserve need for the LFC areas (this calculation combines the individual LFC Area needs for both standard FRR products).

### 5.3 Article 4: Full Activation Time (FAT) for FRR

The full activation time means the period in time between the activation request by the TSO and the delivery of the full power contracted for the concerned product by the Balance Service Provider.

The full activation times are different for each product. EBGL article 25 defines framework conditions for the standard products and the actual FATs have been set in the common European activation platforms. In PICASSO the FAT for aFRR have been set to 5 minutes and in MARI the FAT for mFRR have been set to 12,5 minutes.

### 5.4 Article 5: Input to FRR dimensioning methodology

FRR dimensioning of the LFC block shall take into account the constrained Nordic LFC block and therefore also the FRR dimensioning per LFC area shall be considered. This is further clarified in Textbox 1. Consequently, the input that is specified in paragraph 1(a)-(f) in the Methodology includes both data for the LFC block and for the LFC area. Historical imbalances (paragraph (1)(a)-(b)) are calculated as the difference between the schedules and the measurements, corrected for the activation of reserves. This is commonly referred to as the Area Control Error Open Loop (ACE OL).

The annual calculation defining static values will be calculated with the previous year's data for LFC Area imbalance and ATC. The TSOs may additionally calculate the dimensioning on a daily basis using a smaller data set together with forecast data, including imbalance and ATC. This implies that additional input to what is listed in Article 5 may become relevant to the FRR dimensioning methodology, primarily forecast data, for example forecasts on remaining ATC or imbalance forecasts.

### 5.5 Article 6 – Rules for dimensioning the total amount of reserve capacity on FRR for the LFC block

FRR dimensioning will in principle take place separately for FRR for reference incidents (see section 5.6) and FRR for normal imbalances (see section 5.7). However, article 157(2)(b), (h) and (i) of the SO Regulation include several requirements that can only be applied to the total amount of reserve capacity on FRR. These requirements shall be taken into account by the TSOs in the dimensioning process and are included in Article 6.

Paragraph 3 refers to the FRCE target parameters for the LFC block, which are defined in the synchronous area operational agreement and are calculated in accordance with a separate approved methodology. The FRCE target parameters mirror the frequency quality target parameter that has been approved by the regulators in the frequency quality methodology[1].

Paragraphs 4(a)-(d) refer to the conditions in the second and third sentence of Article 157(2)(b) of the SO Regulation; *In using that probabilistic methodology, the TSOs shall take into account the restrictions defined in the agreements for the sharing or exchange of reserves due to possible violations of operational security and the FRR availability requirements. All TSOs of a LFC block shall take into account any expected significant changes to the distribution of LFC block imbalances or take into account other relevant influencing factors relative to the time period considered*, which have been literally taken into account in the FRR dimensioning rules.

[1] "Nordic synchronous area proposal for the frequency quality defining parameters and the frequency quality target parameter in accordance with Article 127 of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation", dated 10 September 2018.

### 5.6 Article 7 – Rules for dimensioning FRR for reference incident

Similar to what is discussed in the previous section and Textbox 1, dimensioning FRR for reference incidents in the Nordic LFC block requires that congestion shall be taken into account. To safeguard this, paragraph 2 and 5 specify the initial requirement for FRR dimensioning for reference incidents on a control area level.

The choice for dimensioning FRR for reference incident per 'control area' relates to the requirement in Article 152(1) of the SO Regulation that states that *'each TSO shall operate its control area with sufficient upward and downward active power reserve, which may include shared or exchanged reserves, to face imbalances between demand and supply within its control area [..]'*. TSOs operating more than one LFC area will further make sure that each of their LFC areas has access to sufficient FRR to cover a single reference incident at one point in time in any of the LFC areas.

This first sentence of Article 7(2) states that *'the required capacity on positive FRR for reference incidents shall cover at least the positive reference incident for the control area'*. This does not mean that the control area shall be self-sufficient or that the reserves shall be located in the control area itself. However, the TSO shall make sure that the control area has sufficient access to FRR to cover the requirement for its control area. Sharing of FRR with other control areas is one of the possibilities to achieve this. Article 7(3) and (6) explains that sharing between control areas will reduce the required FRR for the LFC block.

Since reference incidents only require occasional FRR activation and it is unlikely that reference incidents take place at the same time in all control areas, it may well be feasible to share FRR for reference incidents over more than one control area. This is described in paragraph 3 and 6, including the rules for sharing. Sharing of FRR requires the availability of transmission capacity. The availability of transmission capacity will be assessed by considering historical data on ATC and information on known outages, or, alternatively, the ATC forecast for the period under consideration.

