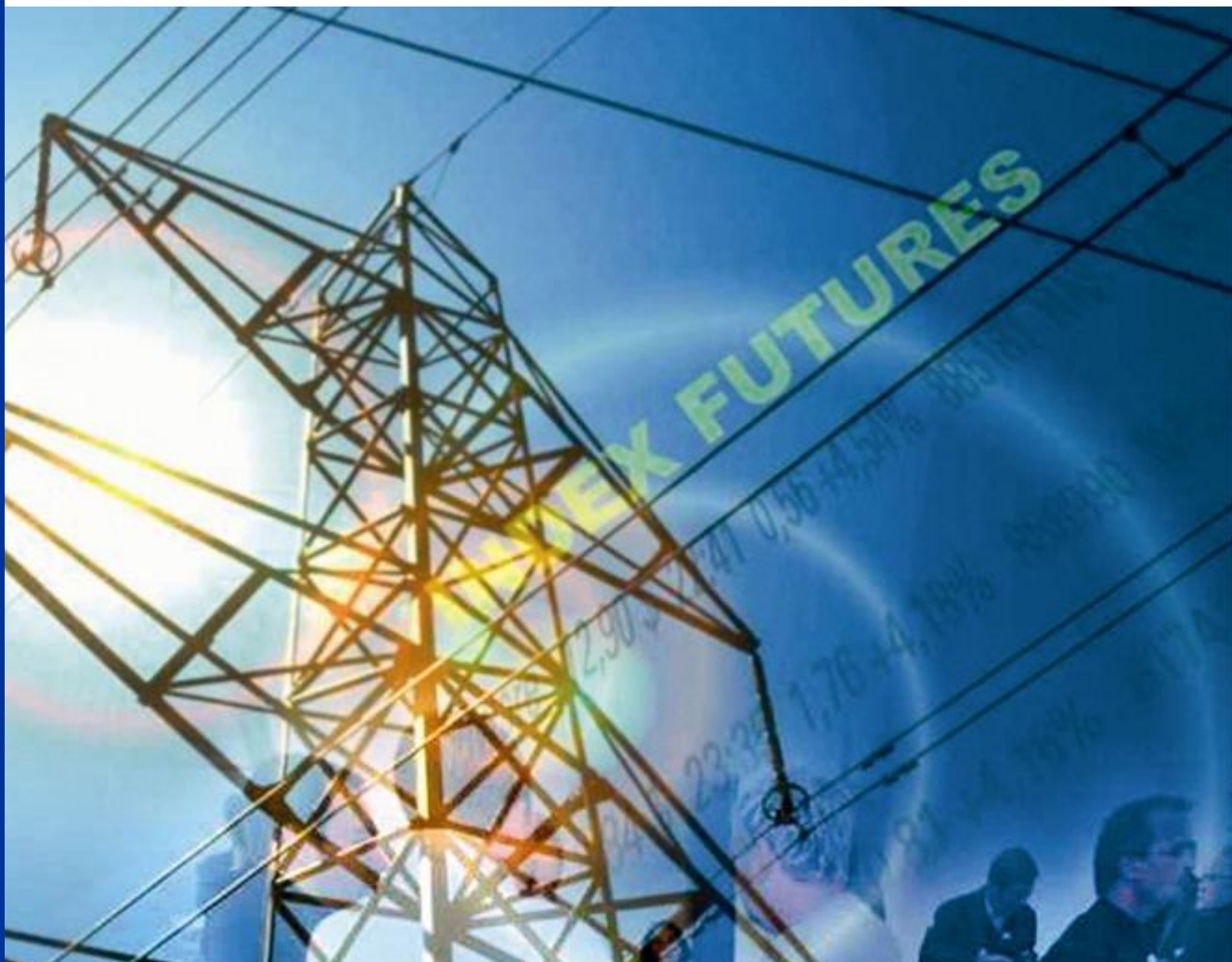


Nordic Market Design Forum – Feasibility study

Final report

September 2017



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EXECUTIVE SUMMARY

Background to the study

The Nordic power market is the world's oldest and most successful international power market. The market design was far-sighted and has lasted for two decades with limited change, while adapting to new zones. It has all the features of an effective market: liquidity, trust, diversity, transparency and growth; with a range of derivatives traded around the main spot market. The market covers four currencies, three synchronous electricity systems, and a broad range of technologies including reservoir hydro, nuclear, conventional thermal, biomass and wind generation; which brings shared welfare benefits. In recent years the market has expanded to include the Baltic region. Its success is recognised worldwide, and the underlying market design is the basis for the European Target Model, encompassing a day-ahead price coupling action, continuous intraday trading and a close-to-real-time balancing market.

Despite its success, the Nordic market design is showing signs of stress. Structural changes – including increasing wind generation, a growing energy surplus, the retirement of thermal capacity, and increasing interconnection with the continent – introduce complex, interlinked challenges.

Flat and low prices as well as a shortage of flexible generation assets put pressure on the Nordic market design and drive the need to refine it further. Finland and Sweden have a strategic reserve, which may be at odds with the stated philosophy of an 'energy only' market design. In view of the new challenges, the Nordic intraday market is underdeveloped and there are different detailed arrangements for reserve and balancing products in each Nordic country. Markets for non-frequency system services are generally immature.

