NBM
Nordic Balancing Model

SVENSKA KRAFTNÄT ENERGINET FINGRID Statnett

Disclaimer: This report has been prepared mainly for TSOs' internal purposes to support decision making. Thus any views or positions directly or indirectly expressed in the text shall not be regarded as official views or opinions of the Nordic TSOs. The document is published "as is", with no guarantee of completeness, accuracy, timeliness or of the results obtained from the use of this information.

Analysing different alternatives for single pricing model implementation timeline

Final report

Version 1.0 10.9.2019

Project team members

Mats Elmer	Svenska kraftnät
Pär Lyden	Svenska kraftnät
Mikael Kröckel	Svenska kraftnät
Henning Parbo	Energinet
Mikko Heikkilä	Fingrid
Eveliina Seppälä	Fingrid
Finn Pettersen	Statnett
Per Otto Garsjo	Fifty
Anders Naville Gisnås	Fifty

NBM
Nordic Balancing Model

Content

1 Introduction

The roadmap for NBM program was updated during April-May 2019. The roadmap proposes to delay implementation of 15 min ISP at least until Q4/2022. NBM roadmap was on stakeholder consultation during the summer 2019. The consultation ended on 19.8. A firm roadmap, including implementation deadlines, will be prepared and agreed in autumn 2019.

During the update process of the NBM roadmap, the question of implementation timing of single price – single balance imbalance model (referred as "single price model" in this document) was raised. Previously the Nordic TSOs had planned to implement 15 min ISP and single price model on a same date (Q4/2020). However, when implementation of 15 min ISP was postponed two years, until Q4/2022, this plan needs to be reconsidered.

The purpose of this report is to:

- List and analyse the key concerns and risks for the implementation of the single price model prior to the go-live of the 15 minutes time resolution
- Propose a set of measures and actions that could be used to mitigate identified concerns and risks.
- Identify and describe the set of conditions that must be fulfilled in order to implement single price model in the Nordic countries in line with EBGL timeline and prior to the go-live of the 15 minutes time resolution
- Create a draft roadmap to illustrate in timeline the introduction of the single price model into the Nordic countries

This report focuses on the single pricing topic but besides that there is many other complex issues demanding Nordic decision for the imbalance settlement design. The Annex 2 provides list of other design questions.

1.1 Legal background

According to the Electricity Balancing Guideline (EBGL) requirement, all European TSOs have submitted, in the turn of the year 2018 – 2019, a proposal to specify and harmonise imbalance settlement. After approval of all relevant regulatory authorities, it will become a binding requirement for TSOs to implement imbalance settlement according to the rules set in the all TSOs proposal.

The EBGL sets a deadline for the implementation of the all TSOs proposal to be 18 months after the regulatory approval. The NRAs gave in August a request for amendments to the proposals, this means that the deadline for TSOs to implement the proposal will be June 2021[1].

In the EBGL there is no link between harmonizing the imbalance settlement period to 15 minutes and harmonizing other features of the imbalance settlement. However, in the request for amendments delivered in August the NRAs have asked all TSOs to include a condition to the proposal which gives a possibility to apply dual pricing until 15 min ISP is implemented. However, even there is expected to be a possibility to apply dual pricing until the 15 min ISP is implemented, there is no similar possibility given in the proposal to delay the implementation of single position. In case TSO wants to continue with dual position after the deadline to implement the proposal, TSO has to apply derogation from the Article 54 of the EBGL, which covers the calculation of position.

As a conclusion it is not possible to continue with the current Nordic imbalance settlement scheme after June 2021 unless Nordic NRAs grant a derogation for the dual position.

1.2 General view on two different timing options for single price model implementation

As described earlier, there's two timing options for single price model: default option is to implement single price model as required by EBGL (by June 2021). The other option is to postpone implementation until simultaneous implementation of 15 min imbalance settlement period (Q4 2022). The time period in between the options is approximately 1,5 years.

The main advantages with separation of the plans are related to the early realisation of presumed market efficiency gains, including harmonised and level playing field for BRPs (in terms of portfolio composition and geography), incentives for market participants to restore the system balance and benefit from, as well as influence the real-time value of energy.

The main drawback is TSO operational concerns in some geographical areas and operational situations. Real-time information feedback loop on system balance state combined with single imbalance pricing may cause power oscillations in system balance, thus negatively impact on operational security on those ISPs. The power oscillation may either occur when the self-regulation response overcompensates for the system imbalance or when the imbalance price incentives are misaligned with TSO real-time and geographical need of balancing energy. This could in turn trigger an opposite self-regulation response. A 60 min ISP combined with single pricing opens a relatively long time window for self-regulation actions which may strengthen these effects.

On the other hand, alignment of the plans would conversely imply that mentioned market efficiency gains are postponed one and a half year, but

[1] The deadline date is June 2021, in case there is no second amendment from the NRAs and in case that there is no referral to the ACER.

the TSO operational risks can be mitigated differently in a15 min ISP context.

