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Impact of Recent Market Changes on the Nordic Balancing Market

Nordenergi is the collaboration between the Nordic energy associations Finnish Energy, Green Power Denmark, Renewables Norway, Samorka and Swedenergy.

Within a short period of time, several major changes to the Nordic energy markets have been implemented. This has caused a disruption in the market functioning, specifically in the balancing markets. In addition to the implementation of flow-based capacity calculation in the day ahead market there has been several changes in the Nordic balancing markets. Besides from 15 min ISP and the European standard mFRR product, the Nordic TSOs implemented ACE based balancing and a new, Nordic mFRR Energy Activation Market (mFRR EAM) across all Nordic countries – Denmark, Finland, Norway and Sweden. In addition, the Danish and Finnish TSOs have implemented a new design for the imbalance price, where both mFRR and aFRR can set the price.

These implementations are largely aligned with European regulation and the Central European approach to balancing the electricity grid. While intended to improve and future-proof the balancing of the Nordic power system, several unintended consequences and market inefficiencies have been observed. Some of the inefficiencies will be solved as market matures and the TSO's get more experience with the new market. Further, some of these inefficiencies will improve as the market participants increase their volumes, more market participants enter the market and more sophisticated bidding attributes are implemented. However, the number and severity of these consequences - and the risk they may become self-reinforcing - create a need for a market evaluation, followed by adjustments to mitigate the most critical issues.

We acknowledge that the TSOs are already taken some steps to improve the situation[1], and we welcome more dialogue and transparency in the continued work in ensuring a robust and well-functioning Nordic balancing market.

This memo summarizes the various market design changes, their combined consequences, and points to some of the main drivers of the observed market inefficiencies. Furthermore, it presents an idea catalogue of solutions aimed at addressing and mitigating the most critical market inefficiencies.

The description of the main drivers and solutions is based on publicly available information and may therefore be non-exhaustive. Additionally, quantifying the impact of each driver and solution depends largely on data only available to the TSOs. We therefore encourage the TSOs to continue to engage in dialogue with market participants to complete the overview of main drivers and solutions, and to identify the most suitable measures for implementation

[1] Updates and newsletter - Nordic Regional Coordination Centre, Stora prisvariationer under första tiden med ny balansering | Svenska kraftnät

Consequences of the implemented market changes

The many recent market implementations have brought substantial changes to the functioning of the Nordic balancing market. A significant portion of the issue arises from the implementation of flow-based market coupling (FB), which has been applied solely to the day-ahead (DA) timeframe, without corresponding integration into the intraday and balancing timeframes (ID/BT). This partial implementation has resulted in numerous locked cross-zonal flows and, at times, severely limited transmission capacity in the ID/BT timeframes. Consequently, cross-border electricity exchange becomes increasingly difficult, heightening the dependency on balancing resources within individual bidding zones.

Further, the introduction of the standard European mFRR product has reduced the volume of pre-qualified capacity, while start-up costs must now be recovered over fewer MWhs. Simultaneously, the implementation of ACE-based balancing and the mFRR Energy Activation Market (EAM) has increased the level of mFRR activations, including local ones.

This has contributed to changed operational patterns, higher mFRR activation prices, and consequently, an overall rise in balancing costs for the Nordic power system. Beyond the direct cost impact, the market is now facing growing uncertainty. Seemingly irregular and non-transparent activation- and pricing patterns have made it increasingly difficult for market participants to interpret market results. The lack of clarity not only increases risk but also affects the ability to make sound operational and investment decisions, ultimately reducing trust in the market.

Besides the consequences for the balancing time frame, there are also signs of negative effects on other markets. A NEMO has observed reduced liquidity on the Intraday market in the Nordics, which effectively reduces market participant's possibilities to trade themselves into balance. It has also been reported that current market conditions cause renewable generators to reduce output to limit financial exposure—an outcome clearly at odds with broader system and climate objectives[2].

So far, the above-described consequences have been considered temporary challenges characterizing a start-up phase. However, after more than two months operation, it seems clear that these consequences, and their magnitude, are not sustainable. The complex interplay between some of the recent market changes may even lead to self-sustaining or even self-reinforcing dynamics. It is therefore essential to build a shared understanding of market dynamics and to identify and implement mitigating measures, and here transparency is key.