The Nordic market has faced stress in recent years with low price levels, and needs to adapt to the changing circumstances, in particular replacing flexible thermal electricity generation with renewables and incorporating decentralised technologies. The Nordic region is expected to maintain an energy surplus into the future, implying that the markets for imports/exports to the Continent and Britain need to be improved. Furthermore, bringing more of the flexibility in demand side assets into the market and imperfections in Nordic market design that prevent the efficient flows of electricity in the region also need solving. The contribution of this report is to propose regional solutions to these regional challenges.

The work presented in this report has been sponsored by a group of 10 clients representing a broad coalition of Nordic market participants¹. The group has worked together to define the overall package of proposals in this report. From the perspective of the group, the market design concepts in this report are directionally correct both in terms of the plan and vision for Nordic market design and also in terms of priorities. The detailed market design proposals need to be clarified and further developed.

¹ Study participants included: Danish Energy Association, DONG Energy, Energinet, Elering, Fingrid, Finnish Energy, Fortum, Statkraft, Energi Norge, Vattenfall. Stakeholders present as observers at the workshops included OED (Olje- og energidepartementet) and Energistyrelsen.

Vision for the Nordic market design

Early discussion in the region revealed a strong desire among most stakeholders to continue with the principle of **energy-only market design**. The motivation for the proposals detailed in this report therefore centres upon maintaining these **principles**, and strengthening their **implementation**, evolving the design of the market to be better aligned to the challenges of today and the future. It is this route that we advocate as the vision for future electricity market design in the Nordics.

The Nordic market design should:

- § support system operation;
- § empower consumers;
- § send correct and reliable price signals for efficient resource allocation; and
- § support innovation and the incorporation of new technologies into the market.

The role of the market should also increase. The Nordic market design vision described in this report would give the Nordics an opportunity to be a **first mover in providing a high level of security of supply in a market-based and cost-efficient way**, and incentivises innovation and investment where needed. The role of the market in balancing timeframes would also increase. Overall, the vision will deliver **an efficient and competitive Nordic electricity market, thereby minimising the need for political and regulatory interference**.

Now is the right time to sharpen the core Nordic market design so it is fit to meet the coming challenges. The Nordic TSOs are finalising their solutions paper, and the report from Jorma Ollila's investigation calls for a renewed effort of Nordic co-operation in the Nordic energy sector. The proposals in this report support both initiatives and have been defined so that they are aligned with the vision for the Nordic market and implementable by 2020 with a visible impact by 2025.

Achieving the vision for the Nordic market design

A scoping study prioritised mutually reinforcing areas of market design to enable the Nordic market to adapt to meet the vision set out above.

The proposals start with pricing for balancing energy, which is the ultimate real-time market. Energy prices in all other timeframes should reflect the expectation of the real time energy price. The underlying philosophy is to ensure that balancing prices may be formed freely, reflecting scarcity where appropriate; and that this will drive expectations and forward contract values. Where the resolution of the imbalance settlement period requires additional services to be defined, these should be delivered and remunerated in a way which is as market-based as possible. Strategic reserve should be organised in a way which minimises market distortions. In all cases, our work is exploratory and qualitative, and any specific reform proposal merits a more formal assessment and cost benefit analysis before implementation.

The following pages summarise the market design proposals in the order below:

- § real time price signals that support system operation and market functioning;
- § an enhanced intraday market better equipped to facilitate the market functioning;
- § system services that are adequately rewarded and similarly compensated across the Nordic market;

- § a common Nordic market design and implementation of strategic reserve;
- § further considerations for market design development;
 - these were considered to be of potential relevance for the future but not a priority in the near term;
- § roadmap for implementation of the next steps of the market design proposals; and
- § the creation of an enduring market design forum to monitor progress and drive the change.

The proposals should be considered part of an overall consistent reform package. However, we consider that most elements are likely to be beneficial in their own right and may – if necessary – be implemented in isolation or as part of a more narrow reform programme.

Real time price signals that support system operation and market functioning

The proposals support the evolution of correct real time price signals, even in scarcity situations, to better support market functioning; robust real time price signals are a pre-requisite for better functioning markets in other timescales. Sharper price signals during times of scarcity are a key element of the energy-only market functioning properly. Increased transparency, shorter lead times and lower barriers for entry make it easier for market participants and allow a wider range of resources to support TSOs in system balancing.