As bigger reference incidents will occur rarely compared to normal imbalances, and FRCE in these cases shall be restored within Time to restore frequency, it is not necessary to dimension automatic FRR for this purpose but this part of total FRR volume can be covered by mFRR. For this reason, paragraph 7 indicates that the minimum reserve capacity on aFRR for reference incident per control area / LFC area is 0 MW.

### 5.7 Article 8 – Rules for dimensioning FRR for normal imbalances

As explained in Textbox 1, FRR dimensioning shall take the ATC between the LFC areas into account when aggregating the FRR need for the LFC areas. Accordingly, paragraph 2 and 4 include a number of rules related to the FRR requirements for LFC areas.

Paragraph 2(a) and 4(a) states that aggregation of normal imbalances between LFC areas within the control block shall be performed as part of the dimensioning. This is referred to as imbalance netting, see Textbox 2. When performing imbalance netting both the normal imbalances of the individual LFC areas are taking into account as well as the ATC. Transmission constraints will be taken into account by considering historical data on ATC and adjusting it according to information on known outages, cross-zonal capacity allocated for the exchange of balancing capacity by the market and other factors which may impact the results for the time period for which FRR is dimensioned. This should provide the best indication of the probability that sufficient transmission capacity will be available. Additionally, ATC already allocated to the dimensioning of FRR for reference incidents is deducted. Imbalance netting is performed in two steps:

1. Imbalance netting on a control area level, i.e. a statistical aggregation of normal imbalances between all LFC areas within a control area using remaining ATC after the dimensioning of FRR for reference incidents.

2. Imbalance netting on a LFC block level, i.e. a statistical aggregation of normal imbalances between all LFC areas within a LFC block using remaining ATC after step 1.

The reason why the procedure is performed in two steps is to guarantee that the TSOs which control area consists of multiple LFC areas are not unduly disadvantaged by the FRR dimensioning methodology. The result from imbalance netting is a new imbalance dataset for all LFC areas where the imbalances, when possible, have been reduced by imbalance netting.

Textbox 2: Imbalance netting

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| It is often the case in the Nordic LFC block that one LFC area has a positive imbalance while another LFC area has a negative imbalance. When that happens, those imbalances can be netted against each other meaning that, in that point in time, one area will completely cover its FRR need with netting while the other may activate less FRR since part of the need was covered by netting. The FRR need for an LFC area can thus be reduced by considering the probability that the area may be able to net some of its imbalances against other imbalances inside the LFC block. This reduction is limited by the remaining ATC, it is only possible to net two imbalances against each other if there is available transmission capacity. For an example of imbalance netting, see the Figure 1 below |

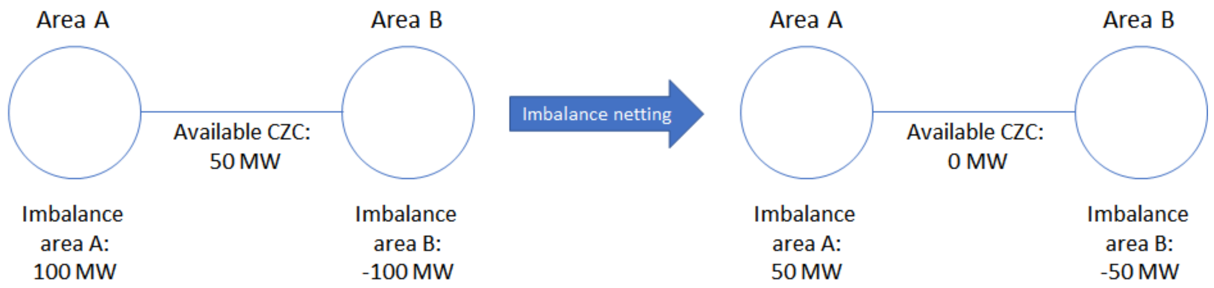


Figure 1: An example illustrating imbalance netting

Paragraphs 2(b) and 4(b) refer to a risk level, this is the accepted risk of insufficient reserve capacity on FRR in a LFC area. It is applied after imbalance netting in the dimensioning process. The risk level shall be subject to a periodic evaluation that will take place at least once a year, see Article 10 in the Methodology. If the risk level would have been fixed in the Methodology, FRR dimensioning could result in either over dimensioning or insufficient FRR to safeguard security of supply. A regular evaluation addresses these issues by applying the evaluation criteria as discussed in Textbox 3.