For the remainder of this memo, the 15-minute ISP and the standard European mFRR product will be considered fixed framework conditions. Accordingly, the focus will be on the implications of Flow based only in the DA timeframe, ACE-based balancing, mFRR EAM, and the new imbalance price design in Denmark and Finland.

ACE-based balancing and mFRR EAM

The Nordic TSOs have historically had a strong collaboration when it comes to balancing the power system. The frequency-based approach to balancing, where the Nordics were balanced jointly, enabled extensive netting of imbalances, while the shared Nordic mFRR energy market facilitated socio-economic optimized use of the available balancing resources.

[2] Montel 11th of April 2025: Wind output curbed amid extreme balancing prices – consultant and Montel 14th of May 2025: Solivind: Obalanskostnader raderade ut halva intäkten i mars

The new ACE-based approach to balancing, similar to the approach used in Central Europe, effectively divides the Nordics into 12 areas being balanced individually. While this may be necessary to enable the TSOs to balance a power system increasingly based on renewables and smaller scale active market participants, it sets high requirements for the well-functioning of the markets supporting the balancing.

To support the new balancing approach, the Nordic TSOs implemented a new and automated Nordic mFRR EAM. The Nordic mFRR EAM is – as we understand it – a copy of the European MARI, since the Nordic TSOs re-use the MARI AOF.

Together, these two changes have led to a significant increase in mFRR activations. Now, practically all ISPs have a need for mFRR – expressed as a dominating direction for the imbalance. Previously, a large share of the ISPs, in DK more than 40%, had no identified need for mFRR activations[3]. Hence, in a Nordic context, the ACE-based balancing combined with the MARI AOF, leads to significant increase in mFRR activations. While additional mFRR activations—whether local or cross-border—can support improved system balancing, it raises the question of whether the associated cost is justified. From a socio-economic perspective, TSOs often view the relationship between mFRR compensation and the imbalance price as a zero-sum game, where increased costs for one party are offset by revenues for another. However, the level of increased activations has led to changed operational patterns of physical assets, influencing their underlying costs of delivering mFRR. At the same time, activation- and pricing patterns seem irregular, making it difficult for market participants to understand the market, which increases risk premiums. This suggests that the zero-sum assumption may not fully capture the broader impact from the two market changes.

The main drivers of the increase in mFRR activations seem to be the partial implementation of flow-based market coupling (FB), which has been applied solely to the day-ahead (DA) timeframe resulting in numerous locked cross-zonal flows heightening the dependency on balancing resources within individual bidding zones. In combination with the mFRR AOFs approach to socio-economic optimization and its aim to reduce any forecasted imbalance to zero, regardless of the circumstances. While these main drivers will apply across Europe, the consequences and magnitude may differ between regions. For regions with multiple smaller, well-connected bidding zones, like the Nordics, we suspect the consequences are likely more visible.

Below, we elaborate on the identified main drivers, which will later be addressed in the idea catalogue for solutions.

Reduced netting

Contrasting the previous Nordic approach, where imbalances were netted when cross-border capacity was available, in some cases eliminating the need for mFRR activations in a given ISP entirely. The mFRR AOF can lead to activations of mFRR in opposite directions, even if cross-border capacity is available. This seems to be a result of the AOF taking the mFRR bid prices in each bidding zone into consideration when performing the socio-economic optimization. As such, the AOF will activate bids in opposite directions if the mFRR price in the bidding zone requiring down-regulation is higher than the mFRR price in the bidding zone requiring upregulation.

Requested and activated mFRR

In addition to reduced netting, the AOF is designed to be perfectionistic, meaning it aims to reduce the imbalance to 0MW regardless of the circumstances. mFRR will be activated regardless of the size of the forecasted imbalance, while indivisible bids can be skipped in favor of a smaller more expensive bid,

[3] Energinet webinar 5th February 2025

and bids with opposite regulating directions can be activated simultaneously to counter the effect of an activated indivisible bid.