Table 1 – Proposed changes for balancing and imbalance market design

| Proposed change | Description |
|---|--|
| Single price for imbalance settlement | Move to single-price and single portfolio imbalance settlement |
| Adjust price caps in the balancing market to reflect Value of Lost Load | Raise the price cap in the Nordic Regulating Power Market from 5,000 EUR/MWh to better reflect Value of Lost Load (this price should be higher than the Intraday price cap) |
| Estimate any lost load in the imbalance position of the BRPs and the marginal imbalance price | In the event of involuntary load curtailments, any lost load should be estimated and included in the imbalance positions of individual BRPs and the calculation of the system imbalance volume and the marginal imbalance price |
| Remove direct link between balancing, imbalance prices and day-ahead prices | Remove the condition that the day-ahead price sets the floor for the up-regulation price and the cap for the down-regulation price, and consequently for imbalance prices (except as a backstop price in the event that there are no balancing trades, and if an intraday price cannot be used) |
| Include balancing energy exported outside the Nordics in balancing price formation | Whenever balancing energy is exported from one of the price zones in the Nordics to a price zone outside the Nordics, the exported energy should be included in the marginal price formation for balancing energy as is currently done with imported balancing energy (similarly as in day-ahead price coupling) |
| Remove obligation on BRPs to balance | Remove any balancing obligations at the day-ahead and any other stage, better allowing the market to support system balancing |
| Publish information on system imbalance and balancing and imbalance prices in real-time | Balancing activations and prices should be published as close to real-time as possible, which serves as an indication for imbalance prices to guide behaviour of market participants |
| Balancing market gate closure closer to real-time | The gate closure to submit bids to the Regulating Power Market should be moved as close to the operating hour as possible |
| Balancing market minimum bid size to 1 MW | Reduce the minimum bid size in the balancing market to 1 MW and take electronic activation into use |

An enhanced intraday market better equipped to facilitate the market functioning

The proposals for the intraday market will give market participants a better platform to trade into balance closer to real time. Taken together, the changes support effective intraday markets, the valuing of flexibility in different market timeframes and forward trading of flexibility products. In the Nordic market, rapid load and flow changes between hourly day-ahead blocks create disturbances in system frequency. Today, this ramping challenge is solved through requirements placed on the generators and on maximum hourly flow changes on DC links. The ID market will have an important role in bridging hourly commitments to 15-minute imbalance settlement², enabling to solve the ramping challenge of cables and stabilising system frequency at hour changes within the market.

Table 2 – Proposed changes for the intraday market design

| Proposed change | Description |
|--|---|
| Intraday auctions | <p>§ A single opening auction on day D-1 (no later than 3pm CET) for all market time units for the following day as close as practically possible to the setting of day-ahead prices and recalculation of available capacities. The auction should use 15-min products.</p> <p>§ Continuous trading from the resolution of the opening auction until the gate closure time of the ID market, which could be combined with a closing auction (subject to further consideration).</p> |
| Intraday gate closure time (GCT) as close to real-time as possible | <p>§ The regional cross-zone intraday GCT in the Nordics should be as close as to the operating hour as possible, using 30 min as a starting point.</p> <p>§ Shortening the GCT for ID trading should ideally be accompanied with change to the deadline for submitting production plans.</p> |
| Information transparency between market participants and TSOs | As market participants trade closer to real time, greater transparency is needed. Market participants should provide the TSO with detailed, up to date information. TSOs should provide up to date, consolidated data on the overall system position. |
| Price cap in the intraday market | In line with the change to the balancing market, the price cap in the intraday market should be set to better reflect the value of lost load (9999 EUR/MWh as outlined in the all NEMO proposal ³). |
| Allocation of cross-zone capacity across market timeframes through an explicit cross-zone capacity product | Start a process to find a method to allocate cross-zone capacity across market timeframes, opening up intraday trading between price zones. This report contains a proposal by Pöyry for a dynamic market based approach. There are alternative (less complex) solutions which may be workable, perhaps as transitional measures. We recommend this topic for further exploration. |

² The day-ahead market is, for the time being, expected to remain with hourly time resolution, and balancing to move to 15-minute resolution.

³ All NEMO's proposal for harmonised maximum and minimum clearing prices for Single Intra Day Coupling in accordance with Article 54(2) of Commission Regulation (EU) 2015/1222 of July 2015 establishing a guideline on capacity allocation and congestion management. 14 February 2017.

System services that are adequately rewarded and similarly compensated across the Nordic market

The objective for market design around non-frequency system services is to move away from the ‘obligation, no payment’ approach which is currently in place for some of these services, and move towards a more market-based approach for all services, as far as this can be made workable.

As thermal capacity is operating fewer hours or is decommissioned, the supply of different system services reduces. This means that services, which were previously considered as ‘automatic’ by-products of electricity generation, might become scarce. New technologies with different performance parameters to incumbent technologies will enter the system – incentives to provide reserves and other system services will also need to be accessible for these sources.