1.3 Stakeholder feedback in the NBM roadmap consultation

NBM roadmap was on stakeholder consultation during the summer 2019. The consultation ended on 19.8.

Quick implementation of the single price model is generally supported by the stakeholders. It is stated that single price model will create only small adjustments for the stakeholders so it can be implemented early in the roadmap. Therefore stakeholders' preference is that implementation is completed in accordance with EBGL (Q2/2021) and simultaneously in all Nordic countries.

Respondents are widely in the opinion that a single price model should not be implemented same time with 15 min ISP as the preference is to implement one thing at a time. That supports the other views of the quick implementation timeline.

There is also an interest to understand better the TSOs operational concerns and possible operational situations which are referred in the roadmap, in case these are used as arguments to delay the implementation of single price model.

2 Practical implementation in TSOs' systems and eSett

Implementation of single price model on TSO side can be split as follows:

- Implementation in TSOs' local IT systems
- Implementation in the common Nordic imbalance settlement, eSett.
- Update of national terms & conditions
- Implementation of the new imbalance fee structure

Implementation effort of single price model in TSOs' local systems is estimated to be relatively small. Typically each TSO needs to make small changes to the balancing market system (for example in Fingrid's local system currently market players need to identify if mFRR bid is considered to be part of consumption or production balance) and balancing/ancillary services market back office system. *Required calendar time for these changes is estimated to be 3-6 months.*

Main implementation of single price model needs to be done to the common Nordic imbalance settlement, eSett. Together with the IT vendor, eSett has estimated about 12 months implementation time. As today (June 2019), eSett has already started preparation for the change. The planned IT implementation allows two main options 1) implementation of single price model before 15 min ISP, or 2) implementation of single price model and 15 min ISP together at the same time.

In addition to IT system changes, each TSO needs to update national terms and conditions for BRPs and BSPs. Estimated changes are minor, but public consultation and NRA approval of the changes might take some time. *Required calendar time for the changes, including NRA approval, is 6-9 months*.

The change to the single price model also makes a change to the TSOs cashflow, as the dual pricing for production balance has created surplus for TSO. With single price model, this will change. As the cashflow will change, it is expected, that the surplus which was collected from the production before through the dual pricing system need to be collected through the imbalance fee structure. This means that before implementing the single price model, TSO need to reconsider and potentially revise the current fee structure.

For consumption, which is settled with single price today, there also exist an imbalance fee. The level varies in the Nordic countries. For a future single pricing settlement, it must be considered whether this imbalance fee shall continue and also be used for production. It can provide some of the same incentives as dual pricing does for production today, but it is a question whether it can be interpreted to be in line with EBGL. If it should continue to be applied, it is also a question if the Nordic TSOs should harmonize the level of this fee.

The choice between the two different implementation timelines, either before or at the same time with the 15 min ISP implementation has an effect on the timing of the above mentioned practices. The required issues above need to be prepared before the implementation of single pricing model. The earlier the single imbalance pricing model is implemented, the earlier TSOs need to implement the above mentioned issues.

3 The effect of the imbalance price incentives for balancing responsible parties

The imbalance pricing is a design variable, which can be used to control BRP behavior. The choice for imbalance pricing mechanism determines the strength of the incentive.

The dependencies between the BRP’s imbalance, system’s imbalance, balancing energy demand, balancing energy price and the imbalance prices can be in simplified manner be described with the feedback loop illustrated in figure 1.