This increases mFRR activations and can lead to non-intuitive market outcomes, making it difficult for market participants to understand the activation- and pricing patterns in the market. Additionally, imbalance prices in individual ISPs can increase significantly, without being proportional with the value for the physical balancing of the power system. An example of this, is when the Danish bidding zone, DK2, had a forecasted imbalance of 1MW[4].This was sent as a mFRR request to the AOF resulting in an increase in the imbalance price of more than 350 €/MWh compared to a scenario where no mFRR would have been requested. Hence, a significant increase in imbalance price, caused by an mFRR request with little to no impact on the physical balance of the power system and which likely lies within the forecast error.

Local merit order lists

Prior to mFRR EAM, the Nordic TSOs shared all mFRR bids in a common merit order list. But with the current implementation of mFRR EAM, only Scheduled Activations (SA) can be performed cross border while Direct Activations (DA) are limited to local bids within each bidding zone. This significantly reduces the flexibility available to each TSO and reduces the overall efficiency of balancing the Nordic power system. Cheaper resources in neighboring bidding zones may be idle while more expensive, local resources are activated leading to unnecessary high balancing costs, increased market volatility, and higher imbalance prices.

Pricing errors

During the first months of the new mFRR EAM several pricing errors have occurred. The algorithm struggles to calculate the correct price under certain operational scenarios. Several ISPs per day are left with no price until the TSOs have done a manual check the following day. The ISPs, where the algorithm struggles to set the correct price, are identified using a threshold implemented by the TSOs. The error in the algorithm is likely to affect more ISPs, but the TSOs have evaluated that with the threshold majority of ISPs with incorrect prices are detected.

Besides the price errors caused by the design of the algorithm, some activation- and pricing errors have occurred due to incorrect data for interconnectors. In one case, the available capacity was set to 0MW effectively decoupling two neighboring bidding zones, limiting the TSOs' access to mFRR resources and causing a record low imbalance price of -10.000€/MWh. A few weeks later, the TSOs adjusted the imbalance price to -500€/MWh. In another case, a data error on an interconnector led to a wrong mFRR request of 1.800MW[5] causing all bids in a bidding zone to be activated and flow on the interconnector to be changed.

The situations caused by data errors on interconnectors do not occur often but have a large impact when they occur. Not only on the price, but also on the physical activation of mFRR. Contrary, situations caused by an error in the algorithm may have less impact per ISP but happen frequently. All these events and corrections made afterwards cause disturbances and reduce trust in the market.

Imbalance price design

Besides the root causes mentioned above, two specific changes to how the imbalance price is being set reinforces the consequences described.

[4] DK2 9th of April 18:30 DK time
[5] DK2 1st of April 13:00 DK time

Balancing needs caused by grid faults

Previously, mFRR regulations performed due to grid faults would not impact the imbalance price. With the implementation of mFRR EAM, this has changed and grid faults – both locally and in adjacent bidding zones – will impact the imbalance price.

An example of this, is when a grid fault in Norway caused an automatic safety trip of the interconnector between DK1 and NO2. The sudden reduced imports to DK1 caused the mFRR AOF to automatically activate large amounts of mFRR increasing the imbalance price in DK1 to ~4.800€/MWh[6]. Since the imbalance was handled by the AOF, the activated bids were price setting for the imbalance price.

While it's evident the TSOs have limited time to intervene in case of unforeseen grid faults, it is also evident that grid faults are beyond the control of the market participants. Letting balancing resources activated due grid faults set the imbalance price therefore distorts the price signals in the market and increase market participants' risk with limited ability to mitigate.

Danish and Finnish design for imbalance price

The Danish and Finnish TSOs have implemented a new design for the imbalance price. From being set entirely by the mFRR activation price, the imbalance price is now set by the highest/lowest of the mFRR price and the volume-weighted aFRR price.

While there's a regulatory requirement to include both mFRR and aFRR in the imbalance price, the chosen design creates unnecessary volatility while not reflecting the underlying cost of balancing the system. An example of this is when the Danish bidding zone, DK2, had a forecasted balancing need of ~60MW upregulation[7]. Only 0,09 MWh aFRR was used while majority of the imbalance was handled by mFRR. But due to the new pricing rule, aFRR was setting the price increasing the imbalance price with ~200€/MWh compared to the mFRR price. Similarly, the link between the size of the system imbalance – i.e. how stressed the system is - and the imbalance price has been weakened. Now, an ISP with a large imbalance can have a much lower imbalance price than an ISP with a small imbalance.