Table 3 – Proposed changes for system services market design

| Proposed change | Description |
|--|--|
| Remove requisitioning of services without remuneration through supply and grid connection conditions | Wherever generators are required to provide system services without remuneration or at below market rates, there should be a transparent needs assessment to establish whether there is a demand for the service in the system. If there is, a market-based procurement approach should be developed as far as possible. At minimum, there should be a regulated remuneration and equal requirements for all technologies. |
| Level playing field between TSOs and market participants providing the same services | Service providers should compete with any TSO assets providing system services on an equal footing. Minimum requirement is to increase transparency on the system, cost levels of TSO assets and market participant compensation when they are providing the same services as TSO assets. |
| Marginal pricing of availability fees of reserve products | Marginal pricing should be used for pricing the availability fees of all reserve products (FCR, aFRR and mFRR). |

A more Nordic market design for strategic reserve that does not distort market price signals

If Nordic cooperation works well in tight supply situations, the market should be able to cope. Peak load constraints should also be manageable with the development of price signals, grid development and ordinary market operations. In the absence of effective demand side response, strategic reserve could be necessary as a transitional measure. Given that peak load reserves exist, regulators and TSOs should see these resources as together across national borders and use them in a way that distorts the market as little as possible. To ensure that the rules governing the activation and pricing of this strategic reserve do not have a distorting effect on energy market prices, we have identified a set of recommendations for the market design of strategic reserve in the Nordics, which stops short of recommending its abolition. Strategic reserve may have a role to play in minimising the impact of political intervention in the market which could be a result of involuntary scarcity arising from a market with poor demand side participation.

Table 4 – Proposed changes for strategic reserve

| Proposed change | Description |
|--|---|
| Activation and pricing principles to better reflect the value of avoided scarcity | Activation of the strategic reserve should happen in the last market possible, the regulating power market, even if the capacity requires a longer warm-up time and the notification for a start-up is given earlier. If the strategic reserve is actually used to solve an energy shortfall, and not only warmed up, the activation should be reflected in imbalance prices at Value of Lost Load (e.g. balancing market price cap). |
| An explicit target level for power adequacy to define the dimensioning of strategic reserves | The size of strategic reserve should be defined, based on: <ul style="list-style-type: none"> § an explicit target level of power adequacy based on the Value of Lost Load (VOLL, EUR/MWh); § cost of capacity (EUR/MW per year); and § a probabilistic analysis on Expected Unserved Energy (EUE, MWh/a). |
| Regional cooperation to utilise strategic reserves more efficiently across countries and transparent protocols to handle scarcity situations | Adequacy assessments should be done on a regional basis and based on a common methodology. Strategic reserves in different countries should be seen together and considered as a common strategic reserve, including harmonised activation principles. The Nordic TSOs should have coordinated and transparent protocols to handle scarcity situations and how cross-zone flows are managed these situations. |

Further considerations

In addition to the market design proposals mentioned above, the study also identified concepts deemed by the study members to be of potential relevance for the future but which were not considered to be a priority in the near term.

Table 5 – Further considerations

| | | |
|---|---|---|
| Balancing and imbalance arrangements | § | Scarcity adder and pricing; |
| | - | Inclusion of reservation costs in balancing and imbalance pricing; and/or |
| | - | Administered scarcity price function or adder; |
| | § | Combining aFRR and mFRR activation prices into a common merit order; and |
| | § | Increasing the role of market participants in reserve procurement and provision |
| System services | § | Granular reserve products; |
| | § | Inertia and/or the need for faster responding frequency containment reserves; and |
| | § | Nordic FCR-N market |
| Strategic reserve | § | Deeper Nordic cooperation to further reduce the size of strategic reserves and improve policies, criteria, and procedures for procurement |
| | § | Demand-side participation |

There are additional areas to address that we consider important for the vision of future Nordic market design including forward trading timeframes and TSO incentives.

Implementation of proposals

Next steps to implement the market design concepts in this report

This study focuses on pragmatic changes to Nordic market design that can be implemented by 2020 with a visible impact by 2025. The next steps for implementation are outlined in the table below.

Figure 1 – Next steps to implementing the market design concepts

| Topic area | Next steps | Comments |
|---------------------------------------|---|--|
| Proposals for balancing and imbalance | Input to Nordic TSO projects on full cost balancing and reducing minimum bid size Input to balancing market co-operation between Nordic and Baltic markets | Main dependency is on integration of balancing markets and settlement rules under Electricity Balancing Guideline and Nordic-Baltic markets |
| Proposals for intraday | Start a Nordic process to implement ID market improvements Input to Nordic TSO finer time resolution project | Main dependencies: start of XBID in 2018 and ENTSO-E proposal on ID capacity pricing Transitional arrangements – pilots for ID auctions and or cross zone capacity allocation |
| Proposals for system services | Start a Nordic process among stakeholders to look at system services Input to further development of Nordic aFRR and other system products | Main dependency is the implementation of the clean energy package; how services should remunerated and TSO ownership of assets |
| Proposals for strategic reserve | Input to Nordic TSO project to harmonise activation rules Process to harmonise methodologies and principles of co-operation | Main dependencies are ENTSO-E work on a common methodology for security of supply and Commission view on CRMs |

A Nordic forum should be established to progress Nordic market design

In order to monitor progress and push forward the ideas presented in this report, a Nordic forum should be established with a remit to promote and drive forward Nordic market design

- § The forum should bring together ministries, market participants and financiers, regulators, power exchanges and TSOs as well as other appropriate entities such as the EU Commission. The forum should include representation from the Baltic markets.

- § The purpose of the forum should be to promote common discussion and implementation of solutions to regional market design challenges.
- § The remit of the forum should be to initiate regional discussion of market design issues and drive development of the regional electricity market.