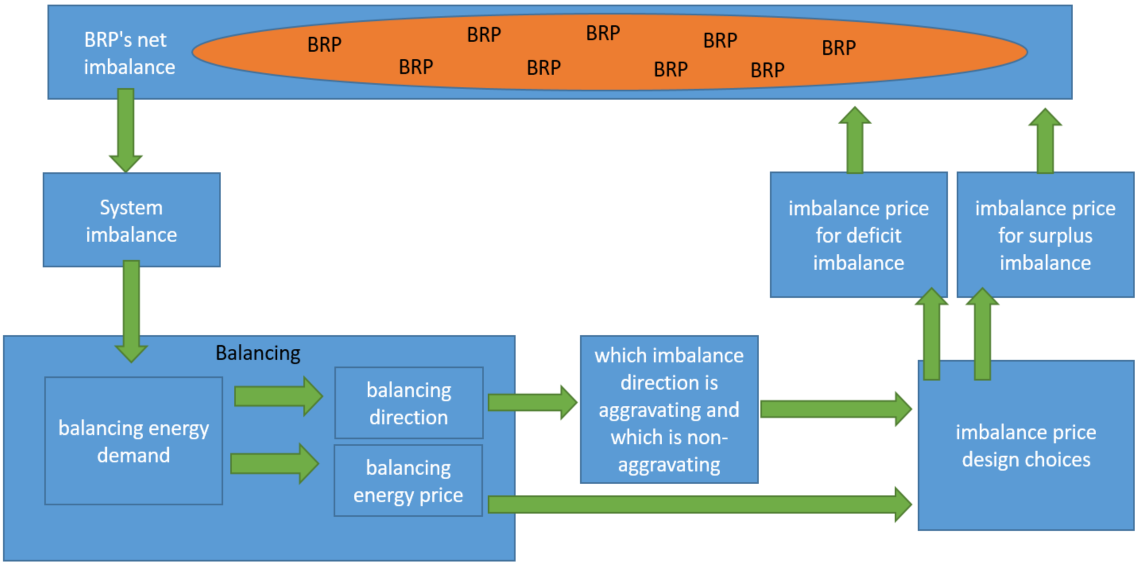

Figure 1 The imbalance price as a control mechanism in the feedback loop

Figure 1 describes the ideal feedback loop, where the BRPs' net imbalance do create the imbalance in the system. This again serves as an input for the balancing energy demand, and activation of balancing energy bids to satisfy the demand again sets the direction and price for balancing energy. Balancing energy direction and price serve as an input to the imbalance price design: balancing directions determine which BRP's imbalance direction (deficit/surplus) is aggravating and which is non-aggravating and the balancing energy price normally serves as a main input to the imbalance price formation.

With the imbalance pricing design choices also the choice between single and dual pricing is done. With the single pricing, the prices for both, deficit and surplus would be equal, when again with the dual pricing, these prices would be different. Depending on the imbalance pricing rules, the price signals serve as an input to the BRP's behavior, which again can have an effect on the net imbalance of the system.

3.1 The differences between the dual and single imbalance pricing

The choice for the imbalance pricing mechanism between the single and dual pricing is dependent on how the BRP behavior is wanted to be affected. The single pricing can be designed such that the imbalance price incentivizes the BRP to reduce aggravating imbalance as having imbalance to the direction that is supporting the system balance can be beneficial to BRP. The aggravating and supporting imbalance direction is dependent on the real-time situation and thus with single pricing BRP is incentivized actively follow the price signals.

The incentive a single imbalance price create for BRPs to support the system balance can in practice be limited as the price is determined after the operational hour and the BRPs doesn't get accurate signals real-time of what actions that are positive for the system balance. Too much self-regulation is also a risk as discussed in chapter 5. However, beside this incentive mechanism the single imbalance price can be claimed to better reflect the actual costs that the imbalance of a BRP actual lead to. In this context it should be noted that the imbalance price level is sensitive for the market structure and the overall functioning of the market, at least in a long term perspective.

Dual pricing means, that the price for deficit and price for surplus differ. There is variety how this pricing method can be used. The current way used is to use the same price as would be used with single pricing to the aggravating imbalance and BRP is assumed to avoid the aggravating imbalance. For the non-aggravating imbalance the price is designed such, that it is not attractive to create imbalance to the supporting direction. This can be done either with neutral way, by using price for supporting imbalance, which is not bringing any significant benefit but also not causing any significantly negative financial consequences, or the price can be also designed to bring a stronger incentive to BRP to avoid also the imbalances in the supporting direction. So dual pricing fits better for the philosophy, where single BRP is wanted in all cases to strive towards the balance, thus it for BRP it is enough just to follow actively its own imbalance, and there is no extra benefit to follow actively the overall balance situation, as there is anyway only the “punishment” or in best case the neutral outcome waiting.

So dual pricing can be used to create incentives, which will encourage BRP to keep it’s own balance, when single pricing does incentivize to reduce the imbalance that is aggravating and create the imbalance for the direction that supports the system. With single pricing the BRPs can be described to taking more actively part to the TSO balancing.

3.2 Current Nordic imbalance pricing and expected changes in future

The above description of dual and singe pricing does not separate whether the imbalance is due the consumption or production. In Nordics there is currently separation of these two. The imbalance is calculated separately for the consumption and production, and the imbalances for the production are dealt with the dual-pricing mechanism, as the consumption imbalance is dealt with the single pricing mechanism.

By the feedback-loop model, for the consumption side BRP is incentivized to avoid aggravating imbalance and get benefits from imbalance that is supporting the system. For the production side dual pricing incentives also to avoid aggravating imbalance, but there is no incentive for BRP to provide supporting imbalance energy.

It should however be noted, that currently the imbalance prices are not published in the real time, and thus the BRPs cannot follow the real-time situation and thus the feedback-loop model is not fully exploited. It should also be noted, that the BRP can have both, production and consumption in its' portfolio, and for those BRPs having both, consumption and production the final net financial consequence comes from the net results taking into account both, the production and consumption.

