European Network of Transmission System Operators for Electricity

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Explanatory document to Energinet, Fingrid, Statnett and Svenska kraftnät proposal in accordance with Article 33(1) and Article 38(1) of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

DISCLAIMER

This document is released on behalf of Energinet, Fingrid, Statnett and Svenska kraftnät only for the purpose of the public consultation on proposal for establishment of common and harmonized rules and processes for the exchange and procurement of aFRR balancing capacity in accordance with Article 33 (1) of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing. This version of the proposal for establishment of common and harmonized rules and processes for the exchange and procurement of aFRR balancing capacity does not in any case represent a firm, binding or definitive TSOs' position on the content.

Contents

1. Introduction

This document gives background information and rationale for Energinet, Fingrid, Statnett and Svenska kraftnät proposal for establishment of common and harmonized rules and processes for the exchange and procurement of aFRR balancing capacity in accordance with Article 33(1) and Article 38(1) of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (hereinafter referred to as "EB GL"). This proposal is hereinafter referred to as "Proposal", and Energinet, Fingrid, Statnett and Svenska kraftnät are hereinafter collectively referred to as the "Nordic TSOs".

1.1. Purpose

The purpose of the aFRR capacity market is to ensure availability of aFRR reserves in accordance with the LFC block dimensioning rules and thereby ensure the operational security.

The purpose of the establishment of a common Nordic market for aFRR capacity is to increase socioeconomic welfare on a Nordic level and to increase operational security in the most efficient way. This is done by enabling cross-zonal procurement of aFRR capacity available for balancing the Nordic Synchronous Area, whilst taking into account network constraints.

1.2. Background

The Nordic TSOs intend to establish regional balancing capacity markets for aFRR and mFRR balancing capacity.

The Nordic aFRR capacity market shall be followed by a Nordic aFRR energy activation market which, in line with EB GL, shall later integrate with the European balancing market coupling via the establishment of the European balancing market platforms (developed under the European project PICASSO).

The regional balancing capacity market is based on the FRR dimensioning process, which will result in FRR volumes per LFC area (equal to bidding zone). This initial LFC area reserve requirement can then be procured in another LFC area provided that there are available cross-zonal capacities (hereinafter "CZC") that can accommodate the exchange.

The Nordic TSOs therefore propose that the capacity procurement optimisation function for the common aFRR capacity market shall include a methodology for the allocation of CZC. The initial choice of methodology is the market-based allocation process as described in Article 41 of EB GL. This methodology was also tested in a pilot project denoted the "Hasle pilot"[1]. The methodology for the allocation of CZC is included in separate proposal.

Regarding the introduction of the mFRR capacity market, the current working assumption is that the same principles shall be used also in this market and that the allocation of CZC for the two markets shall be carried out in a coordinated manner. The mFRR capacity market design will be consulted separately at a later state.

[1] Description of the pilot, the results and conclusions can be found in two published documents: "The Hasle pilot project" published on 2015-03-17, and "Memo: Hasle pilot experiences" published on 2015-12-21.

1.3. Legal basis

Regional capacity markets are not mandatory under European legislation, but they are regulated. Title III Chapter 2 of EB GL and Article 33 in particular are relevant for the Nordic aFRR capacity market. Furthermore, the Nordic TSOs have agreed to allocate CZC for the exchange of aFRR capacity; consequently Title IV Chapter 1 of EB GL and, in particular, Articles 38 and 41 are of relevance.

According to Article 5(3) of EB GL:

"The proposals for the following terms and conditions or methodologies shall be subject to approval by all regulatory authorities of the concerned region:

(b) for the geographical area concerning two or more TSOs exchanging or mutually willing to exchange balancing capacity, the establishment of common and harmonized rules and process for the exchange and procurement of balancing capacity pursuant to Article 33(1);

(g) in a geographical area comprising two or more TSOs, the application of the allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves pursuant to Article 38(1);

(h) for each capacity calculation region, the methodology for a market-based allocation process of cross-zonal capacity pursuant to Article 41(1);

From the perspective of EB GL, it should be stated that since the Nordic aFRR capacity market is based on a voluntary agreement between the Nordic TSOs, the Proposal is consequently not legally bound by a stipulated timeline. The proposal for the market-based allocation methodology according to Article 41(1), however, shall be submitted to relevant regulatory authorities for approval at latest two years after EB GL entered into force, which is translated to the 18th of December 2019.

1.4. Definitions

Generally, the definition of terms found in EB GL, SO GL and CACM shall apply in the proposal and explanatory document. In order to ease reading of this document, here follows the definition of the main terms used.

(1) 'area control error' or 'ACE' means the sum of the power control error ('ΔP'), that is the real-time difference between the measured actual real time power interchange value ('P') and the control program ('P0') of a specific LFC area or LFC block and the frequency control error ('K*Δf'), that is the product of the K-factor and the frequency deviation of that specific LFC area or LFC block, where the area control error equals ΔP+K*Δf;

(2) 'balancing service provider' means a market participant with reserve-providing units or reserve-providing groups able to provide balancing services to TSOs;

(3) 'capacity calculation region' means the geographic area in which coordinated capacity calculation is applied;

(4) 'capacity procurement optimisation function' means the function of operating the algorithm applied for the optimisation of the procurement of balancing capacity for TSOs exchanging balancing capacity;

(5) 'common merit order list' means a list of balancing energy bids sorted in order of their bid prices, used for the activation of those bids;

(6) 'connecting TSO' means the TSO that operates the scheduling area in which balancing service providers and balance responsible parties shall be compliant with the terms and conditions related to balancing;

(7) ‘divisibility’ means the possibility for a TSO to use only part of the balancing energy bids or balancing capacity bids offered by the balancing service provider, either in terms of power activation or time duration;

(8) ‘exchange of balancing capacity’ means the provision of balancing capacity to a TSO in a different scheduling area than the one in which the procured balancing service provider is connected;

(9) ‘FRR dimensioning rules’ means the specifications of the FRR dimensioning process of a LFC block;

(10) ‘full activation time’ means the period between the activation request by the connecting TSO in case of TSO-TSO model or by the contracting TSO in case of TSO-BSP model and the corresponding full delivery of the concerned product;

(11) ‘load-frequency control area’ or ‘LFC area’ means a part of a synchronous area or an entire synchronous area, physically demarcated by points of measurement at interconnectors to other LFC areas, operated by one or more TSOs fulfilling the obligations of load-frequency control;

(12) ‘load-frequency control block’ or ‘LFC block’ means a part of a synchronous area or an entire synchronous area, physically demarcated by points of measurement at interconnectors to other LFC blocks, consisting of one or more LFC areas, operated by one or more TSOs fulfilling the obligations of load-frequency control;

(13) ‘operational security limits’ means the acceptable operating boundaries for secure grid operation such as thermal limits, voltage limits, short-circuit current limits, frequency and dynamic stability limits;

(14) ‘standard product’ means a harmonised balancing product defined by all TSOs for the exchange of balancing services;

(15) ‘TSO-TSO model’ means a model for the exchange of balancing services where the balancing service provider provides balancing services to its connecting TSO, which then provides these balancing services to the requesting TSO;

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2. The proposal

2.1. Application of the TSO-TSO model

The Nordic TSOs will exchange aFRR capacity based on a TSO-TSO model. This implies that each Balancing Service Provider (hereinafter "BSP") provides balancing capacity to its connecting TSO which also has prequalified the BSP. There shall only be contractual arrangements between the TSOs and between BSPs and their connecting TSO.

The Nordic TSOs shall strive to establish national requirements (BSP agreements) that are as similar as possible to those of their Nordic counterparts in order to ensure a level playing field for BSPs and to facilitate the functioning of the Nordic aFRR capacity market. Revised BSP agreements are currently developed and proposed in all Nordic countries. The BSP agreement is regulated by Article 18 of EB GL.

2.2. Product definition and bid characteristics

2.2.1.Pre-qualification of aFRR capacity

Only a BSP with prequalified aFRR resources can submit bids in the aFRR capacity market. Each of the Nordic TSOs are responsible for the pre-qualification process and monitoring of the delivery from the BSPs in their own control area.

The Nordic TSOs have the intention to make the requirements and process of the pre-qualification as similar as possible in order to facilitate a well-functioning Nordic aFRR capacity market. The end goal is to have fully harmonized rules and contracts regarding a standard format, but some national differences will be necessary in the first phases since the general framework for Nordic and European balancing processes is not yet fully developed.

In particular the prequalification rules for the full activation time (FAT) will be different in the Nordics for a transition period after the aFRR capacity market has started. This is in accordance with the prequalification requirements that prevails today, where BSPs in Norway and Sweden is prequalified according to a FAT equal two minutes and BSPs in Denmark and Finland have been prequalified to deliver according to a FAT of five minutes. The Nordic TSOs are, however, working towards having a harmonized FAT equal to five minutes in the future. The foreseen development is further described in section 3 Outlook.

2.2.2.Bid formats

From the start of aFRR capacity market the bids shall be in accordance with the following formats:

- FAT shall be in accordance with prequalification (see section 2.2.1), but the maximum FAT is harmonized to 5 minutes.
- Minimum bid quantity shall be 1 MW and bid granularity shall be 1 MW steps.
- The bid shall include the bidding zone it belongs to, and no other locational information will be required. This implies that portfolio bids for units within a bidding zone are allowed.
- Single bids can be marked as indivisible. This means that either the bid must be accepted as a whole or rejected. Indivisible bids give BSPs more flexibility for pricing of the bids and this can both increase the bid volume and decrease bid prices. On the other hand indivisible bids can potentially

have a negative effect for the procurement optimisation function to find an efficient solution. A maximum bid size of 50 MW applies to indivisible bids as this will reduce the probability for such adverse effects and also disincentivises strategic bidding that can result in loss of efficiency.