We see the forum proposed here as complementary feeding into the policy-level forum proposed by Jorma Ollila⁴ on topics related to electricity market design as the vision also requires action from the political level i.e. complementary energy policy to enable the market design to work.

As a concrete task, the market design forum would monitor progress on implementation of the market design changes outlined in this report, alongside other topical market design issues. The forum would update the list of market design topics as new information came to light and proposals are made for investigation. The forum would also serve as a platform where different national initiatives could be brought together and discussed.

⁴ The Ollila report can be downloaded from: <https://tinyurl.com/y7cqjggl>.

1. INTRODUCTION

1.1 Overview

This report describes concrete changes to elements of Nordic electricity market design. The purpose of the proposed changes is to enable the Nordic market to cope with the coming challenges while preserving the Nordic market philosophy.

The work presented in this report has been sponsored by a group of 10 clients representing a broad coalition of Nordic market participants⁵. The group has worked together to define the overall package of proposals in this report. From the perspective of the group, the market design concepts in this report are directionally correct both in terms of the plan and vision for Nordic market design and also in terms of priorities. The detailed market design proposals need to be clarified and further developed. The proposals should be considered part of an overall consistent reform package. However, we consider that most elements are likely to be beneficial in their own right and may – if necessary – be implemented in isolation or as part of a more narrow reform programme.

Electricity markets are undergoing a series of profound changes in the response to technical and social developments; the integration of renewables, technological developments that empower the customer, digitalisation and new technologies such as storage. The market design needs to evolve to suit the new challenges. The general market design challenges are:

- § Valuing flexibility and real time price signals that support system operations and signal scarcity;
- § Valuing system and non-frequency services appropriately;
- § A market design framework for empowering the consumer and integrating new decentralised technologies into the market; and
- § Investibility and risk management for long term security of supply.

The Nordic market is the world's oldest cross border electricity market. It has operated successfully since the 1990's, acting as a beacon for pan-European electricity market development, and an example of the benefits of creating a regional energy market.

The Nordic market is rather well functioning and will face different challenges to continental markets. The market has faced stress in recent years with low price levels, and needs to adapt to the changing circumstances, in particular the replacement of thermal electricity generation with renewables and the incorporation of decentralised technologies. With a regional energy surplus expected surplus forecast to continue⁶, well-functioning markets for imports/exports to continental markets need developing. Imperfections in Nordic market design that prevent effective internal flows of electricity also need solving. The contribution of this report is to propose regional solutions to these regional challenges.

⁵ Study participants included: Dansk Energi, DONG Energy, Energinet, Elering, Fingrid, Finnish Energy Industries, Fortum, Statkraft, Energi Norge, Vattenfall. Stakeholders present as observers at the workshops included OED (Olje- og energidepartementet) and Energistyrelsen.

⁶ See e.g. Statnett. Long term market analysis, the Nordic region and Europe 2016-2040. <https://tinyurl.com/y8j5h4jn>






Nordic market design is under pressure. Market rules need to be reformed to comply with European Union requirements for the common electricity market that are entering into force. The rules are set out in the network codes and guidelines and will set the market operation and connection rules for the integrated electricity market. At the same time there has been an increase in national led developments. Nordic markets have been developing national energy strategies. Finland and Sweden published energy strategies to meet 2030 targets. In 2015 Denmark initiated the Market Model 2.0 project that sought to create a Danish market design that was fit to meet the coming challenges.

There is a clear opportunity for Nordic market participants to seize the initiative to develop Nordic market design. Doing so has clear benefits. It will re-establish Nordic principles as a reference for regional market design. It will ensure that a Nordic approach is taken and hence the benefits of a well-functioning and regionally integrated market will avoid sub-optimal national outcomes.

The remit of the study is to focus on pragmatic changes to the regional Nordic market design that support the continuation of the Nordic market as an energy only market. The market design concepts that are outlined in this report should be implementable before 2020 with a visible impact by 2025.

The study consisted of a scoping phase and a feasibility phase. During the scoping phase, the topic areas for detailed market design proposals were identified. The topic areas and detailed proposals for changes to market design were then investigated more thoroughly during the feasibility phase. The output of the scoping phase is shown in Figure 2. Given the requirements to be implementable by 2020 most focus has been on the arrangements around balancing and imbalance, intraday, system services and strategic reserve.

Figure 2 – Summary of topics from the scoping study

| |  Balancing + imbalance, intraday, strategic reserve and system services |  Trading flexibility forwards and cross-zone |  Empowering the customer |  Investability and allocation of market risk |  Regional cooperation from grid perspective |
|--|---|--|--|--|---|
| Benefits | Facilitating more market participation in markets closer to real time resulting in a more efficient use of system resources | Allows hedging against price and volume risk across timeframes and zones | Incentives and possibilities for the customers to contribute to system reliability and flexibility | Improved investment horizon and longer-term stability for investors | More efficient use of resources across the region |
| Is it covered somewhere else? | Nordic TSOs (due to finish by summer 2017), Clean energy package | Limited attention in the Nordics at the moment, Clean energy package | European and Nordic policy makers (to some extent), Clean energy package | EU State Aid Guidelines and national policy makers, Clean energy package | Nordic TSOs and policy makers, and ENTSO-E, Clean energy package |
| Provisional decision on scope and role in feasibility study | Provide industry perspective and assess feasibility of changes | Requires further definition on key issues | Requires further definition on key issues | Raise key issues based on quantitative analysis and earlier work done by Pöyry e.g. on CRMs | Limited possibility for visible impacts before 2025. Will comment on importance |