As currently in the Nordics the dual pricing is applied only for the production imbalance and the production imbalance is calculated as the difference between the production plans and the actual production, the current system can be seen as a tool, which incentives BRP not to diverge from their production plans, not even when it would be beneficial for the system balance.

In future the imbalance pricing will change in Nordics due the European harmonization such, that there will not be separate imbalance calculation for production and consumption. Instead there will be calculated only one imbalance per BRP, which will net the consumption and production imbalances. For this single imbalance volume, the applied pricing model will in future be the single pricing. This will provide the TSOs a possibility to exploit the above described feedback-loop with the same price incentives given to the production and consumption.

Depending on the TSOs balancing philosophy, the single-pricing model with the visibility to the prices can have positive effects, in case the imbalance prices can strive the BRPs to the direction, which supports the TSO balancing practices. However, the model can also have negative effects, which are considered more in detail in Chapter 5.

4 Nordic balancing approach

With the development of the Nordic balancing model, the approach to balancing will change in several ways over the next years. The changes will involve taking part in the European integration of balancing markets, developing new IT tools and define responsibilities of the Nordic TSOs that enable more efficient system operation and efficient utilization of new balancing products to maintain operational security.

However the complete change to new balancing approaches will not happen before implementation of 15 min ISP. Thus the options for the single imbalance price model is either before or at the same time with the 15 min ISP implementation, the single price model will be implemented before the NBM market reform is fully implemented.

The Nordic approach is currently based on TSOs being in control of the balancing after the intraday gate closure. The BRPs are expected to balance their portfolios before operational hour by trading in the day-ahead market, in the intraday market and by bilateral trade between BRPs within bidding zones. Gate closure for intraday trading is 1 hour before operational hour, expect in Finland, where the gate closure time is 30 min.

Even if the current imbalance settlement would change from current Nordic pricing scheme to single pricing, if BRP's doesn't have visibility to the prices, it is not expected, that BRP's behavior will have an effect on balancing.

5 Key concerns for the implementation of the single price model prior the go-live of the 15 min time resolution

5.1 Too strong self-balancing behavior

Real-time price information feedback loop on system balance state combined with single imbalance pricing generates incentives for self-regulation which in its extension may trigger oscillations in system balance which in turn impact negatively on the efficiency of the system operator balancing actions and consequently on operational security.

There are in principle three cases where the self-regulation incentives may be counter-productive for system operation:

1. In case of too strong self-regulation response which overcompensates for the initial system imbalance which in turn triggers an opposite self-regulation response.

2. In case the incentive for self-regulation is global and generates cross-border flows that overloads the remaining available transmission capacities, which in turn trigger bid activations to handle both system imbalance and bottlenecks and/or generates market splits.

3. In case the imbalance price do not reflect local congestions inside a bidding zone, strong self-regulation behavior may be counterproductive and trigger re-dispatch actions.

The Nordic TSOs consider the second case to be the most demanding in the Nordic synchronous system. The system is formed by eleven relatively small bidding zones with transmission grid limitations (bottlenecks) in-between. In situations where there are available transmission capacity, the system operator will activate the first (cheapest) bid in the regulation power market bid list, which not necessarily are located in the same bidding zone as the source of the system imbalance. If the bid activation then triggers system global incentives for self-regulation, it is vital that this response is proportional to the remainder of available transmission capacity and/or to the size of the initial imbalance.

The problem of global incentive for self-regulation can be mitigated by making pricing rules that reflect better the local bidding zone imbalances. If the global incentive is mitigated by the pricing design (Annex 2), the problem is more as described in case 1.

A 60 min ISP combined with single pricing opens a relatively long time window for self-regulation actions which may strengthen these effects. Shorter, 15 min ISP should mitigate potentially too strong self-regulation behavior as the price signal will be more precise in time.

The power oscillation may either occur when the self-regulation response overcompensates for the system imbalance or when the imbalance price incentives are misaligned with TSO real time and geographical need of balancing energy. This could in turn trigger an opposite self-regulation response.

A proportional response can only be assured in case a number of information data is taken into account. This info cannot be conveyed to the market players and will not necessarily be aligned with the financial incentives.

Illustrative example of inefficient self-regulation response:

1. Negative ACE_{OL} in SE4 causing low system frequency
2. Available transmission capacity permits activation of the first bid in the Nordic RPM bid list which is located in SE1 (frequency is restored)
3. The bid activation generates publication a positive imbalance price (and a negative system balance)
4. The positive imbalance price triggers self-regulation (in proportion to the published price) in all bidding zones. (frequency is rising above 50 Hz)
5. The cross border capacity between SE2 and SE3 are overloaded (measured flow is larger than NTC) as a result of the self-regulation in SE1 and SE2 on top of the activated bid.
6. The up-regulation bid in SE1 is deactivated.
7. The deactivation of the bid will however not result in deactivation of production, the previously activated bid is now to be considered as self-regulation (positive BRP imbalance), thus remunerated with the imbalance price (currently positive and determined by the activated bid)
8. The first downregulation bid located north of SE2-SE3 is activated. The activation will reduce system frequency but not impact on the imbalance price since the net balancing energy is still positive.
9. The second down regulation bid is activated which results in net balancing energy equal to zero. The imbalance price is set to the reference price (currently spot price).
10. The activation of the second down regulation bid results in a reduction of self-regulated power and relieves the cross border capacity between SE2 and SE3. The net system balance however is still positive which keeps the frequency above 50 Hz.
11. A third down regulation bid is activated. The net activated balancing energy is now negative which results a negative system balance and publication of the related imbalance price
12. This causes incentives for negative self-regulation, frequency drops below 50 Hz.