- Bids may be linked, upward- with downward capacity bids and in time ("block bids"). Bids may also be presented as a bid curve, where only one of the bids constituting the curve can be accepted.
- Bid curves cannot be combined with linking of upward- and downward capacity bids.

The predefined volume of aFRR capacity will be procured daily for a predetermined set of market time units (hereinafter "MTU"). When the aFRR capacity market goes live, the MTU will be one hour.

The linking of bids can be done in different ways. In order to clarify the possibilities, an explanation of the linking that is allowed follows below.

Block bids

Block bids refer to linking in time and are bids that are valid for a number of consecutive MTUs. A block bid shall have the same volume, direction and price in all MTUs. A block bid can be submitted as divisible or indivisible. For a divisible block bid that is accepted, the same share of the bid's volume is selected for all MTUs for which the bid is valid. Figure 1 illustrates an upward block bid.

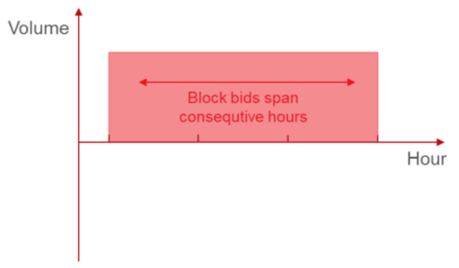

Figure 1. Illustration of an upward block bid

Linked upward- and downward bids

It will be allowed to link an upward bid with downward bid of the same MTU, meaning that both bids must either be accepted or rejected. The two linked bids can have different volumes and prices. It will be possible to submit the linked bids as divisible and a minimum quantity can be set, but divisibility is then expected only to be relevant in one direction. The linking of an upward- and downward bid is shown in Figure 2.

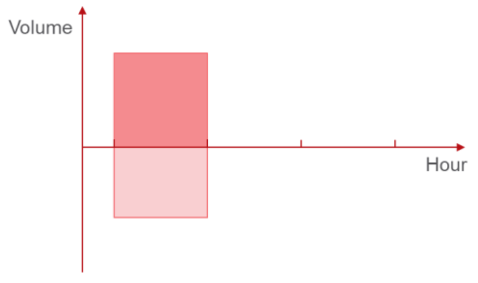

Figure 2. Illustration of linked upward- and downward bid

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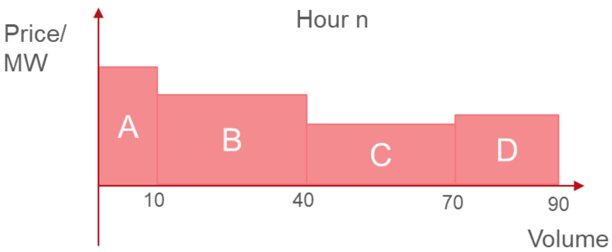
Linked upward- and downward bids can be combined with a block bid. This can be used if for example the main cost for the BSP is running the machine, but when running, both directions can be delivered.

Mutually exclusive bids – bid curve

An alternative way to submit single bids with the possibility to use links as described above, is to submit a bid curve where only one bid of the group of bids constituting the bid curve can be selected. This give BSPs great flexibility in presenting their actual cost structure in their bidding. All kinds of links between different units of a portfolio can be converted into a bid curve for a certain MTU. However, if the option of bid curve is used, the BSP foregoes the opportunity to use block bids. An example of a bid curve is shown in Figure 3 for upward bids.



Bid	Price/ MW	Volume	Min volume	Divisible?
A	50	10		No
B	40	40	10	Yes
C	30	70	40	Yes
D	35	90	70	Yes

Figure 3. Example of bid curve for upward bids

Exclusive bids can be combined with linked upward- and downward bids, where only *one pair* of bids can be selected in the group of bid pairs. An example of this is shown in Figure 4.

Up / Down	0	5	10	15	20	25
0		U:20	U:12	U:8	U:6	U:5
5	D:40	D:40 U:2	D:40 U:2	D:40 U:4	D:40 U:4	D:40 U:4
10	D:30	D:30 U:2	D:30 U:2	D:30 U:3	D:30 U:3	
15	D:25	D:25 U:2	D:25 U:3	D:25 U:3		
20	D:25	D:25 U:3	D:25 U:3			
25	D:22	D:22 U:3				

Figure 4. Example of a matrix depicted a number of linked upward- and downward bids, with volume (MW) on the axes and prices (price/MW) within the matrix. Here most of the cost of reserving capacity is related to downward capacity and the maximum total quantity is 30 MW

In Annex 2 an overview of allowed combinations of bid formats can be found, in addition to some examples of combinations that are invalid.

2.3. Geographical scope

The geographical scope of the aFRR capacity market is limited to all bidding zones in the Nordic synchronous area. According to the current bidding zone configuration this includes the following bidding zones: DK2, NO1, NO2, NO3 NO4, NO5, SE1, SE2, SE3,SE4 and FI.

While being a part of the Nordic Balancing Model, Kraftnät Åland does not employ aFRR resources and does not take active part in the Nordic aFRR capacity market.

The possible inclusion of DK1 (Fyn/Jylland) will be considered at a later stage in connection with the introduction of ACE-based balancing, since DK1 is part of the continental synchronous area where ACE-based balancing currently is applied.

2.3.1. The procurement volume of aFRR capacity

The procurement volume and how its distributed between the bidding zones shall follow the prevailing rules for dimensioning in the Nordic LFC block.

In the first phase of the Nordic aFRR exchange, when the dimensioning rules according to the SO Regulation art. 157(1) are in place, an initial geographic distribution is defined as the total amount of aFRR capacity to be procured and allocated among the bidding zones to minimise the risk of cross-zonal congestion when aFRR balancing resources are fully activated.

The calculation of the initial geographical distribution considers a situation in which the short-term imbalance in each individual bidding zone is assumed to be equal to the historical average short-term imbalance of the bidding zone. The short-term imbalance is the imbalance that is mitigated by aFRR (currently between 5-30 minutes).

If aFRR is distributed among bidding zones proportionally to the historical average short-term imbalance values, aFRR is then only used to mitigate short-term imbalances in the bidding zone where it is allocated.

Minimum and maximum values will be defined separately for positive and negative imbalances:

- the bidding zone’s share in the sum of the positive absolute short-term imbalance will be the value for the downward aFRR;
- the bidding zone’s share in the sum of the negative absolute short-term imbalance will be the value for the upward aFRR.

The inputs to this methodology are:

- $Imbi(t)$: One minute values of imbalance per bidding zone i
    - The imbalance data shall be collected for the historic periods (hours, weekday, month) corresponding to when aFRR capacity is procured. If no decision is made for when aFRR capacity shall be procured, the contracting hours from last year shall be used.
- One minute values are based on several inputs, including:
    - Flow after intraday day
    - Measured flow on AC tie lines[2] out of an area

[2] Fennoskan DC cable is also included in the calculation of the short-term imbalance, thus treated as an AC tie line.

- Frequency bias factor
- aFRR activation signals
- mFRR activation
- Quarterly movements

The short-term imbalance for each bidding zone *i*; this is calculated by:

$$Imb_{short,\,i}(t) = \frac{1}{t_s}\int_{t-t_s/2}^{t+t_s/2} Imb_i(\tau).\,d\tau - \frac{1}{t_l}\int_{t-t_l/2}^{t+t_l/2} Imb_i(\tau).\,d\tau$$

in which, t_s is 4 minutes and t_l is 30 minutes

Since upward aFRR and downward aFRR are considered separately, negative short-term imbalance (driver for upward aFRR) will need to be considered separately from positive short-term imbalance (driver for downward aFRR). Therefore $Imb_{short,\,i}(t)$ in $Pos\_Imb_{short,\,i}(t)$ and $Neg\_Imb_{short,\,i}(t)$ is split according to:

$$Pos\_Imb_{short,\,i}(t) \quad \begin{cases} Imb_{short,\,i}(t) \text{ if } Imb_{short,\,i}(t) > 0 \\ \text{'no value' if } Imb_{short,\,i}(t) \le 0 \end{cases}$$

$$Neg\_Imb_{short,\,i}(t) \quad \begin{cases} Imb_{short,\,i}(t) \text{ if } Imb_{short,\,i}(t) < 0 \\ \text{'no value' if } Imb_{short,\,i}(t) \ge 0 \end{cases}$$

The averages are calculated over time of the existing values of $Pos\_Imb_{short,\,i}(t)$ and $Neg\_Imb_{short,\,i}(t)$:

$\overline{Pos\_Imb_{short,\,i}}$: Average of short-term imbalance for bidding zone *i* for times that short-term imbalance is positive;

$\overline{Neg\_Imb_{short,\,i}}$: Average of short-term imbalance for bidding zone *i* for times that short-term imbalance is negative;

The total amount of Nordic aFRR, c_{aFRR} , shall be distributed among the bidding zones in proportion to the imbalance.

For each bidding zones i, this will result in an allocation of downward aFRR, $aFRR_{Downward,\,i}$, and an allocation of upward aFRR, $aFRR_{Upward,\,i}$, as follows:

$$aFRR_{Downward,\,i} = \frac{\overline{Pos\_Imb_{short,\,i}}}{\sum_{i=Elspot\ areas}\overline{Pos\_Imb_{short,\,i}}} \cdot Nordic\_aFRR$$

$$aFRR_{Upward,\,i} = \frac{\overline{Neg\_Imb_{short,\,i}}}{\sum_{i=Elspot\ areas}\overline{Neg\_Imb_{short,\,i}}} \cdot Nordic\_aFRR$$

The sets of $aFRR_{Downward,\,i}$ and $aFRR_{Upward,\,i}$ are the initial geographic distribution and consequently the output of the methodology.