Trading flexibility forwards and cross-zone refers to the market products that are expected to emerge that enable participants to hedge themselves against more volatile real time prices. Trading the products forwards enables producers to realise the value of flexible resources and hence supports investment and risk management. In principle, such

products are of strategic importance as they would enable the Nordics to export the value of flexibility to the continent and Britain. The product concepts have been developed in previous Pöyry studies⁷. Discussions with participants in this study revealed that these products should emerge from the market as needed. Empowering the customer and the topic investment and risk allocation were identified as key issues in the scoping phase. It was also decided that the topics needed to be refined further before launching into a feasibility study of the proposals. Hence, additional workshops were run to sharpen the proposed changes to Nordic market design in these areas. We note that the proposals contained in this report to some extent overlap with those required under the topics of empowering the customer and investment and risk management. The additional proposals from the workshops will need to be further developed by the group in the future.

Regional co-operation from the grid perspective includes operations, governance, grid development and market development. The topic is a vital part of a well-functioning Nordic market. As the Nordic market is not homogenous, good regional co-operation is required to ensure the most cost efficient resources are used across the Nordics. As an example, the effect of delaying investment in grid is to exacerbate the stress that is seen in the Nordic system between deficit and surplus areas and this could give reason for intervention which could potentially lead to national market solutions rather than regional solutions. During the workshops participants strongly agreed on the importance of this topic but on the other hand it is a topic that is highly political and the potential for visible impacts before 2025 is unlikely, hence it was ruled out of scope.

1.2 Structure of this report

The report is structured as follows:

- § Chapter 2 describes in detail the challenges for market design that were elaborated on in the scoping phase of the study. The objective of the scoping phase was to identify and focus on the key market design proposals to be investigated. The work was carried out with input from the study participants and workshops. The specific issues facing the Nordic market design and the key European legislation that is relevant is also described. The vision for the future market design is presented and then split into the three main strands - wholesale market arrangements, a framework for balancing and system services and resource adequacy. The reasoning for the selection of topic areas concludes Chapter 2.
- § Chapter 3 describes the proposed changes to the balancing and imbalance settlement arrangements. Efficient real time price formation is a keystone of good market design. Driven by new technologies, the market should and can be used to help the TSOs manage the system in the balancing timeframes; this requires a shift in the current Nordic balancing philosophy to a more market based approach. The detailed market design proposals cover two main areas.
 - First, balancing and imbalance price formation – enabling prices to better reflect the real time value of energy, especially during scarcity and provide incentives to support the system balance. Detailed proposals include: single price; adjust price cas in the balancing market to reflect the value of lost load; a mechanism for estimating lost load in the imbalance position of BRPs and the marginal price; removing link between balancing and imbalance prices with the day ahead

⁷ Pöyry, Revealing the value of flexibility, 2014: <https://tinyurl.com/ybvjmnky>

market; including balancing energy exported outside the Nordics in balancing price formation.

- Second, market facilitation for system balancing - increase transparency, shorter lead times and lower barriers to entry making it easier for market participants to support the TSOs in system balancing. Detailed proposals include removing obligations to balance, publishing information on imbalance and balancing prices close to real time; moving the minimum bid size to 1 MW as soon as possible.

- § Chapter 4 describes the proposed changes to the intraday market and the consequences for the day ahead and balancing markets. The intraday market needs to be developed as it will become increasingly important in the future. The market will act as a bridge between hourly wholesale market and 15-minute imbalance settlement; provide the opportunity to adjust volume commitments due to forecast errors and deal with the cable ramping challenge that is currently solved outside the market. A liquid intraday market will provide flexible resources to capture value from the close to real time markets and have a positive impact to support stabilising Nordic system frequency. There is a corresponding need to increase transparency and accuracy of information so that participants can react accordingly. The detailed proposals for the intraday market cover intraday auctions single opening auction, 15-min products and continuous trading; moving ID gate closure as close to real time as possible; improved information transparency between market participants and TSOs; price caps in the intraday market to be raised as outlined in the all NEMO proposal; a process to investigate the allocation of cross zonal capacity across market timeframes. Taken together, the proposed changes support effective intraday markets with good liquidity, the valuing of flexibility in different market timeframes and forward trading of flexibility.
- § Chapter 5 describes the proposed changes to the market design around system services. The capability to deliver system services is built into power plants but is not always remunerated. The proposals advocate a process to move from a no payment approach to a more market based approach. The proposals outline the steps including the removal of requisitioning of services without remuneration through supply and grid connection conditions – a process is proposed, similar to that undertaken in Denmark under Market Model 2.0; a level playing field between TSOs and market participants when providing the same system services; and marginal pricing of availability fees of reserve products – currently pay as bid pricing is used for procurement of some Nordic reserve products.
- § Chapter 6 describes the proposed changes to the market design for strategic reserve. While strategic reserve is not seen as an enduring solution (but can be necessary in the absence of a developed market for demand response), it is in place in Finland and Sweden. The proposals for Nordic strategic reserve are about ensuring that the activation and pricing of the strategic reserve does not have a distorting impact on energy market prices. Proposals include activation and pricing principles that better reflect the avoided value of scarcity; an explicit target level for power adequacy to define the dimensioning of strategic reserves and regional co-operation to utilise strategic reserves more efficiently across countries and transparent protocols to handle scarcity situations.
- § Chapter 7 presents conclusions and a way forward with next steps, recommendations and further considerations regarding the proposals for Nordic market design. The next steps also include an implementation plan and a proposal to establish an enduring Nordic forum to drive forward Nordic market design. The purpose of the forum is to bring together stakeholders and promote common discussion of regional market design challenges and monitor implementation of solutions. If Nordic forum is not