5.1.1 Possible delay between the price signal and real-time situations

The previously mentioned, the operational concerns related to self-regulation are strengthened if single pricing is combined with long (i.e. 60 min) ISP. This issue is elaborated below.

The imbalance settlement process shall among other general principles (EBGL, article 44) be designed to; establish adequate economic signals which reflect the imbalance situation, ensure that imbalances are settled at a price that reflects the real time value of energy, provide incentives to balance responsible parties to be in balance or help the system to restore its balance and avoid distorting incentives to balance responsible parties, balancing service providers and TSOs.

Single pricing incentivizes the BRP to self-regulate to support system balance while the dual pricing incentivizes the BRP to keep balanced positions. The different pricing schemes will consequently trigger different BRP behavior and are therefore closely linked to the precondition for system operation and the possibilities for the TSO to ensure efficient balancing.

The achievement of the EBGL general principles will require different design depending on the ISP length since the desired BRP behavior (from a TSO perspective) should support the momentary system power balance. When applying a long ISP, the BRP is economically incentivized to act on their energy balance over one hour. Since an energy balance over a longer time period has a relatively weak link to the physical power balance (the TSO concern), the EBGL general principles are more correctly achieved by a settlement design that incentivizes the BRP to keep their position – "be in balance". It is in these cases the dual pricing scheme should be used.

However, in a situation when the ISP length is significantly reduced, the link between the BRP target based on an energy balance over the ISP and the TSO target to physically balance the system will be strengthened. A brief analysis of the extremes could serve as an illustration; With an ISP of 24 hours, the BRP financial incentive would be completely delinked from the TSO physical responsibility. With a one minute ISP, the link would be very strong.

In addition, the ISP length will determine the magnitude of self-regulation simply because it impacts on the feed-back loop and the time to respond. A single imbalance pricing scheme are generally beneficial and supports system operation when the triggered BRP self-regulation is moderate and the incentive is confined in a short imbalance settlement period. A too strong BRP response reinforced by a long valid response time (long ISP) results in balancing energy oscillations which will impact negatively on system operation and/or create economical inefficiencies. In congested grids the consequences for system operation may be even more inefficient since the BRP response is based on the system balancing state which neglects bottlenecks. Hence any change in imbalance pricing schemes must be carefully assessed before being implemented.

The implementation of 15-minute imbalance settlement period and the introduction of a single imbalance pricing scheme and the implications for system operation should therefore be carefully assessed before the implementation plans are delinked. As discussed, separate implementation may also be in conflict with the EBGL general objective with the imbalance settlement, which is to ensure that balance responsible parties support the system's balance in an efficient way.

5.2 Production plans quality

The production plan is a schedule with hourly or quarterly resolution that BRPs send to the TSOs to notify the TSO about expected production. The production plans are important input to the TSOs in the balancing and together with their own production and consumption forecast they determine the actions carried out by the TSO to maintain operational security.

These actions involve regulations by activating balancing energy bids, but also adjustment of the production plans itself, which is useful for managing structural imbalances caused by the mismatch between production and consumption changes within the hour:

Quarterly adjustments of hourly production plans. This is a requirement applied by the TSOs in Finland, Sweden and Norway on the BRP when the hourly production plan changes more than 200 MW at hour shift to reschedule their plan with quarterly steps 15 minutes before hour shift, at hour shift and 15 minutes after hour shift in order to adjust the plans to better correspond to the consumption pattern.

Smoothing of hourly production plans. In Norway a voluntary alternative to the requirement above, "Smoothing", is implemented. The system service allows the TSO to reschedule hourly production plans D-1 into production plans with quarterly steps. In the smoothing process, Statnett level out hourly plans in quarterly steps based on known information at the time to reduce deterministic imbalances per quarter.

Production shift schedules is a system service used after intraday gate closure that allows the TSO to reschedule the changes in the production plans to better correspond to the consumption pattern.

The key concern is, that when there is no financial incentive for production plans, the quality of the production plans will reduced. The current 2-price system in production balance incentivizes BRPs to inform the TSO about planned production – through the production plans – and to follow the planned production to the best of their ability. BRPs that deviate from the production schedule provided to the TSO will at best be cost/revenue neutral compared to Day-Ahead market, but risk and additional cost. This incentive scheme will change not only due to the implementation of a single price model, but also due to the implementation of the single position.