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The calculations for initial geographic distribution will be published by the Nordic TSOs. Updating of the initial geographic distribution is expected to be done annually.

2.3.2. Dimensioning rules for FRR in the Nordic LFC –block

The dimensioning rules for the Nordic LFC block is under development and is out of scope of article 33 in EB GL. The dimensioning rules will take into account both mFRR and aFRR and the rules will set a volume for the whole LFC-block and an obligation per TSO within the LFC-block. The volume for the LFC-block represent the FRR (both aFRR and mFRR) volume needed to secure system operations in real time balancing. The dimensioning volume can differ from the procured volume in the FRR capacity markets if responsible TSO for a LFC area assess that there will be enough voluntary FRR bids on the energy activations markets to secure TSO obligations and real time balancing needs.

2.4. The procurement rules

2.4.1. The market process

The gate closure time for BSPs to submit aFRR capacity bids shall be two days prior to the day of delivery (D-2), with a gate closure at 20:00 CET. This timing allows for rectifying possible failures in the optimisation for bid selection before information is then provided to the CZC calculations on the morning of D-1. When CZC is allocated for the exchange of aFRR capacity, this changes the available day-ahead CZC.

The Nordic TSOs do not foresee restricting the gate opening time for the BSPs more than necessary, taking into account technical reasons. The exact time for gate opening will be determined during the implementation phase but it will be at least D-7.

Between the gate closure time and a deadline for TSO approval of the bids, the TSOs can review the bids of their control area. The optimisation of the bids and allocation of CZC will then lead to clearing of the aFRR capacity market later in the evening of D-2. An overview of the timeline for the market process is shown in Figure 5.

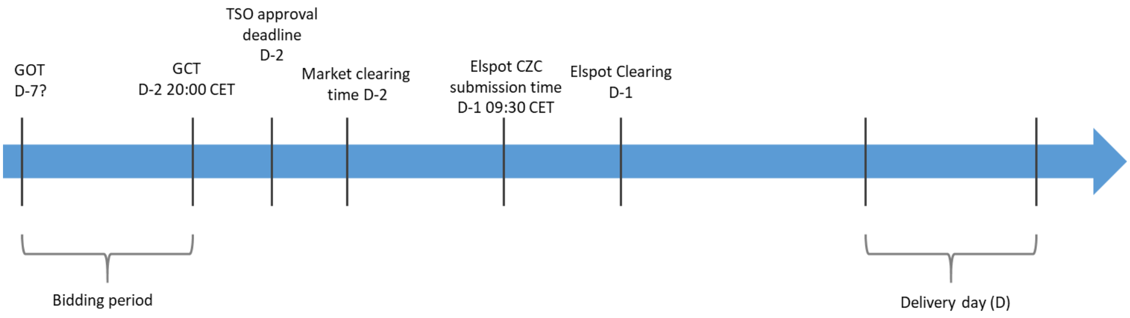

Figure 5. Overview of the market timeline

The detailed process for determining allocated CZC differ between the NTC capacity calculation method and Flow-based capacity calculation method that will be implemented at a later stage. This is explained in the explanatory document for methodology proposal pursuant to article 41 in EBGL.

2.4.2. The overall process of bid submission and bid selection

A schematic illustration of the bid submission, optimisation and selection process is shown in Figure 6.

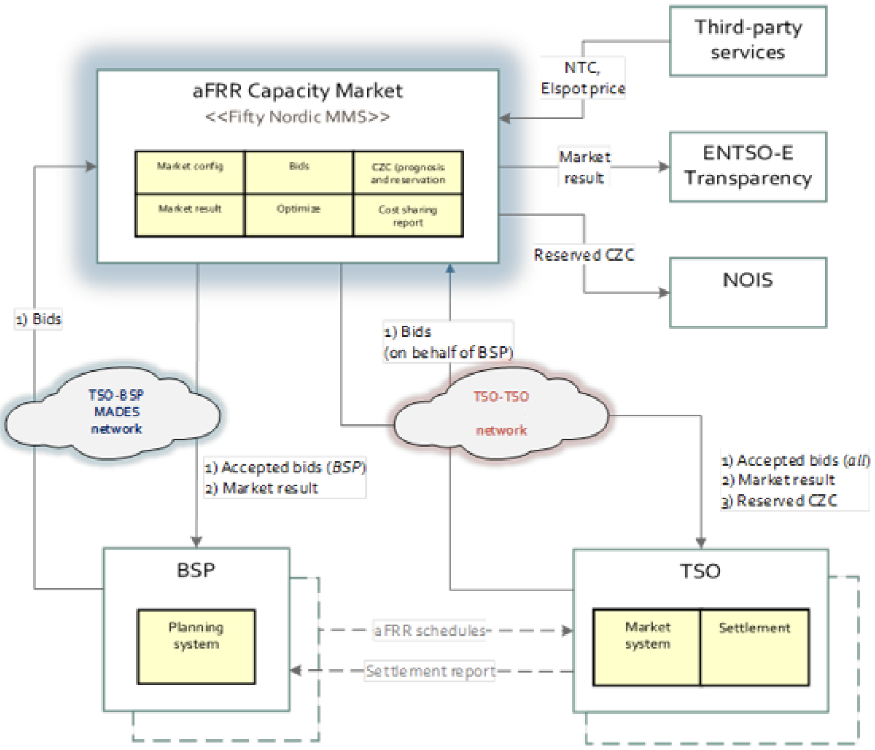

Figure 6. Bid submission, optimisation and bid selection in the Nordic aFRR capacity market

The bid format will be based on ENTSO-E Reserve Resource Process (EERP), a standardised bidding format for the procurement of Reserve Capacity.

BSPs will initially at least have two different options to send in their aFRR capacity bids:

- Directly to the host. ENTSO-E's Market Data Exchange Standard (MADES) communication protocol will be used for the exchange of data.
- Via a web interface.

Connecting TSOs will have full access to all bidding data, also when bidding data is sent directly to the host.

2.4.3. The procurement optimisation function

Objective function

The goal of the procurement optimisation function is to maximize the socio-economic surplus of the aFRR capacity market. As the demand of aFRR capacity in each area is submitted as price inelastic volumes, this is equivalent to minimizing the bid costs and alternative costs of CZC in the energy market based on the forecasted value. For each hour in the day, direction (up-/down-regulation) and bidding zone, the function is minimizing the sum of all

- $\boldsymbol{bid\_cost_i \cdot x_i}$

- $\boldsymbol{czc\_cost_{from,to,hour} \cdot czc\_res_{from,to,hour}}$

Where x is the accepted volume the algorithm sets for each bid i. Bid_cost is the cost in MW associated with each bid given as input.

For CZCs, the cost associated with each connection and hour is given by input as czc_cost. The czc_res is an endogenous variable representing the volume of CZC allocated to exchange of balancing capacity. For a specific connection and direction it will equal the maximum of exchanged up- and down- regulation .

The constraints of the optimisation

- All demand in each bidding zone, hour and direction must be met either by local or imported balancing capacity bids
- Between all bidding zones there is defined a maximum CZC which represents the maximum volume of balancing capacity to be transferred between the bidding zones. By default the maximum CZC will equal 10 percent of expected NTC, but it can be set lower for operational security reasons in accordance with article 165(g) of the SOGL.
- Bids can only be selected in 1 MW steps
- A bidding zone or a predefined set of adjacent bidding zones may have a pre-determined restriction on minimum volume and/or maximum volume that must be procured in the respective bidding zone or set of bidding zones.
- The restrictions of bids, including links to other bids, minimum volume, maximum volume and price must be respected.

The constraints can either be ‘hard’ (must be met) or ‘soft’ (should be met). If constraints are hard, they can cause the problem to be infeasible (not able to find a solution), and the algorithm cannot return a solution. If the constraints are soft, it will be able to find a solution, but some of the rules above are ‘relaxed’ in order to find a solution.

Among the constraints listed above the following are soft constraints:

- Demand
- Minimum procurement volume of a bidding zone or a set of bidding zones

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Technically soft constraints are handled with a cost applied to the relaxation of the constraint. An example can be that the demand in a bidding zone is greater than the volumes available locally and from neighbouring bidding zones. With a soft constraint the algorithm is allowed to set a value to the 'missing' volume at a very high cost, and thus still give a solution.

- *Sum(bids) + imports – exports >= demand – "penalty"*

The penalty cost needs to be set high enough to make it the last option to use. The penalty cost should at least reflect the highest bid cost plus the CZC cost according to the maximum number of bidding zone borders for the bid to cover all regions.

If a problem is infeasible, but it is possible to find a solution given the penalty variables, the output of the algorithm will give information about this.

Maximum CZCs and bids characteristics (links, indivisibility etc) are examples of hard constraints. The maximum CZCs available for allocation is by default set to 10% of expected NTC, and this is a constraint in the optimisation that always must be met.

Maximum and minimum procurement volumes for a bidding zone or for a set of bidding zones

The maximum procurement volume can be applied as a constraint to avoid that a too large share of the overall balancing capacity volume is located in a small part of the Nordic synchronous area reducing the operational security in accordance with Article 165(g) of SOGL. This restriction will only be used if it is considered necessary based on experience with how the procured bids are distributed in the Nordic region.

The minimum procurement volume can be used if the dimensioning process according to Article 157(3)(g) requires such limitations in order to ensure that dimensioning requirements are fulfilled.