established, there is a risk that no entity will take ownership of the Nordic challenge and there will be a reversion to a country led debate on market design that risks Nordic cohesion.

1.3 Conventions

1.3.1 Sources

Where tables, figures and charts are not specifically sourced they should be attributed to Pöyry Management Consulting.

1.3.2 Abbreviations

We have occasionally, in tables and text, abbreviated Denmark to DK, Finland to FI, Norway to NO and Sweden to SE.

The Nordic electricity transmission system is operated by, respectively, Energinet, Fingrid, Statnett and Svenska Kraftnät, and those bodies are separately or jointly referred to as the Transmission System Operators (TSOs).

Other abbreviations are provided as first used.

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2. FUTURE NORDIC MARKET DESIGN

2.1 Motivation

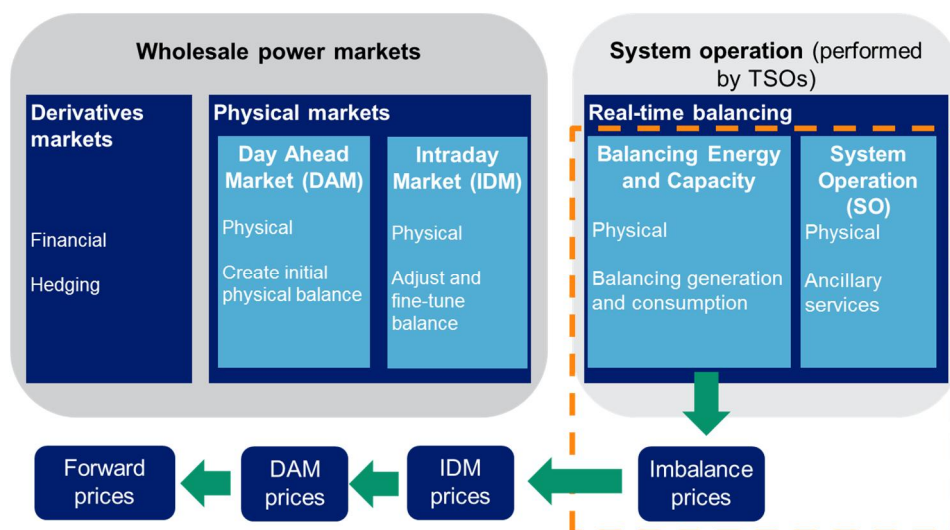
2.1.1 *Fundamental drivers for change*

Electricity markets worldwide are undergoing transformation in response to policy objectives for decarbonisation and technological advances in the electricity sector itself and, critically, also in relation to IT and communications functionality. The situation in the Nordics is no exception.

The generation mix is changing as the penetration of renewable generation technologies, such as wind and solar, increases in pursuit of ambitions for power sector decarbonisation and as costs of these technologies fall. Cost reductions are also enabling technologies such as battery storage to grow in prominence. At the same time, electricity demand is also evolving. Greater electrification of heat and transport would increase overall demand and consumption patterns, while the advance of 'smart' technologies has the potential to change patterns of consumption and to create much greater potential for demand side response within the wholesale market.

The conventional model of electricity market design based on dispatching large scale, controllable generation to meet predictable patterns of demand is, therefore, becoming less and less relevant. With much more short-term weather driven, autonomous sources of generation, there may be a lack of flexibility for system balancing and critical properties required to maintain power system stability. Flexibility can come from many sources; flexible generation, interconnection, demand side management and storage of various types. But it will only be provided efficiently if flexibility is appropriately rewarded and the costs associated with inflexibility are appropriately targeted, through the operation of the competitive markets for energy and balancing services.

In addition to ensuring efficient short term operation, valuing flexibility appropriately ensures that the market framework can cover the maintenance of and investment in the right type of capacity in the long run. This is illustrated in Figure 3.

Figure 3 – Wholesale prices are a reflection of the expected imbalance prices

Similarly, for non-energy services which are critical to the operation of the system, appropriate incentives are needed to ensure that they are available in the long term and used effectively in the short term.