Besides not adequately reflecting the cost of balancing, the new design for the imbalance price entails a risk the TSOs will not be financially neutral in their balancing activities. The design may generate a surplus for TSOs, which would be the case in the example given above. To avoid distorting incentives, the TSOs should remain financially neutral to the outcome of the balancing process. This would include that TSOs should not be allowed to reallocate income obtained from the imbalance price mechanism to other tariffs.

Idea catalogue for solutions

Based on the above description of the main drivers of the observed market consequences, we've identified a range of mitigating solutions. The solutions have different impact on the root causes, but with the level of information publicly available it is not possible to quantify. This task remains with the TSOs as they have access to all required information.

The identified solutions have the overall objective to support well-functioning markets with meaningful price signals without compromising the TSOs ability to balancing the Nordic power system

[6] For context, the ISPs on both sides of the event had a need for downregulation and imbalance prices of ~40 and -9€/MWh and the highest upregulation imbalance price on the day was 260 €/MWh (excluding the ISP where the grid fault occurred).
[7] DK2: 10th april 21:00 DK time

Implement Flowbased in all markets

Introduction of flowbased marketcoupling in first the intraday auction (IDA) time frame then in the Intraday continues and balancing timeframes would reduce the dependency on balancing resources within individual bidding zones as more transmission capacity would be available. However, since implementing flow-based capacity calculation in one or more timeframes is likely to involve a long lead time, there is a need for an intermediate solution in the meantime. Such a solution would also remain relevant even if flow-based is introduced in IDAs, as these are executed several hours ahead of the delivery period and therefore cannot take advantage of the most up-to-date forecasts.

One possible solution could be to introduce a new operational TSO process where, some hours before delivery, the anticipated operational situation and power flows for the relevant delivery period are reviewed. This would allow for a risk-weighted evaluation of the planned flows versus the ATCs and could help determine whether additional physically available capacity might be released to the intraday market and/or the balancing market/AOF, depending on when updated capacities can be made available. Such a process could in some ways mirror the earlier, risk-based decision-making approach where TSO operators manually assessed which mFRR bids to activate and how to best use import/export capacity to net imbalances.

Netting when cross-border capacity is available

Netting when cross-border capacity is available will reduce the level of mFRR activations leading to more consistent market outcomes and reduced volatility. The overall costs of balancing the system should also be reduced when fewer flexibility resources are activated.

Netting could also be used to a greater extent if TSOs continuously made an analysis of the flow prognosis before every ISP. This could then be compared to what ATCE already is available to the market. Then there could be a risk assessment of overloading CNEs if allowing a greater flow. This extra capacity could then be released to either ID or to the balancing timeframe. This method has been used by TSOs to support the system when lager imbalances have occurred, therefore it would be preferred if this was implemented into the balancing process. Allowing for more cross-border capacity to make more cross-border netting possible.

There is a need for more transparency regarding the current implementation. An evaluation on whether the new functionality with less netting between price areas leads to a higher socio-economic surplus is needed. In several instances it seems like a price area with lower DA price gets much higher up regulation price than a neighboring area with higher DA price.

Implementation of deadband

To mitigate situations where minimal mFRR requests have an extreme impact on the imbalance price, a deadband on the mFRR requests can be introduced. The mFRR requests are based on forecasts which inherently have statistical uncertainty, i.e. TSOs may request too little or too much mFRR from the AOF. Implementing a deadband would allow the AOF to disregard mFRR requests below a certain threshold. The size of the deadband could be based on statistical uncertainty, which would limit the deadbands' influence on the quality of the TSOs balancing actions. Such an approach will be adopted by Energinet who will implement a deadband of 25MW

Extended use of a tolerance band

To reduce the number of skipped bids, a tolerance band can be implemented. Such a tolerance band would allow the AOF to activate mFRR beyond the requested volume to reduce the number of skipped bids and counter-activations aimed at managing the same imbalance.

Such a tolerance band, allowing for "over-activation" of up to 10MW, is already implemented in the Nordic mFRR EAM as part of a pilot. This allows the AOF to activate an indivisible bid that would otherwise have been skipped or avoid activation of counteracting bids to manage the same imbalance.