Minimum and maximum constraints for procurement volumes can be applied to specific bidding zones or a set of bidding zones. The constraints must be made public before applied in the algorithm.

Mathematical formulation

Below is the description of the most important variables, parameters and constraints, as well as the objective function.

Variables:
x_i: sales bid variable (integer), $i \in BIDS$
x_bin_i: binary bid variable (0 if not selected, 1 if selected), $i \in BIDS$
f_agg_{mnt}: flow variable (in MW) from region *m* to region *n* in hour *t*
f_{mndt}: flow variable (in MW) from region *m* to region *n* in hour *t*, in direction *d*
p_dem_{mdt}: penalty variable (in MW) for demand constraint, for region *m* t in hour *t*, in direction *d*
p_minreg_{mdt}: penalty variable (in MW) for minimum procurement volume constraint, for region *m*, in hour *t*, in direction *d*
p_minmac_{zdt}: penalty variable (in MW) for minimum procurement volume constraint, for macro region *z*, in hour *t*, in direction *d*

Parameters:
Dem_{mdt}: demand for aFRR for region *m*, direction *d*, hour *t*

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bid_cost_i: cost of selecting 1MW of bid *i*
$minvolume_i$: minimum volume to be selected for each bid *i*
$maxvolume_i$: maximum volume to be selected for each bid *i*
$hourFrom_i$: the first hour bid *i* is valid from
$hourTo_i$: the first hour after hourFrom bid *i* is not valid (i.e. if a bid has hourFrom = 4 and hourTo = 6, the bid is valid in hour 4 and 5)
$flow\_cost_{mnt}$: cost of allocating 1MW on the CZC from region *m* to region *n*
CZC_{mnt}: maximum allocation capacity on the CZC from region *m* to region *n*
$minReg_{mdt}$: minimum aFRR selected for region *m*, direction *d*, hour *t*
$maxReg_{mdt}$: maximum aFRR selected for region *m*, direction *d*, hour *t*
$minMac_{zdt}$: minimum aFRR selected for set of bidding zones *z*, direction *d*, hour *t*
$maxMac_{zdt}$: maximum aFRR selected for set of bidding zones *z*, direction *d*, hour *t*
$pencost\_dem_{mdt}$: penalty cost per MW for demand for region *m*, direction *d*, hour *t*
$pencost\_minreg_{mdt}$: penalty cost per MW for minimum procurement volume for region *m*, direction *d*, hour *t*
$pencost\_minmac_{zdt}$: penalty cost per MW for minimum procurement for set of bidding zones *z*, direction *d*, hour *t*

Constants:
$iQuant$: a constant that defines the bid step size used. As default set to 5

Objective function:
Minimize total bid costs for all bids *i*, all penalty costs for region *m*, direction *d* and hour *t*, and all CZC reservation costs from region *m* to region *n* for hour *t*.

$$min \sum_i x_i \cdot iQuant \cdot bid_{cost_i} \cdot (hourTo_i - hourFrom_i) + \sum_m \sum_d \sum_t p_{dem_{mdt}} \cdot pencost_{dem_{mdt}} + \sum_m \sum_d \sum_t p_{minreg_{mdt}} \cdot pencost_{minreg_{mdt}} + \sum_z \sum_d \sum_t p_{minmac_{zdt}} \cdot pencost_{minmac_{zdt}} + \sum_m \sum_n \sum_t f\_agg_{mnt} \cdot flow\_cost_{mnt}$$

Constraints:
Demand constraint for region *k*, direction *d*, and hour *t*:

$$\sum_{\substack{i \\ if\ i_{region}=k \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant + \sum_m f_{mkdt} - \sum_n f_{kndt} \geq Dem_{kdt} - p\_dem_{kdt}, \qquad \forall k, d, t$$

CZC constraint from region *m* to region *n* in hour *t*:

$$f\_agg_{mnt} \leq CZC_{mnt} \qquad \forall\, m, n, t$$

CZC constraints for aggregate flow variables from region *m* to region *n* in hour *t*:

$$f\_agg_{mnt} \geq f_{m,n,UP,t} \qquad \forall\, m, n, t$$
$$f\_agg_{mnt} \geq f_{n,m,DOWN,t} \qquad \forall\, m, n, t$$

Min and max reservation constraints per region *m*, direction *d* and hour *t*:

$$\sum_{\substack{i \\ if\ i_{region}=m \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant \geq minReg_{mdt} - p\_minreg_{mdt}, \qquad \forall m,d,t$$

$$\sum_{\substack{i \\ if\ i_{region}=m \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant \leq maxReg_{mdt}, \qquad \forall m,d,t$$

Min and max reservation constraints per set of regions *z*, direction *d* and hour *t*:

$$\sum_{\substack{i \\ if\ i_{macro}=z \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant \geq minMac_{zdt} - p\_minmac_{zdt}, \qquad \forall z,d,t$$

$$\sum_{\substack{i \\ if\ i_{macro}=z \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant \leq maxMac_{zdt}, \qquad \forall z,d,t$$

Minimum and maximum bid volume for each bid *i*:

$$x_i \cdot iQuant \geq x_{bin_i} \cdot minvolume_i, \qquad \forall\ i$$

$$x_i \cdot iQuant \leq x_{bin_i} \cdot maxvolume_i, \qquad \forall\ i$$

Bid linking constraints for all bids in linked list *J*:

$$x\_bin_{j1} = x\_bin_{j2}, \qquad \forall\ j\ in\ linked\ list\ J$$

Exclusive group constraints for all bids in exclusive group *k_group*:

$$\sum_{\substack{k \in k\_groups \\ if\ k\ \ in\ k_{gropus} is\ a\ linked\ bid}} x\_bin_k \cdot 0.5 + \sum_{\substack{k \in k\_groups \\ if\ k\ in\ k_{groups} is\ not\ a\ linked\ bid}} x\_bin_k \leq 1 \qquad \forall\ k\_groups\ in\ exclusive\ group\ list\ K$$

Demand constraint to add cuts to the problem for direction *d* and hour *t*:

$$\sum_{\substack{i \\ i_{hour}=t \\ i_{direction}=d}} x_i \cdot iQuant \geq \sum_m Dem_{mdt} - p\_dem_{mdt}, \qquad \forall d,t$$

Comments to the optimization problem:

- As bids can be marked indivisible, the bid selection problem is what is called a combinatorial optimization problem or an Integer Program (MILP). Bids may also be linked across time and with other bids, as well as be included in exclusive groups. The linking and non-divisibility of bids is a critical and fundamental characteristic of the bid selection problem that makes a traditional selection method of sorting the bids by price not a feasible approach to guarantee the most socioeconomic solution. Given the size of the problem, the algorithm will not always be able to find the optimal solution with the time limit set by the user. To be able to control the solver and get solutions that are close to optimal, the algorithm is designed with a set of control parameters

- In MILP problems, a set of inputs can have more than one optimal solution, i.e. two different bid selections and CZC reservations can give the exact same total cost. In these cases, by default the system will return the same solution if the user run the same problem several times. In order to control this behavior and to make sure that selecting among two equally good solutions is a random process, the algorithm is designed with a random seed value that controls this.

Implication of pricing regime

When the pricing regime changes from pay-as-bid to marginal pricing, this will not change the principles for the bid selection. The optimisation will still maximize socio-economic surplus of the aFRR capacity market, which is equivalent to minimizing the procurement cost and costs of CZC given price inelastic demand. This relies on the assumption that the bids represent the true alternative cost of providing aFRR capacity.

With pay-as-bid the bid costs will equal the procurement costs of TSOs. This is not the case with marginal pricing. The marginal price will be set to the highest accepted bid in uncongested areas. All BSPs within an uncongested area will be paid the marginal price, and the payment to BSPs and the procurement costs of the TSOs will be higher compared to the bid costs. However, the true redistributional effects depends on how the bidding behaviour of BSPs change.

2.4.4. Settlement of contracted capacity

The settlement of procured balancing capacity is proposed to be based on pay-as-bid towards the BSPs. BSPs will receive an availability payment (in Euro), for each MTU where the aFRR capacity bid is accepted, equal to the bid price multiplied with bid volume ("pay-as-bid").

Pay-as-bid is the settlement method that is in place in all Nordic countries today, except in Norway which applies marginal pricing. It is also the predominant settlement method in different electricity balancing capacity markets throughout Europe.

Pay-as-bid is preferable when there is a risk for market imperfections. In particular limited product homogeneity and insufficient supply surplus. Such imperfections does not impair the efficiency of pay-as-bid.

Bid selection is done in the merit order when settling according to pay-as-bid, just as when employing marginal price settlement.

The long term target for the Nordic aFRR capacity market is to settle according to marginal price. The Nordic aFRR capacity market will adopt marginal pricing when the aFRR energy market is in place, at which point the capacity market will have gained volume, liquidity and experience.

Before marginal price can be implemented, some market design questions must be solved.

a. Cost-sharing between TSOs
b. Price determination cross borders
c. Price determination over congested borders

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d. Price determination in the event of no bids in the LFC-area

These questions will be solved by the Nordic TSOs before the implementation of the aFRR energy market.

Concluding on the proposal to use pay-as-bid as an interim solution, TSOs find that the above given reasons and explanations indeed do ensure that there is no conflict between the proposal and Article 3 in EB GL. Pay-as-bid does not prevent or limit effective competition, non-discrimination, transparency, efficiency or fairness. Pay-as-bid it is a suitable market solution, under the market conditions we initially expect.

2.5. Activation of balancing energy bids

For the first phase of the aFRR capacity market, balancing energy bids will be activated pro-rata and activated aFRR energy is settled with regulation power price.