Textbox 3: Evaluation criteria for dimensioning

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| The dimensioning process will be regularly evaluated and adjusted based on experiences from real time operation. Relevant evaluation criteria may include:<br>a) Saturation of aFRR;<br>b) Access to resources for Reference Incidents for each LFC area;<br>c) Statistics for time with flows exceeding TTC on lines/cuts between LFC areas;<br>d) Yearly frequency quality target, distributed per quarter or shorter (related to e.g. seasonal variations in inertia);<br>e) FRCE target levels performance (ACE quality target levels);<br>f) Unnecessary large volumes of unused FRR capacity;<br>g) Costs for capacity procurement over time;<br>h) Alert state conditions and observed operational incidents; |

Paragraph 5 explains the rules for determining the minimum reserve capacity on automatic FRR for normal imbalances per LFC area, which will be based on what is here referred to as the short-term imbalance per LFC area (see Textbox 3 for the definition). These short-term imbalances represent the imbalances that are to be handled by automatic FRR. The required minimum volumes of automatic FRR shall be based on an appropriate confidence interval on the probability distribution of the short-term imbalances, see the risk level referred to in 2(b) and 4(b). This will result in individual volumes for each LFC area based on its particular challenges.

Textbox 4: Definition of short-term imbalance

Short-term imbalances are the imbalances that are intended to be handled with automatic FRR. The determination of short-term imbalances shall take into account the automatic FRR and the manual FRR full activation times. In order to extract the short-term imbalances, the original time series of imbalance data is filtered twice to extract the fast-changing and slow-changing imbalance. The filtering can for example be performed by applying a rolling average to the data. To extract the fast-changing imbalance a shorter time window is used for the rolling average, for example 5 minutes to match the full activation time of the automatic FRR. A longer time window is applied when filtering the imbalance data to extract the slow-moving imbalances, for example 15 minutes to match the manual FRR EAM time frame. The time series for slow-changing imbalances are then subtracted from the time series for fast-changing imbalances, which gives us the short-term imbalances. Figure 2 illustrates this process.

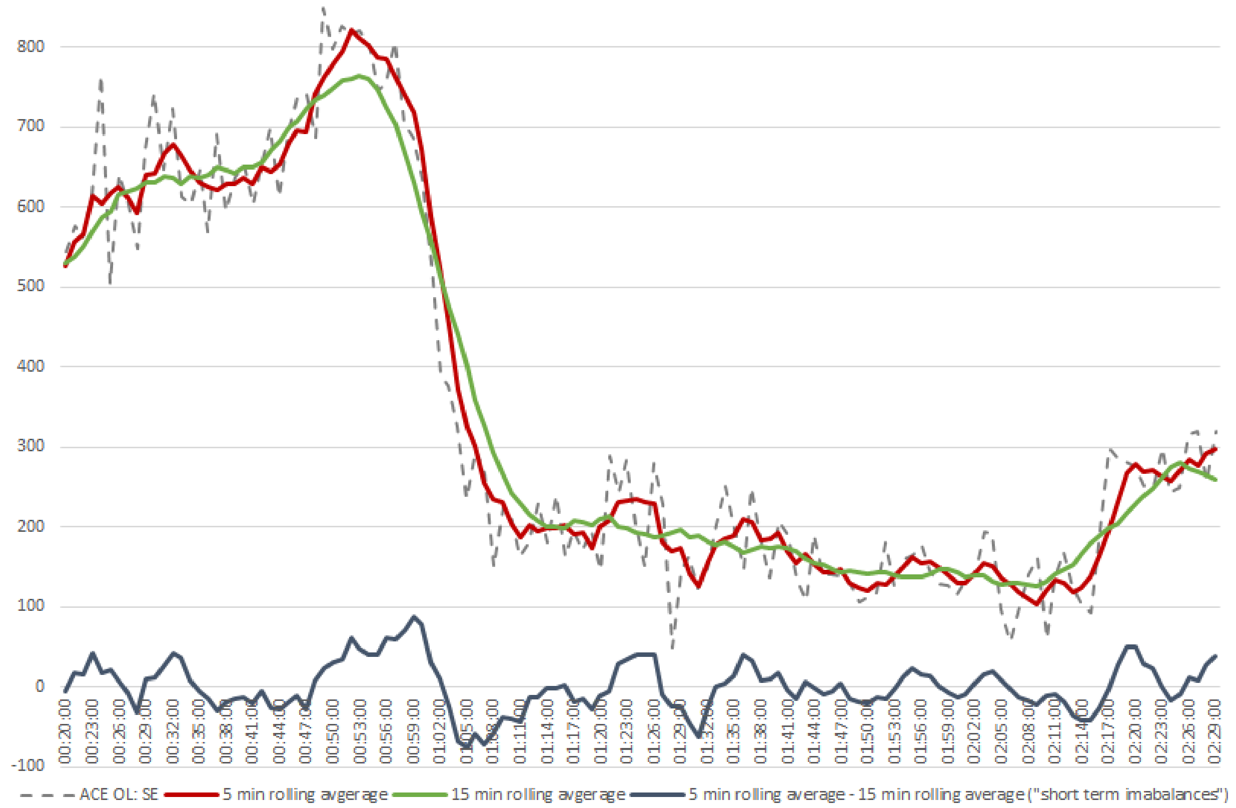


Figure 2: Definition of short-term imbalances.