The use of a tolerance band can be extended by making it symmetric so also "under-activation" is possible. From a system balancing perspective, a symmetric tolerance band would not result in different operational situations for the TSOs compared to the current asymmetric band. There should therefore be no barriers to implementing symmetry. As a next step, the size of the tolerance band and its influence on the system balance should be assessed to evaluate if it can be increased from the current 10MW.

Enable cross-border Direct Activations

The local handling of imbalances contributes to increased cost of balancing and market volatility, as the size of the Nordic bidding zones imposes a natural limitation on the amount of locally available flexible resources. Enabling cross-border Direct Activations (DA) through a shared merit order list will increase the TSOs' access to flexible resources, which will have a positive effect on system security, reduce overall cost of balancing the Nordic power system, and support greater market stability.

Ensure correct prices and publication of prices for all ISPs

The errors leading to incorrect mFRR activations- and prices must be corrected as soon as possible. Guidelines and descriptions of control mechanisms for this should be publicly available to ensure transparency. In the meantime, the incorrect prices calculated by the algorithm should be published and marked as "temporary" or similar until the manual check has been performed and the prices can be marked as final. This will increase market transparency, and support market participants to better understand the market.

Remove grid faults' impact on the imbalance price

Since grid faults are outside the span of control for market participants, they ought not to be price-setting.

A general rule stating that activations due to grid faults cannot set the imbalance price would enhance market transparency and remove an unnecessary risk for market participants. Such a solution is preferred even if it requires adjustment of the imbalance price after the event has occurred.

We believe the suggested solution is mandated in the Electricity Balancing Guideline article 30,1(b) and therefore see no regulatory obstacles.

Reevaluate the Danish and Finnish design for the imbalance price

The European Balancing Guideline allows for three different designs of the imbalance price: a max/min approach, an average approach, and a combination of the two. In Denmark and Finland, the latter has been implemented.

Implementing an average approach instead, is likely to better reflect the cost of balancing the system and ensure financial neutrality of the TSOs. It is therefore important that the TSOs take steps to assess

the practical implications of the current design compared to an average-based model, drawing on data from the initial period of operation under the new imbalance price regime

Also, the method for determining the dominating direction should be evaluated as it seems the Danish and Finnish design diverge on this topic. It should therefore be clarified why they diverge and what consequences it has for the imbalance price in the two countries.

Assessment of whether TSOs are securing an appropriate volume of capacity in the mFRR Capacity Market (CM)

An increase in procurement within the mFRR CM would also enhance liquidity in the mFRR Energy Activation Market (EAM). While this could come at the expense of liquidity in the Day-Ahead (DA) and Intraday (ID) markets—potentially affecting prices—it may lead to a more accurate DA price signal. In any case, we believe this is an issue TSOs should carefully consider.

Enhancing flexibility and participation in the mFRR Energy Activation Market

It is important that market participants strive to offer as much of their flexibility as possible into the mFRR Energy Activation Market (EAM). This applies both to down-regulation and up-regulation. To enable this, participants must prepare and prequalify more volume and additional resources. At the same time, TSOs must evaluate whether the current participation requirements are appropriate. Furthermore, TSOs must ensure that the prequalification process and the approval of new resources are not delayed any more than necessary.

Questions have also been raised whether the technical requirements for heartbeat communication are sufficient for balancing service providers. There are indications that there have been incidents where problems with the heartbeat communication have led to the loss of multiple bids from the market. There should be a thorough evaluation by the TSOs into this issue.

Increase market transparency

Besides publishing all prices calculated by the mFRR EAM algorithm, more publication of market information to increase transparency on the energy activation markets is strongly recommended and should be initiated. This will also reduce the risk of insider trading.

Further, it should be examined whether it's possible to increase transparency around market depth and if the mFRR AOF is not strictly following the merit order but skipping bids to activate more expensive ones. There may be several reasons for the AOF deviating from the merit order, and thus various opportunities to improve transparency. Finland could serve as an example, where more real-time information is published e.g. forecasted imbalance and mFRR exchanges with neighboring bidding zones. Denmark's experience with real-time publication of imbalances with high resolution can also be beneficial in these assessments.

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