The Nordic TSOs foresee to introduce an energy activation market for aFRR at a later stage. This is described in section 3.

2.6. Publication of market information

The market results will be sent for publication to the ENTSO-E transparency platform in accordance with Article 12(3) of EB GL. The data will include:

- Anonymised prices and volumes of the procured aFRR capacity bids. These data will be published as soon as the market results of the tender are completed and at the same time as BSPs are notified about the acceptance of their aFRR capacity bids.
- The CZC allocated for the exchange of aFRR capacity. This will be published after the market clearing results are available.
- The use of allocated CZC for the exchange of aFRR capacity, including realised costs and benefits of the allocation process. The Nordic TSOs will monitor the efficiency of the CZC allocation process and, based on the aFRR capacity bid data, will calculate the reduction in procurement costs compared to fulfilling the initial distribution of capacity without allocating CZC for exchange. As long as energy activation is done through pro-rata activation without an energy activation market, the efficiency of realised energy activation is not estimated. The estimated costs and benefits will be published as values per day for the entire market region within one week after the delivery day.

2.7. Allocation of cross-zonal capacity

Pursuant to Article 33(4)(b) of EB GL, the Nordic TSOs exchanging balancing capacity shall ensure both the availability of CZC and that operational requirements are met by one of the methodologies for allocating CZC to the balancing timeframe which are presented in Chapter 2 of Title IV of EB GL. Of these methodologies, the Nordic TSOs intend to use a market-based allocation process of CZC in order to secure the exchange of aFRR. Pursuant to Article 38(1) of EB GL, the proposal for a methodology for this process is found in the separate proposal document also submitted to the national regulatory authorities, entitled "Energinet, Fingrid, Statnett and Svenska kraftnät proposal for the methodology for a market-based allocation process of cross-zonal capacity for the exchange of aFRR capacity in accordance with Article 38 (1) of the

Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing".

2.8. TSO-TSO settlement

For the first phase of the aFRR capacity market Nordic TSOs will apply a cost sharing model based on the polluter-pay-principle. With the introduction of marginal pricing at a later stage, the Nordic TSOs will also change the settlement between TSOs, explicitly sharing the congestion rent, which is implicitly shared in the model for the first phase.

2.8.1. Cost-sharing key

The financial obligation for the procurement of aFRR capacity will be shared between the TSOs according to a pollution-based sharing key, which is based on the polluter-pays principle per control area.

The indicator for the 'pollution' shall correlate with the need for aFRR energy, i.e. if the total pollution as indicated by this indicator decreases, the need for aFRR shall decrease as well. Consequently, when costs are allocated to each of the Nordic TSOs based on this indicator, this shall provide an incentive to each TSO to reduce their 'pollution'.

The indicator for pollution is the imbalance minus the rolling average of the previous MTU. The "90th percentile" is used as the 'pollution' indicator for aFRR capacity. It is a good proxy for the maximum use of contracted capacity and consequently for the need for contracting that amount of capacity. It is not sensitive to special conditions (including disturbances) and outliers that are caused by data errors.

The inputs to this methodology are:

- $Imbi(t)$: One minute values of imbalance per Control Area *i*
    - The imbalance data shall be collected for the historic periods (hours, weekday, month) corresponding to when aFRR capacity is procured. If no decision is made for when aFRR capacity shall be procured, the contracting hours from last year shall be used.
- One minute values are based on several inputs, including:
    - Flow after intraday day
    - Measured flow on AC tie lines out of an area
    - Frequency bias factor
    - aFRR activation signals
    - mFRR activation
    - Quarterly movements

The short-term imbalance for each Control Area *i*; this is calculated by:

$$Imb_{aFRR,\,i}(t) = \frac{1}{t_s}\int_{t-t_s/2}^{t+t_s/2} Imb_i(\tau).\,d\tau - \frac{1}{t_l}\int_{t-t_l/2}^{t+t_l/2} Imb_i(\tau).\,d\tau$$

in which, t_s is 5 minutes and t_l is 60 minutes

The calculation is made by each control area and will be published. The Nordic TSOs are jointly responsible for the data quality and the calculation methodology.

With the introduction of the marginal pricing at a later stage, the Nordic TSOs also look to change the settlement between TSOs, explicitly sharing the congestion rent, which is implicitly shared in the model for the first phase.

2.8.2. Cost-sharing model

Control areas with more procured aFRR capacity than their aFRR obligation are termed exporting control areas. Control areas with procured aFRR capacity below their aFRR obligation are termed importing control areas.

Balancing capacity offers from BSPs will be settled pay-as-bid. The methodology to share the costs arising from BSP settlement will be based on the principle that exporting control areas first fulfil their own aFRR capacity obligation with the cheapest available aFRR capacity bids , after which the remaining bids are "exported" to importing control areas. Importing control areas pay the average cost of the aFRR capacity imported across all Nordic control areas.

In more detail, the above methodology entails the following:

1. The choice of cost sharing methodology will not affect the optimisation process. The common Nordic procurement of aFRR capacity will be made optimally on a Nordic level. This means that FRR balancing capacity will be procured where it is cheapest, taking into account the initial geographical distribution and cross-zonal restrictions.
2. An obligation per control area is defined by the chosen sharing key, see 2.8.1.
3. In control areas where the amount of procured balancing capacity exceeds the local aFRR obligation, the local aFRR obligation will be met by the cheapest aFRR capacity bids in that control area.
    - If the amount of procured aFRR capacity in a control area exceeds the aFRR obligation, the excess bids (more expensive) will be paid for by the remaining control areas' TSOs.
    - If the amount of procured aFRR capacity in a control area does not meet the area's obligation, the residual aFRR obligation is met by "import" from control areas with excess capacity.
4. Importing control areas pay the average price of the "imported" aFRR capacity. In other words, the total cost of the excess aFRR capacity is divided among importing control areas in relation to how much they "import".

3. Outlook

As a part of the Nordic balancing model, the Nordic TSOs aim to introduce a Nordic aFRR energy activation market after balancing in Nordic LFC Block is based on Area Control Error (ACE-based balancing). BSPs whose balancing resources are procured by the Nordic TSOs in the aFRR capacity market will then have an obligation to bid into the aFRR energy activation market, whereas other BSPs may do so on a voluntary basis. Activation of bids will then be according to a Common Merit Order List across the Nordic market region.

In the time period before introducing the Nordic aFRR energy activation market, only procured aFRR capacity can be activated. Activation will be done pro rata and activated aFRR energy is settled with balancing energy price on Nordic regulating power market.

The Nordic TSOs expect that future challenges will require more automated balancing. The Nordic TSOs will increase the number of aFRR contracting hours from the starting level of 35 hours per week to all hours of the week. The aFRR volume will gradually be increased from the starting level of 300 MW to a tentative target volume of 600MW. When the dimensioning rules for FRR is developed and implemented the volumes to be procured will follow the dimensioning rules.

As part of this development, the Nordic TSOs aim to further harmonize the prequalification rules and in particular the length of FAT. The length of FAT has a direct impact on the frequency quality in the synchronous area and the stability of the system, especially when relatively small volumes of aFRR is employed. The increase of the number of hours and the volume of aFRR will enable a re-evaluation of the activation process as a whole. A FAT of five minutes is most probably the FAT that will be used in the Energy standard product across Europe and therefore what the Nordic TSOs expect to apply as the harmonized FAT

The MTU for the capacity market will be the same as for the day-ahead market and this implies that when the Nordic day-ahead market shift to a shorter MTU this will also be changed on the aFRR capacity market. In the current proposal of Clean Energy Package (CEP) MTU for the day-ahead market shall be the same as the Intra-day market. When in time a shorter MTU is implemented on the day-ahead market is not solely up to the Nordic TSOs but to Nordic and European harmonisation and requirements set out in the coming CEP.

Annex 1. Answers to stakeholder consultation

After restructuring of the legal proposals this consultation note is relevant for the proposal "Energinet, Fingrid, Statnett and Svenska kraftnät proposal in accordance with article 33(1) and Article 38(1) of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing"

Subject matter and scope", Definitions and interpretations and general remarks to the overall method

SFE Produksjon:
We are very positive to the Nordic TSOs initiative to establish a common Nordic aFRR capacity market with allocation of CZC where this gives an increased socio-economic welfare. We find the proposal good enough for a start-up phase […]

Swedenergy:
Swedenergy strongly supports the further integration of the balancing markets in the Nordics and the EU. However, a prerequisite for a fair competition are common and harmonized rules and processes which is not the case in the proposal.

Finnish Energy:
Finnish Energy supports the establishment of a regional balancing capacity market for aFRR. The market should be based common and harmonized rules and process for the exchange and procurement of aFRR balancing capacity as laid out in this proposal. In general, we find the proposal balanced, though consider the proposal of using pay-as-bid pricing unacceptable and the reasoning for applying it scandalous. This and other remarks are explained more in detail below.

Danish Energy:
Danish Energy supports the establishment of a regional balancing capacity market for aFRR. The market should be based common and harmonized rules and process for the exchange and procurement of aFRR balancing capacity as laid out in this proposal.

Energy Norway:
This proposal from the Nordic TSOs on common and harmonized rules and processes for the exchange and procurement of aFRR balancing capacity is a part of the new Nordic Balancing Concept (NBC). Although many elements of NBC are still unknown, Energy Norway supports the objective of the NBC – maintaining a high frequency quality through a more effective balancing market design.