It shall be noted that FRR for normal imbalances is "implicitly shared" between TSOs of the LFC block in the optimisation process for dimensioning and cannot be shared further.

## 5.8 Article 9 – Process for FRR dimensioning

Based on the rules in the Methodology, the TSOs develop the detailed FRR dimensioning methodology, paragraph 1-3 describes the steps of this methodology. The first step is the collection of input data, all TSOs of the LFC block will contribute with the necessary data, as described in Article 5.

When the input data is available, the upper and lower bounds of the dimensioning of reserve capacity on FRR can be determined. Calculation of the upper bound is described in paragraph 2(a)(i) and calculation of the lower bound is described in paragraph 2(a)(ii). The upper bound for the LFC areas corresponds to the FRR requirement if each LFC area was in itself an LFC block, i.e. calculation of reserve capacity on FRR for reference incident for each LFC area, instead of for each control area, and no imbalance netting when calculating the reserve capacity on FRR for normal imbalances. For the LFC block, the upper bound on reserve capacity on FRR is given by the sum of the upper bounds of the LFC areas. The lower bound is the reserve requirement on FRR if the LFC block only consisted of one LFC area and there were no geographical limitations for the distribution of the reserves within the LFC block.

Paragraph 2(b) describes the actual dimensioning. The calculation of reserve capacity on FRR for reference incidents is described in paragraph 2(b)(i) and 2(b)(ii). Paragraph 2(b)(i) corresponds to the first step in the dimensioning of reserve capacity on FRR for reference incident. In the first step the necessary capacity is determined so that each LFC area within a TSOs control area has access to sufficient capacity on FRR for reference incident to cover the LFC area reference incident. This will result in a reserve requirement per LFC area. In the next step the reserve requirement is reduced by sharing of reserves between control areas as described in paragraph 2(b)(ii).

The calculation of reserve capacity on FRR for normal imbalances is described in paragraph 2(b)(iii) and 2(b)(iv). Paragraph 2(b)(iii) corresponds to imbalance netting on a control area level (step 1 in section 5.7) and paragraph 2(b)(iv) corresponds to imbalance netting on a LFC block level (step 2 in section 5.7). Figure 3 shows an illustration of the process for calculating reserve capacity on FRR for normal imbalances. It illustrates where the netting fits into the FRR dimensioning methodology. Netting is part of dimensioning FRR for normal imbalances, it is not part of dimensioning FRR for reference incidents. For more information on imbalance netting see Article 8 in the Methodology or chapter 5.7 in this explanatory document.

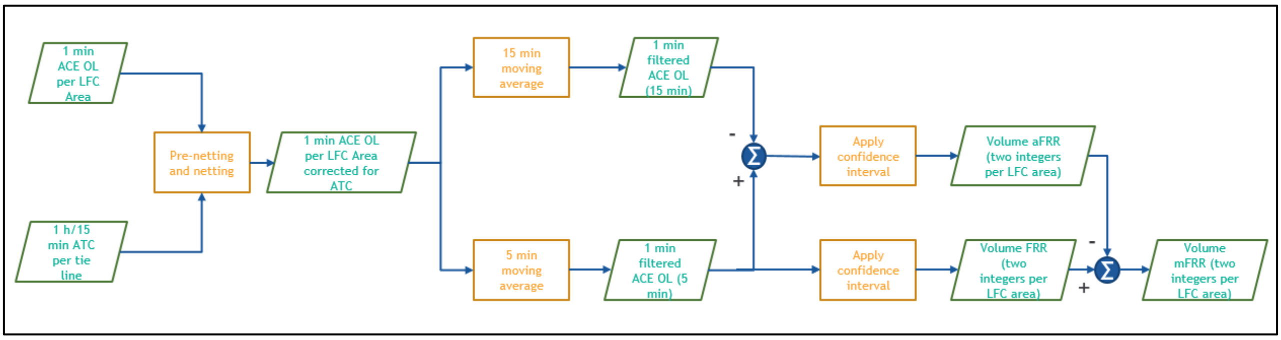


Figure 3: Process illustration for FRR dimensioning, normal imbalances

If the output after the steps described in 2(b) is outside the interval set up by the upper and lower bound it will be limited to either the upper or lower bound, depending on whether it is above or below the interval. The result after going through the steps in paragraph 1-3 will be the reserve capacity on FRR for normal imbalances per LFC area, including the minimum required aFRR volume.