6 Mitigation measures

6.1 Dual pricing during the ISPs with balancing actions in two directions

In some power systems where single pricing is otherwise used (for example in the Dutch power system), dual pricing is used on specific ISPs when TSO requests both up- and down regulations. This means that BRPs are incentivized not to perform self-regulation during the ISPs when dual pricing is used.

Usage of dual pricing should mitigate self-regulation behavior of BRPs which could be harmful for the system balance.

This mitigation measure is more related to the single pricing in general, and not that directly on the question of the implementation timeline.

6.2 Limiting the real-time information

As previously described in chapter 3, the availability of real-time information on system balance is a central part of the self-regulation feedback loop. Without (close to) real-time information, the BRPs will not be able to take actions to appropriately support the system. Real-time information on system balance can obviously be extracted either implicitly from either the activation of bids in the regulation power market or from any source of explicit publication. The former is however only available for the BRPs that are active participants (are activated) in the balancing markets. The latter alternative has the advantage of real-time accuracy, transparency for all market players and will therefore more efficiently support a level playing field when the single price model is implemented. EBGL, article 12.3 states that:

Each TSO shall publish the following information as soon as it becomes available:
(a) information on the current system balance of its scheduling area or scheduling areas, as soon as possible but no later than 30 minutes after real-time;[…]

According to the EBGL, the TSOs should strive to publish data in real time (as soon as possible), but have a legal time window of 30 minutes. There will most probably be some delay of data publication related strictly to the process of data publication. But there is a significant impact on the self-regulation feed-back loop if the data is published 1 min or 30 min after real-time.

A 30 min delay would most probably heavily limit the possibility to take informed decisions on self-regulation, also in a 60 min ISP context, and could therefore be used in an interim phase to limit the self-regulation before the 15 min ISP is implemented.

Delay publication of real-time information on system balancing state may also be used in combination or as an alternative mitigation measure.

6.3 Contracts for production plans

With the single position model the BRP will be indifferent to whether the imbalance is on the consumption portfolio or production portfolio, since there'll be no financial difference between the two portfolios. Hence, the BRP no longer has a financial incentive to optimize the quality of the production plans provided to the TSO. The quality of the production plans would therefore be incentivized either through requirements in the BRP national terms and conditions or through the BRP's internal use of the same production plans. The national terms and conditions may differ between the countries and the internal use of production plans may differ among the BRPs. It is therefore uncertain how this change will influence the collective quality of the production plans.

There exist different practices in the Nordics for monitoring and following up the BRPs performance related to the plans submitted one hour before operational hour.

In Norway, according to the regulation on system operation, the BRPs are obliged to follow the production plans submitted before the operational hour. Systematic deviations are monitored and the performance of different companies are made public in monthly. The sanctions are, however, limited. In theory, companies with unreasonable systematic imbalances can be excluded from the markets, however, this has historically not happened due to imbalances alone, but it is probably a disciplining factor that a public letter with copy to NVE stating that the company is not compliant with the regulation.

7 Conclusions: Pros & Cons of the options

This section concludes the pros and cons of the two implementation options, including the risks of the options.

7.1 Implementation before 15 min ISP

This option means, that the change to the single balance (position) and single imbalance pricing would be implemented in the imbalance settlement following the default deadline set by the EBGL, which is before the planned 15 min ISP implementation.

Choosing this alternative would **meet the stakeholder expectations** as expressed in the Roadmap consultation. The early implementation would also be a **positive signal for the stakeholders regarding the NBM project** to show, that not all of the implementation plans are postponed. The **step-wise implementation** would also mitigate the risks that may occur, when many big projects (such as 15 min ISP) are implemented at the same time.

Also in a case, if the 15 min ISP would be implemented **following the EBGL timelin**e, there would be **no need for the NRA discussions and for the derogation process**, this would also **save TSO resources** for entering to the NRA discussions. However, also the resources needed for detailing imbalance pricing rules and service fees needs to be considered, in this option these resources are needed earlier

However, these positive effects described above need to be weighed against the concerns regarding the **operational risks** due the combination of 60 min ISP and possible too strong self-regulation behavior of the BRPs, as the 60 minutes ISP may lead to the distortive price signals, there is a detailed explanation about these concern in chapter 5. Also the **financial incentive** from the dual pricing for **the production plans would be lost earlier**.

When doing the weighing, it should be taken into account that **the self-regulation behavior can be mitigated by limiting the real-time information** of the prices. Also for the production plans it should be considered if the **production plans can be guaranteed by the formal requirements and/or fee structure for the imbalance settlement** (independently from the imbalance price).