Agder Energi:
Agder Energi is pleased to welcome the establishment of a common Nordic market for aFRR. We have been actively involved in both planning and development of the Norwegian aFRR market since 2009 and have also prequalified several of our power plants. We are now looking forward to participating in a bigger Nordic market.
We agree with the TSOs that an aFRR market contributes to a safer, a more cost-effective and reliable operation of the power system, and therefore look forward to a development with increased use of aFRR in the Nordic synchronous area. With the increasing complexity of the operation of the power system we think it is important to include automatic solutions, both for the system operators as well as for the market actors and considers the aFRR market as a key instrument for maintaining good quality in the Nordic region in the future.
[…]Although the conditions for the market players are not completely equal in the beginning, we think the proposal is a good starting point.

TSOs:
We appreciate the positive reception of the proposal to launch a common Nordic aFRR capacity market since we as TSOs se this Nordic market as one of the building blocks to maintain a safe and reliable operation of the Nordic power system and also a way to increase efficiency and an increase in socio economic welfare. We also do acknowledge that some of the stakeholders are questioning the lack of harmonization of rules and processes. The reason to non-harmonization of some of the rules and processes e.g full activation time (FAT) (art 5) and the prequalification (art 3) will be explained and discussed more in detail under respective article.

Prequalification of aFRR capacity

SFE Produksjon:
[…]but some improvements should be implemented as early as possible [i.e.:] The prequalification process should be described clearer and be harmonized among the Nordic countries.

Swedenergy:
It is important that the prequalification process is clearly described, and that this information is made available to market participants. The prequalification process should be harmonized between countries in the Nordic synchronous area as prerequisite for a non-distorted market is that all participants face the same conditions.

Energy Norway:
It is important that the prequalification process is clearly described, and that this information is made available to market participants. The prequalification process should be harmonized between countries in the Nordic synchronous area.

TSOs:
Prequalification requirements are clearly described in detail for each involved TSO, and are available on their respective homepages. There are other reasons for maintaining national prequalification requirements than to have two different FATs, such as the setup of measuring equipment. Of course, rules in this respect could be completely harmonized, but compared to the effort it would demand of BSPs, the gain in terms of equal access to the market is very limited.

High level design of the aFRR capacity market

Finnish Energy:
It is proposed that GCT shall be 20:00 CET two days prior to the day bids are valid. This leads to the question of capacity reservations. We call for consideration, could the aFRR capacity market be arranged simultaneously with day-ahead market? Hence let the market decide whether to reserve capacity for aFRR or to allocate it for day-ahead trades?
Furthermore, a GCT at D-2 at 20.00 CET does not align with the current FCR-N D-2 market GCT at D-2 15.00 CET with a notification of the clearing result at 16.00. When bidding flexibility into the aFRR market it is important to know the result from the FCR-N D-2 market, hence the bidding would need to be performed between 16.00 – 20.00 which is not optimal since it is out of normal operating hours. An alternative solution would be to place the aFRR GCT at ~8.30 D-1 or at 12:00 which is also the GCT for day-ahead markets.

Swedenergy:
It is proposed that GCT shall be 20:00 CET two days prior to the day bids are valid. This leads to the question of capacity reservations. TSOs should consider the aFRR capacity market could be arranged simultaneously with the day-ahead market. In this way, the market decides whether to reserve capacity for aFRR or to allocate it for day-ahead trades.
The bidding periods and GCT between different balancing markets should be harmonized in order not to lead to unnecessary complexity for the bidders. Further, GCT should preferably be within normal operation hours.
For instance, GCT at D-2 at 20.00 CET does not align with the current FCR-N D-2 market GCT at D-2 15.00 CET with a notification of the clearing result at 16.00. When bidding flexibility into the aFRR market it is important to know the result from the FCR-N D-2 market, hence the bidding must be performed between 16.00 – 20.00 which is not optimal since it is out of normal operating hours. An alternative solution could be to place the aFRR GCT at ~8.30 D-1.

Danish Energy:
It is proposed that GCT shall be 20:00 CET two days prior to the day bids are valid. This leads to the question of capacity reservations. TSOs should consider the aFRR capacity market could be arranged simultaneously with day-ahead market. In this way, the market decides whether to reserve capacity for aFRR or to allocate it for day-ahead trades.
Furthermore, a GCT at D-2 at 20.00 CET does not align with the current FCR-N D-2 market GCT at D-2 15.00 CET with a notification of the clearing result at 16.00. When bidding flexibility into the aFRR market it is important to know the result from the FCR-N D-2 market, hence the bidding must be performed between 16.00 – 20.00 which is not optimal since it is out of normal operating hours. An alternative solution would be to place the aFRR GCT at ~8.30 D-1.

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Energy Norway:
The bidding periods and GCT between different balancing markets should be harmonized in order not to lead to unnecessary complexity for the bidders. Further, GCT should preferably be within normal operation hours.
For instance, GCT at D-2 at 20.00 CET does not align with the current FCR-N D-2 market GCT at D-2 15.00 CET with a notification of the clearing result at 16.00. When bidding flexibility into the aFRR market it can be important to know the result from the FCR-N D-2 market. In this case, the bidding must be performed between 16.00 – 20.00 which is not optimal since it is out of normal operating hours. An alternative solution could be to suggest the aFRR GCT at ~8.30 D-1.

TSOs:
The simultaneous allocation of CZC for the day-ahead and balancing markets is described as the co-optimisation method for allocating CZC in EB GL. As described in the Explantory Document, this is a complex and demanding methodology and would requrie development of the Day-ahead algoritm Euphemia and this is not currently feasible.

The gate closure time of the market has been chosen to balance between several factors: There are parallel markets which must be considered. There must be sufficient time after gate closure for aFRR capcaity to ensure that the market optimisation can run and that it is enought time between optimisation and NTC calculations to allow for failure and backup routines, A gate closure time of 8:30 am on D-1 for aFRR capacity does not allow for this.

Nord Pool:
Article 4(1): While some justification for the likely exclusion of Bidding Zone (BZ) DK1 is provided in section 2.3 of the explanatory document, it is at the outset from a market and pricing efficiency perspective hard to see why that exclusion should apply since it reduces the chance for procurement/activation of the most relevant production and consumption assets in the Nordic aFRR balancing arrangement. Furthermore, the time gap between implementation of these aFRR arrangements in the Nordic region and implementation of Nordic ACE-based balancing is assumingly rather short and that is another argument why the initial exclusion of DK1 can be put to question.

TSOs:
First of all, DK1 is covered by long-term contracts until early 2020. Secondly, the aFRR-demand in DK1 differs significantly from what will be supplied in the initial phase of the Nordic aFRR capacity market. DK1 needs a 15 minutes FAT product 24 hours a day. The Nordic market supply a 2 or 5 minutes FAT product 5 hours a day.
The inclusion of DK1 is linked to the introduction of ACE-based balancing in the Nordic synchronous area. There is a number of issues to address before including DK1. Energinet will need dedicated communication lines to all other TSO's SCADA systems to enable activation specifically for DK1, and special reservation arrangements must be in place for the HVDC connection between DK1 and the Nordic synchronous area.

Nord Pool:
Article 4(2): While we in general agree to the notion that the aFRR capacity market shall apply the same market time unit resolution as the day-ahead market, we note in related proposals and explanatory documents from Nordic TSOs that the Imbalance Settlement Period, including the Balancing Arrangements and Intraday trading, is to be shifted to 15-minute (MTU) in 2020/2021, but at the same time the Nordic TSOs have stated that the (Nordic) day-ahead market MTU resolution, including Cross Zonal capacity allocation, until further notice shall keep hourly MTU. Due to that fact we recommend that some clarification on this matter is made in the proposal and background material.

TSOs:
During an interim period, the day-ahead and intraday markets will have different MTUs and we see it as more appropriate to relate the aFRR capacity market to the MTU of the day-ahead market since the procurement of aFRR capacity is done before the day-ahead market and thus is of more importance for market participant than the ID- and balancing market.

Nord Pool:
Article 4(3) [9]: In supportive documents, and as stated by TSOs in a webinar on 20th of SEP, it has been clarified that the predefined total Nordic volume of aFRR/hour (MTU) will initially be 300 MW and some year(s) later it may be increased up to 600 MW. However, it is not stated explicitly in the proposal, and accordingly we find that it should be considered for inclusion in the proposal and/or in the related explanatory document.

TSOs:
The market size is related to the FRR dimensioning process and is therefore out of scope for this Proposal. Both the initial market size and an outlook for the market size is stated in the Explanatory Document.

Nord Pool:
Article 4(5): It is positive that change to predefined volumes will be announced to the market participants, because such changes impact the availability in competitive open markets, e.g. SDAC and SIDC, thus such reporting is likely part of the obligations under EC Transparency Regulation. However, it is not clear in the proposal if such a change could be of a temporary nature, or rather refer to what is referenced by us in the comment to Article 4.3 above. Therefore, we recommend that such a clarification is included in the proposal and explanatory document, and if the application may be of temporary nature then it should also be detailed which circumstances could justify such a temporary (from day to day) change in the procurable aFRR volume.
In addition, for the sake of clarity, the term "market participants" should be clarified to mean "the market in general", thus not only the market participants whom are active in the aFRR market since that leads to them being given inside information of price sensitive nature that is not known to the rest of the market.

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TSOs:
Thank you for your comments. We have changed the proposal in order to clarify on this matter. As mentioned previously, the market sizing is related to the FRR dimensioning process, and the procurement rules that must be followed are detailed in Article 32 of EB GL.

Nord Pool:
Article 4(8): Since the procurement of aFRR has an impact on the availability in, and the price formation of, competitive open markets, e.g. SDAC and SIDC, then a notification of the results without undue delay is not sufficient if provided merely to the bidders, but at the same time (or before) the overall results should be published to the market at large for identical reasons as referred to in the response to Article 4.5 above.