### 5.9 Article 10 – Process for yearly tuning of the FRR dimensioning

Paragraph 1 and 2 states that the process of FRR dimensioning – together with provisioning and operation – includes a continuous optimisation cycle based on regular evaluations. This will allow improving the detailed FRR dimensioning process continuously, which will be essential considering the near future changes in the Nordic LFC block including (but not limited to) the implementation of the New Nordic Balancing Model, the introduction of the 15 minute ISP, new HVDC interconnectors and more intermittent generation. The TSOs can only respond swiftly if the TSOs have sufficient flexibility in improving their processes. Including a detailed process in the Methodology would therefore not be preferable. Because the detailed process shall be compliant with the rules in the Methodology, the objectives and the requirements for the process are safeguarded.

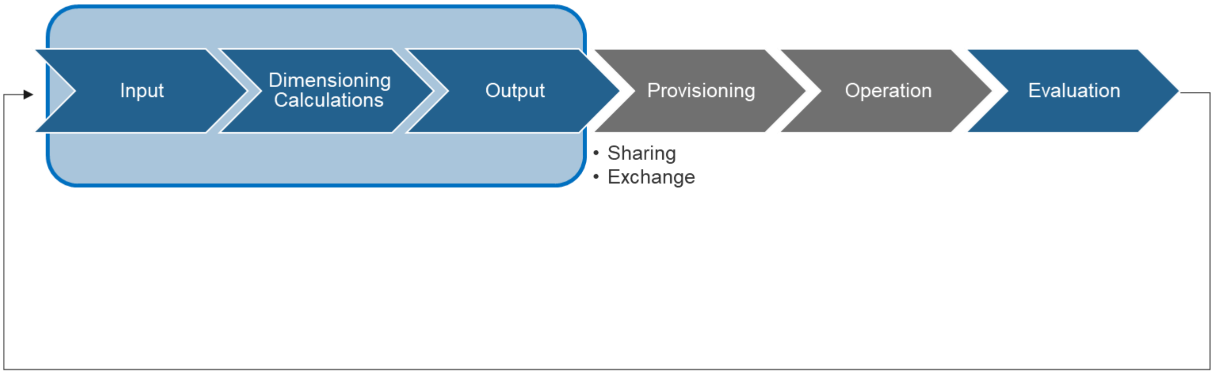


Figure 4: FRR process overview

## 6. Expected impact of the Methodology on the relevant objectives of the SO Regulation

The Methodology 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 Methodology 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

The Methodology contributes to these objectives by specifying the dimensioning rules for mFRR and aFRR, which are key reserves that are used in the common Nordic load-frequency control processes. Sufficient mFRR and aFRR guarantee the right FRCE and frequency quality level and consequently contribute to maintaining the operational security by reducing the risk for automatic under and over Frequency Load Shedding (UFLS and OFLS), automatic reduction of generation and for system blackouts due to under or over frequency.

## 7. Timescale for the implementation

The implementation of the FRR dimensioning rules will be one task within the Nordic Balancing Model project and will consist of many sub tasks including IT development, implementation in control centres and education. The migration from frequency-based balancing for the entire LFC block collectively, to Area

Control Error (ACE) based balancing each LFC area individually, means that the situation changes significantly. For this reason, full implementation of the Methodology will not be finalized until after the implementation of the new balancing concept.

A dedicated website[2] explains and shows the high level roadmap of the Nordic Balancing Model project. According to this roadmap, FRR dimensioning is scheduled to be implemented fully when the Nordic TSOs connect to the MARI and PICASSO platforms.

Before connecting to MARI and PICASSO, the TSOs may apply the Methodology to produce estimates on required FRR in the future.

When the Methodology is fully implemented the dimensioning of FRR for reference incidents will be performed daily.

The long term goal of the dimensioning of FRR for normal imbalances is to perform the dimensioning process daily. However, when this methodology is fully implemented this process may still be performed quarterly.

## 8. Public consultation, transparency and stakeholder involvement

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 means that the TSOs shall invite their stakeholders for a public consultation. For this reason, the TSOs published the Methodology for consultation from 1 March 2022 to 1 April 2022. The TSOs received 0 responses. Appendix 1 includes their individual comments, if any.

[2] http://nordicbalancingmodel.net

## Appendix: Results of Public Consultation