7.2 Implementation together with 15 min

The implementation together with the 15 min ISP would mean, that the current imbalance settlement model would be continuing until the implementation of the 15 min ISP. So there is not actual "pros" for this choice when comparing to current situation, instead the positive effects of continuing with the current system shall be understood as **avoiding the considered negative effects for operations** resulting from another alternative. Implementing the single pricing model together with the 15 min ISP would provide the more accurate pricing signals reflecting the 15 min instead of 60 min.

So by this alternative, the **operational risks are considered to be lower**. With this option it should however be taken into account, that in this case there is **risks related to the stakeholder and NRA acceptance**. Stakeholders would be **disappointed with this alternative**, as by the Roadmap consultation they expect the early implementation. This option also **needs the NRA process for derogation (see section 7.1)**, and the **TSOs are dependable on favorable NRA decision**.

7.3 Summary of pros, cons and the identified risks

In the end, the question is doing the comparison between the two options, and the different pros and cons should be weighed against each other. The pros, cons and identified risks are summarized in the following two tables.

NBM
Nordic Balancing Model

Pros	Cons	Risks
Meets the stakeholder expectations and potentially creates good-will for NBM program	Operational concerns regarding 60 min ISP and self-regulation	Operational risks are considered higher in this option: may be mitigated by limiting real-time information and application of dual pricing on certain ISPs
Enables step-wise implementation (mitigation of implementation risks when changing to 15 min ISP)	Financial incentive (of dual-pricing system) for production plans is lost earlier (from a TSO cash flow perspective, the BRP fee structure may be adjusted accordingly)	
No derogation process with the NRAs is needed		
Nordic TSOs as forerunners in European Imbalance settlement harmonization		

Implementation before 15 min ISP

Pros	Cons	Risks
Mitigation of operational concerns related to self-regulation: shorter window for self-regulating actions	Stakeholders expect early implementation. Delay will create negative stakeholder attitude towards NBM program and Nordic TSOs	Operational risks are considered to be lower
	EBGL requires early implementation: TSOs are dependable on the favorable NRA decision	Stakeholder risk is high: Heavy critic expected.
	Nordic TSOs fall behind the European harmonization process	TSOs are dependable on favorable NRA decision

Implementation together with 15 min ISP

8 Annexes

Annex 1: Calculation examples of single price vs dual price models

Example 1: Up-regulating hour	
Up-regulating price: 50 €/MWh Day ahead spot price: 40 €/MWh	Deficit of production imbalance power -100 MWh Deficit of consumption imbalance power -50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Expenses of production imbalance power: 50 €/MWh * -100 MWh = -5000 € Expenses of consumption imbalance power: 50 €/MWh * -50 MWh = -2500 € In total: -7500 €
Model of one balance: one-price and one-balance system	Expenses of the one-balance system: 50 €/MWh * (-100 MWh - 50 MWh) = -7500 €

Example 2: Up-regulating hour	
Up-regulating price: 50 €/MWh Day ahead spot price: 40 €/MWh	Deficit of production imbalance power -100 MWh Surplus of consumption imbalance power +50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Expenses of production imbalance power: 50 €/MWh * -100 MWh = -5000 € Incomes of consumption imbalance power: 50 €/MWh * +50 MWh = +2500 € In total: -2500 €
Model of one balance: one-price and one-balance system	Expenses of the one-balance system: 50 €/MWh * (-100 MWh + 50 MWh) = -2500 €

Example 3: Up-regulating hour	
Up-regulating price: 50 €/MWh Day ahead spot price: 40 €/MWh	Surplus of production imbalance power +100 MWh Deficit of consumption imbalance power -50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Incomes of production imbalance power: 40 €/MWh * +100 MWh = +4000 € Expenses of consumption imbalance power: 50 €/MWh * -50 MWh = -2500 € In total: +1500 €
Model of one balance: one-price and one-balance system	Incomes of the one-balance system: 50 €/MWh * (+100 MWh - 50 MWh) = +2500 €

Example 4: Up-regulating hour	
Up-regulating price: 50 €/MWh Day ahead spot price: 40 €/MWh	Surplus of production imbalance power +100 MWh Surplus of consumption imbalance power +50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Incomes of production imbalance power: 40 €/MWh * +100 MWh = +4000 € Incomes of consumption imbalance power: 50 €/MWh * 50 MWh = +2500 € <u>In total: +6500 €</u>
Model of one balance: one-price and one-balance system	Incomes of the one-balance system: 50 €/MWh * (+100 MWh + 50 MWh) = <u>+7500 €</u>

Example 5: Down-regulating hour	
Down-regulating price: 20 €/MWh Day ahead spot price: 40 €/MWh	Deficit of production imbalance power -100 MWh Deficit of consumption imbalance power -50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Expenses of production imbalance power: 40 €/MWh * -100 MWh = -4000 € Expenses of consumption imbalance power: 20 €/MWh * -50 MWh = -1000 € <u>In total: -5000 €</u>
Model of one balance: one-price and one-balance system	Expenses of the one-balance system: 20 €/MWh * (-100 MWh - 50 MWh) = <u>-3000 €</u>