TSOs:
We understand your comment and we have clarified or proposal on when to publish market result information. We will publish results at the same time as bidders are notified, without undue delay, once procurement results are known. We aim to provide this information at the same time but there may be cause for an unintentional delay. It should nonetheless be noted that Article 12(f) of EB GL allows for up to one hour between notification of procurement results to the bidders and publishing these results to the market.

Product and bid characteristics

Danish Energy:
Under Item 1, the full activation time, the minimum and maximum bid quantity and finally the bid granularity is not quantified at their values of 5 minutes, 5 MW, “50 “ MW 5 MW respectively.

Nuvve:
While we understand the need for a higher threshold capacity (5 MW) than is common for primary markets, we feel that the requirement for incremental bids of 5 MW decrease the chances that incrementally going distributed resource aggregations would be likely to enter this market.

Hydro Energi:
On bid granularity: A bid granularity of 5 MW would have a negative effect on the offered volumes compared to a smaller bid granularity. This effect would be greater for smaller market parties/smaller power units. We urge the TSOs to reconsider if the bid granularity can be made smaller, perhaps for only some bid types in order to restrict an increase in complexity of the bid acceptance process (assuming this is the reason for the 5 MW granularity). We also urge the TSOs to conduct periodic reviews of the granularity.

Swedenergy:
The justification of values such as 5 MW and 50 MW could also be further explained.

TSOs:
Nordic TSO has reconsidered the bid size and has changed the minimum bid size to 1 MW. Bids less than 50 MW can be marked as indivisible and the reason for not allowing bids larger than 50 MW to be indivisible is due to the risk of market power, operational security and security of supply reasons. If too much aFRR volume is enclosed in one or a few bids the operational security is set at risk. For the Nordic TSOs due to the risk of congestions in the grid it is important that the procured volume is distributed among all areas in the Nordic countries. Also the diversification of risks such as failing of communication and tripping of generators are better if procurement is done with more and smaller bids rather than less and larger bids.

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SFE Produksjon:
[…]but some improvements should be implemented as early as possible [i.e.:] A harmonization of Full Activation Time (FAT).

Finnish Energy:
A prerequisite for a non-distorted market is that all participants face the same conditions. However, the proposal suggests different requirements for pre-qualifications in the different countries, e.g. regarding the aFRR full activation time (FAT). This should be motivated otherwise the implicit understanding is that "it is simpler to us (the TSOs) to keep it so". The potential future shortening of the FAT is also discussed. We discourage unreasonably short FAT values. Longer FAT values allow for greatest number of bids in the market, best possible competition, and lower prices for aFRR. A Nordic harmonization of FAT should not pre-empt the European harmonization currently foreseen in 2025.

Swedenergy:
A prerequisite for a non-distorted market is that all participants face the same conditions. However, the proposal does not comply to this. The proposal for different requirements on Full Activation Time (FAT) between control areas, is not acceptable and not in line with the EU process of harmonization. The proposal or FAT should be changes to 5 min for all areas from day 1.

Vattenfall:
Furthermore, the proposal does not propose equal conditions for all market participants. The proposal for different requirements on Full Activation Time (FAT) between control areas, is not acceptable and not in line with the EU process of harmonization. The proposal or FAT should be changes to 5 min for all areas.

Agder Energi:
Even if it is already described in the proposal we want to repeat that the final solution for the aFRR market must include a harmonization of the prequalification process and the Full Activation Time (FAT) and the use of marginal pricing.

Danish Energy:
A prerequisite for a non-distorted market is that all participants face the same conditions. However, the proposal suggests different requirements for pre-qualifications in the different countries, e.g. regarding the aFRR full activation time (FAT). This should be motivated otherwise the implicit understanding is that "it is simpler to us (the TSOs) to keep it so". The potential future shortening of the FAT is also discussed. Dansk Energi discourage unreasonably short FAT values. Longer FAT values allow for greatest number of bids in the market, best possible competition, and lower prices for aFRR. A Nordic harmonization of FAT should not pre-empt the European harmonization currently foreseen in 2025.

Energy Norway:
A prerequisite for a non-distorted market is that all participants face the same conditions. However, the proposal suggests different requirements for pre-qualifications in the different countries, e.g. regarding the aFRR full activation time (FAT). The FAT should be harmonized within LFC-block as early as possible, preferably from day 1. The justification of values such as 5 MW and 50 MW could be further explained.

TSOs:
We understand your comments and concerns. Our long-term aim is indeed to harmonize FAT. Our intention for the initial phase of the market, however, is to keep our current suggestion of FAT. We will perform an analysis of the impact that the differences of FAT has on the Nordic synchronous system and also how large volume the system need depending on the choice of FAT. To link the Nordic work with the European harmonization, a FAT up to 7.5 min will be allowed until 2025 thereafter FAT shall be 5 min for all resources participating on the European energy platform for aFRR.

SFE Produksjon:
We find the possibilities of linking to be sufficient to cover our requirements.

Swedenergy:
The linking of bids seems sufficient.

Agder Energi:
We find the bid formats and the possibility to link bids to be sufficient, and also the length and the timing of the proposed bidding period.

Danish Energy:
The suggested linking facilities seems to be appropriate for bidding in aFRR capacity effectively.

Energy norway:
The linking of bids seens sufficient.

TSO:
[…no answer required…]

aFRR capacity bid submission

TSO:
There have been no comments to this article.

Settlement of product aFRR capacity

SFE Produksjon:
[…]but some improvements should be implemented as early as possible [i.e.:] Pay as cleared/marginal pricing should be considered implemented from day 1.

Swedenergy:
We strongly oppose the proposal that BSP settlement of procured balancing capacity would be based on pay-as-bid for the first two years. We do not see a technical challenge in moving directly towards marginal pricing for the aFRR capacity, as is in any case the future method foreseen by TSOs.
We are disappointed that TSOs still approach balancing from a national perspective and focus on individual needs rather than Nordic balancing needs as a whole. Even though the needed amount is determined per area, the pricing must be regional and later European. Swedenergy is concerned that individual TSOs' may reserve the cheapest resources for themselves and allocate only to rest for Nordic good and uses this as reasoning for applying pay as bid pricing. The proposed pay as bid regime should be replaced or complemented with a firm deadline for when full marginal pricing should be implemented.

Finnish Energy:
We shocked by the proposal that BSP settlement of procured balancing capacity would be based on pay-as-bid for the first two years, with rationale that it enables individual TSOs to use cheapest resources located within their control area by themselves and only enable others to purchase more expensive resources. This is not in line with having a common market. No, the pricing must be marginal pricing and when possible, subject to transmission capacities, the price same for the whole Nordic region. We do not see a technical challenge in moving directly towards marginal pricing for the aFRR capacity, as is in any case the future method foreseen by TSOs.

Danish Energy:
We strongly oppose the proposal that BSP settlement of procured balancing capacity would be based on pay-as-bid for the first two years. We do not see a technical challenge in moving directly towards marginal pricing for the aFRR capacity, as is in any case the future method fore-seen by TSOs.
Dansk Energi is concerned that, as a result of the pay-as-bid scheme, individual TSOs are incentivized to keep the cheapest resources for themselves and allocate only to rest for the Nordic market. We urge TSOs to elaborate on the different pricing options and justify the choice of pay-as-bid.

Energy Norway:
We strongly oppose the proposal that BSP settlement of procured balancing capacity would be based on pay-as-bid for the first two years. We do not see a technical challenge in moving directly towards marginal pricing for the aFRR capacity, as is in any case the future method foreseen by TSOs. Marginal pricing must be implemented as soon as possible, preferably from day 1.

Vattenfall:
Vattenfall regrets that the proposal is not ambitious enough what regards the timeline for the step towards full marginal pricing. The proposed pay as bid regime should be replaced, or complemented with a firm deadline for when full marginal pricing should be implemented.

Lyse Produksjon:
We are generally positive to the Nordic TSOs' proposal for a common Nordic aFFR capacity marked. However, we believe that the Nordic TSOs should strive to implement marginal pricing (pay-as-cleared) as soon as possible. With pay-as-bid the BSP is incentivized to bid as close to the price level as possible to avoid "losing" to much money compared to other BSPs. This will complicate the bidding process and could also result in an inefficient market.

Hydro Energi:
On pay-as-bid VS marginal pricing: We urge the TSOs to introduce marginal pricing as soon as possible, as pay-as-bid makes the bidding process unnecessarily complex and introduces a strategy element to this process that may obscure the true marginal prices of the market parties. The latter effekt would cast doubt on whether the bid acceptance process can truly provide the optimal socio-economic distribution of aFRR capacity in the

Nordics and lead to a suboptimal use of CZC for exchange of aFRR capacity (as the process would compare the bids of an pay-as-bid market against the results of a marginal pricing market).

Nord Pool:
The proposal to base availability payments of individual orders on pay-as-bid and not marginal pricing is in our view problematic. To begin with it introduces a different principle then that applied for active up/down regulation since over 20 years in the Nordic region. Furthermore, it will likely distort the evaluation of projected value of cross zonal capacity in the day-ahead market versus in aFRR, because marginal pricing is used in day-ahead market and accordingly market participants take that in consideration in their orders, and likewise they would if pay-as-bid principle is applied in aFRR take that in to consideration for that process. Put more concretely, the pricing of a given set of orders (e.g. single units) would be higher in a pay-as-bid regime than in a marginal-price regime and therefore when making projections of the "welfare" value of cross zonal capacity for usage in aFRR versus in day-ahead it would appear like the value would be higher in aFRR while it might only be due to the different pricing models applied.