Example 6: Down-regulating hour	
Down-regulating price: 20 €/MWh Day ahead spot price: 40 €/MWh	Deficit of production imbalance power -100 MWh Surplus of consumption imbalance power +50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Expenses of production imbalance power: 40 €/MWh * -100 MWh = -4000 € Incomes of consumption imbalance power: 20 €/MWh * +50 MWh = +1000 € <u>In total: -3000 €</u>
Model of one balance: one-price and one-balance system	Expenses of the one-balance system: 20 €/MWh * (-100 MWh + 50 MWh) = <u>-1000 €</u>

Example 7: Down-regulating hour	
Down-regulating price: 20 €/MWh	Surplus of production imbalance power +100 MWh
Day ahead spot price: 40 €/MWh	Deficit of consumption imbalance power -50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Incomes of production imbalance power: 20 €/MWh * +100 MWh = +2000 € Expenses of consumption imbalance power: 20 €/MWh * -50 MWh = -1000 € In total: +1000 €
Model of one balance: one-price and one-balance system	Incomes of the one-balance system: 20 €/MWh * (+100 MWh - 50 MWh) = +1000 €

Example 8: Down-regulating hour	
Down-regulating price: 20 €/MWh	Surplus of production imbalance power +100 MWh
Day ahead spot price: 40 €/MWh	Surplus of consumption imbalance power +50 MWh

Balance model	Economic consequence caused by the balance deviation of BRP
Current model: two-price system in the production balance, one-price system in the consumption balance	Incomes of production imbalance power: 20 €/MWh * +100 MWh = +2000 € Incomes of consumption imbalance power: 20 €/MWh * +50 MWh = +1000 € In total: +3000 €
Model of one balance: one-price and one-balance system	Incomes of the one-balance system: 20 €/MWh * (+100 MWh + 50 MWh) = +3000 €

Annex 2

8.1 Additional design parameters

The change of the Nordic imbalance settlement model (in this report denoted the Single price model) comprises a number of changes in addition to introduction of the single pricing and the single portfolio. The below additional design parameters will be necessary to address:

Design parameter	Proposed/Indicated design options	Comments
Calculation of imbalance price	1. Marginal price of FRR (aFRR and mFRR) 2. Volume weighted average of	This is a national choice not regulated by the European proposal. The Nordic TSOs propose to harmonise in the Nordics.

	aFRR and mFRR price	
Calculation of aFRR 15 min balancing energy price	1. Marginal price of activated aFRR 2. Volume weighted average of all activated aFRR within the ISP	The aFRR activations are done per control cycle (every 4th -8th second). Consequently, there will be up to 225 marginal prices per ISP. How will these be conveyed to the imbalance price?
Calculation of the balancing energy volume and consequently the imbalance adjustment volume.	1. Use the metered values for mFRR and/or aFRR 2. No harmonization within Nordics. i.e. leave for a national choice.	The importance of this choice is dependent on the choice of imbalance price calculation, as the price difference between the settled balancing energy and imbalance adjustment has an effect for BSP to deliver the balancing energy. If metered values shall be used instead of calculated values, there are need for changes in both scada- and MMS-solutions. (If the calculation shall be done near realtime.)
Determination of imbalance price in cases where balancing energy price does not reflect the imbalance situation within the imbalance price area.	1. In case the global activated net balancing energy is in the opposite direction from the local need, imbalance	The design choice will determine whether incentives for self-regulation shall correspond to local (bidding zone) or global (uncongested area) need.

	price equals reference price 2. In case the global activated net balancing energy is in the opposite direction from the local need, the imbalance price corresponds to the global activated net balancing energy	The balancing prices are set per uncongested area (which could consist of several bidding zones). This translates to an imbalance price that reflects the net balancing need of uncongested area (thus not the local balancing energy need).
Use of dual pricing	1. Not at all 2. Until 15 min ISP is implemented 3. Use for specific ISPs where system imbalance does not indicate a clear incentive for individual ISP 4. As a mitigation measure for too strong self-regulation incentives in specific ISPs. 5. In combination with scarcity and/or incentivizing component	The European proposal opens up for the conditional use of dual pricing.

Use of additional components in the imbalance price	1. Use of scarcity component 2. Incentivising component	
Calculation of value of avoided activation and possible use of boundary conditions	1. Mid-price of local mFRR and/or aFRR merit order list 2. Mid-price of global mFRR and/or aFRR merit order list 3. Use the incentivising component to as boundary condition, in case the VoAA is less/greater to DA/ID price.	The value of avoided activation will correspond to the current reference price (spot price). In the future imbalance settlement scheme, this will not be the case.