TSOs:
We understand the negative view on PAB-pricing, which is also the reason that we have made a plan to implement marginal pricing within two years after launch. We have added a longer motivation for our choice of pricing method in explanatory document.

Methododlogy for allocating cross-zonal capacity for aFRR capacity market, The procurment volume of aFRR capacity, aFRR capacity procrument optimisation and bid selection

TSOs:
There have been no comments to these three articles, except that the Nord Pool comment to Article 4(3) partly refers to Article 9.

TSO-TSO settlement in the aFRR capacity market

Nord Pool:
While some explanations are given for the concept of "…average of marginal bid values in importing and exporting areas…" in section 2.8.2 of the explanatory document it is in our current understanding neither (1) explicitly explained what effect that would have on imbalance settlement prices per Bidding Zone, nor (2) given any solid justification of why an "averaging pricing principle" shall be applied. We think that "averaging" as a principle for price formation is prone to suboptimal economic results, and furthermore we find it is an important principle that "exporting of extremes" should not become part of the (imbalance) settlement price of Bidding Zones where such "extremes" were not observed, which we are concerned with that the described "averaging principle" can lead to. Due to these concerns, we find it important that more clarity is given in the proposal and in the explanatory document regarding the proposed "averaging pricing principle", and in the event it becomes clear that our concerns are valid then we recommend that an alternative model is applied based on alignment on this matter with market stakeholders.

TSOs:
There seems indeed be some unclear description of the marginal pricing principle in the documentation. The exchange of balancing capacity shall be settled based on marginal bid values and in case of congestion the balancing capacity shall be settled to the average of marginal bid values in importing and exporting areas (middle price)". The legal document is now updated to clarify the meaning.

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Publication of information, Final provision, Publication and implementation of the Proposal, Language and other issues

Swedenergy:
13(1) A general comment is that we would like to point out that the planned go live date in the middle of the summer is unfortunate from an operational perspective, and we recommend the TSOs to change the timeline accordingly.

Vattenfall:
Finally we would like to point out that the planned go live date in the middle of the summer is unfortunate from an operational perspective and we recommend the TSOs to change the timeline accordingly.

TSOs:
Thank you for these comments, we understand your concerns and have changed the go-live date to after summer.

Hydro Energi:
On publishing of anonymized bids: In bidding areas with few market parties and/or one dominant party it may be possible (with high probability) to identify the market party responsible for each of the bids. This would be especially true for the dominant market party. We urge the TSOs to consider this effect when deciding what information to make public.

TSOs:
Publication of the anonymized bids is required in article 12(3) of EB GL. This gives no flexibility to the TSOs to limit the publication of this information.

Nord Pool:
Article 12(3): While it is positive that the estimated reduction in procurement costs for aFRR based on allocation of CZC versus no such (up-front) allocation will be regularly published within a week of the given delivery day it is still not clear what such estimates would be based on. More clarity on that would be beneficial in the proposal and especially in the explanatory document, not least to be able to assess the relevance of the aspects considered in such an estimate.

TSOs:
Estimation is based on the knowledge TSOs will have on the offered bids. The result is relevant when assessing how well the CZC allocation method works.

Swedenergy:
In the longer term, it is important that the proposal facilitates an easy move from a Nordic aFRR balancing capacity market to a full aFRR balancing energy activation market that is ultimately integrated into the European PICASSO platform. While the latter are not within the scope of the current proposal, we urge TSOs to ensure compatibility between the Nordic and European platforms.

Agder Energi:
We look forward to the further development of the aFRR energy activation market into a true common European marked (PICASSO) and hope that the Nordic experience can be useful.

Danish Energy:
In the longer term, it is important that the proposal facilitates an easy move from a Nordic aFRR balancing capacity market to a full aFRR balancing energy activation market that is ultimately integrated into the European PICASSO platform. While the latter are not within the scope of the current proposal, we urge TSOs to ensure compatibility between the Nordic and European platforms.

Energy Norway:
One positive aspect of the NBC is that it provides experience before the integration of European balancing markets. To gain benefits from this it is important that the proposal facilitates a seamless transition from, in this case, a Nordic aFRR balancing capacity market to a full aFRR balancing energy market that is ultimately integrated into the European PICASSO platform. While the latter is not within the scope of the current proposal, we urge TSOs to ensure compatibility between the Nordic and European platforms.

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Finnish Energy:
In the longer term, it is important that the proposal facilitates an easy move from a Nordic aFRR balancing capacity market to a full aFRR balancing energy activation market that is ultimately integrated into the European PICASSO platform. While the latter are not within the scope of the current proposal, we urge TSOs to ensure compatibility between the Nordic and European platforms.

TSOs:
We are indeed aware of PICASSO and keep the focus from the future integration opportunities. That being said, it is also necessary to remember that PICASSO is still under development and practical implementations for such features cannot be guaranteed.

Einar Fjellman:
FRR balancing must not be a matter only for experts. Whenever FRR balancing capacity is required, it is a consequence of an inadequate transmission network or/and inadequate electricity production resources. The cost of maintaining balance may be substantial and will eventually fall upon the subscriber. It is therefore important that the agreement contains a description of the factors that make necessary balancing operations and the nature of balancing. Such a description, easy to understand both by ordinary people, media and politicians, will encourage development towards a more secure and reliable electricity system.

TSOs:
We agree that it is important to communicate as simply and as clearly as possible. We also agree that non-experts should be able to understand the markets and that it is an advantage also to experts and TSOs if there is a good understanding outside of expert-circles.
We believe that the Explanatory Document is relatively easy to understand, and we are always willing to help if media and politicians search understanding of the market.

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Annex 2. Bid Types

Bid Type Combinations – Allowed Combinations

Case	Divisible	Block	Joint linked up-and-down	Exclusive	Description
0	No	No	No	No	(single bid) Indivisible non-block bid can span one or more hours (discontinuous interval is allowed). Each our is cleared sparately, i. e. the bid can be accepted or rejected separately hour by hour. The accepted quantity must be either equal to offered quantity or zero. The result can be different in each hour of the bid.
D	Yes	No	No	No	(single bid - varying quantity) Divisible non-block bid has the same rules as described in case 0 with the difference that it can be accepted in the range between minimum and offered quantity. The divisibility is expressed by the presence of the minimum quantity. The result can be different for each hour of the bid.
B	No	Yes	No	No	Indivisible block bid spans multiple consecutive hours (discontinuous interval is not allowed) with the same or different quantities per hour. In all hours, the bid must be either fully accepted or rejected.
DB	Yes	Yes	No	No	Divisible block (between minimum and offered quantity) bid spans multiple consecutive hours (discontinuous interval is not allowed) with the same or different quantities per hour. In all hours, the bid must be either accepted (between minimum and offered quantity) or rejected. I. e. it is not possible to accept the bid in one hour and reject it in another hour.
L	No	No	Yes	No	Joint linked up-and-down bids consist of two linked bids for different directions and the same price and hour(s). Both linked bids must have the same price and both must be either accepted or rejected; the offered quantity can be, however, different hour by hour. There are no links in time. The partial acceptance of the bid is not allowed.
DL	Yes	No	Yes	No	The same as case L with the exception that, for each hour, the bid can be accepted also partially (between minimum and offered quantity). Please note that it is possible to link together one divisible and one indivisible bid.
BL	No	Yes	Yes	No	The same as case L with the exception that both bids must be either fully accepted in all hours or fully rejected in all hours. It is not allowed to link one block and one non-block bid.
DBL	Yes	Yes	Yes	No	Combination of cases DL and BL: both bids must be either accepted in all hours or rejected in all hours but the accepted quantity can be between minimum and offered quantity.
E	No	No	No	Yes	Exclusive bids in the same group (they have the same exclusive group ID) are mutually exclusive for the same hour (block bids cannot be part of the exclusive bid group). The bid can be accepted in the given hour only if all other bids in the group are rejected.
DE	Yes	No	No	Yes	The same case as E with the difference that the bid can be accepted also partially (between minimum and offered quantity). Please note that the exclusive group can contain both divisible and indivisible bids.
LE	No	No	Yes	Yes	If joint linked up-and-down bid is part of the exclusive group (see case E), both coresponding linked bids must be part of the exclusive group and they both must be either accepted or rejected together, i. e. they are not considered as mutually exclusive. Both linked bids must have the same price.
DLE	Yes	No	Yes	Yes	This is the combination of the cases DE and LE: if the bid is accepted, the second linked bid must be also accepted and all other bids in the exclusive group must be rejected. In contrast to the case LE, the bid can be accepted also partially (between minimum and offered quantity).

Bid Type Combinations – Invalid Combinations

Case	Divisible	Block	Joint linked up-and-down	Exclusive	Description
BE	No	Yes	No	Yes	Block bid cannot be part of the exclusive group.
DBE	Yes	Yes	No	Yes	Block bid cannot be part of the exclusive group.
BLE	No	Yes	Yes	Yes	Block bid cannot be part of the exclusive group.
DBLE	Yes	Yes	Yes	Yes	Block bid cannot be part of the exclusive group

Bid Type Combinations – Invalid Combinations

Case	Divisible	Block	Joint linked up-and-down	Exclusive	Description
BE	No	Yes	No	Yes	Block bid cannot be part of the exclusive group.
DBE	Yes	Yes	No	Yes	Block bid cannot be part of the exclusive group.
BLE	No	Yes	Yes	Yes	Block bid cannot be part of the exclusive group.
DBLE	Yes	Yes	Yes	Yes	Block bid cannot be part of the exclusive group

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