The challenge for many providers of flexibility is that the economics no longer stack up under the current market arrangements. Whereas flexibility from hydropower plants will remain mostly intact, closures of thermal plants due to changing price patterns and reduced number of operational hours may cause a lack of flexibility, peak load capacity and critical non-energy services.

In thermal markets, the investment case for plants was often based on expectations of revenues from baseload operation for the first years of operation, followed by revenues from more variable operating patterns in later years. But now, with a thermal generator's running pattern dependent on wind and solar levels, which are only known in the nearer-term, the basis for investment decisions looks very different, with volume risk and price risk now both very much in the mix from the outset. The upshot is that flexible assets are struggling as opportunities to capture revenue are concentrated into a smaller number of hours, and opportunities to trade in intraday markets and to hedge flexibility forward are limited. Hence, it is more important than before that the full value of services provided, including flexibility and non-energy services, is revealed appropriately.

2.1.2 Drivers for change in the Nordic market

The Nordic region has a diverse generation mix, encompassing large nuclear and thermal units, high penetration of wind in some areas, and large scale flexible hydro and reservoir capacity. Consumption includes a large share of heavy industry as well as electric heating with considerable potential for further demand response enabled by growing electrification of heat and transport and smart metering programmes.

The Nordic market in general will, due to the good access to hydropower with water storage, be much less exposed than other European markets to capacity shortage and scarcity. However, the Nordic market will be exposed to the effects of low inflow seasons. The present surplus situation is expected to remain at least for a decade, after the policy

decision to keep Swedish nuclear generation, and there is only a low risk of a real shortage situation due to low inflow.⁸

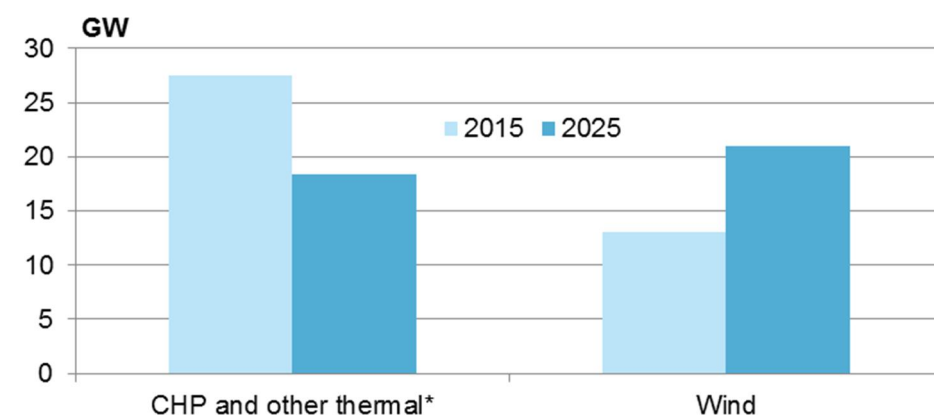
On the other hand, decreased value for hydropower generation due to new generation, variable or not, reduces water values and depresses the price level of the market. Day-ahead prices remain mostly flat in the short-term due to hydropower flexibility.

Another uncertainty for the longer term seems to be the development of networks, including cables to other synchronous areas, which will determine the degree to which flexibility reaches the entire Nordic area and whether a Nordic tightness of peak load capacity will be created by export to Britain and the European Continent.

Although the market as a whole is expected to remain energy- rather than capacity-constrained, some areas may face a serious tightening of the capacity margin as thermal capacity is expected to close, but on the other hand new nuclear units are being built in Finland. Without sufficient grid development to improve access to hydropower flexibility, lack of incentive to invest in thermal capacity may however become an issue in areas with insufficient access to hydropower flexibility.

In common with most electricity markets worldwide, the Nordic market lacks the full ability to set predictable prices at a level that reflects the societal costs of supply curtailment in a shortage situation. This is particularly important in the Nordic market, since high price expectations would be reflected into water values and thus prices in the season leading up to the relevant reservoir crisis or a peak load capacity constraint. The potential of import flows and demand response may thus not be fully utilised, and the incentive for flexible generators is reduced.

Figure 4 – Nordic capacity development for thermal and wind generation



Source: ENTSO-E

*Excluding nuclear capacity.

Despite the success of existing arrangements, there is scope for more efficient use of the existing flexible capacity and demand side potential, if appropriate market arrangements are in place. Beyond the Nordics, the region as a whole has capacity to export flexibility to Britain and the European Continent, if the right market design and arrangements for trading flexibility across borders can be created.

⁸ See e.g. Statnett. Long term market analysis, the Nordic region and Europe 2016-2040. <https://tinyurl.com/y8j5h4jn>

2.1.3 Regulatory drivers for change

A lot of the market framework development is driven by European-wide harmonisation and initiatives required by the EU's 'Target Model'⁹ and 'Clean Energy for All Europeans'¹⁰ proposals (also referred to as the Clean Energy Package). The most relevant drivers for change for the scope of this report are:

- § Cross-Border Intraday Market Project (XBID)¹¹ and the associated intraday Capacity Management Module (CMM);
- § a requirement to price intraday cross-zonal capacity for which ENTSO-E has submitted a proposal^{12,13};
- § adoption of the Guideline on Electricity Balancing which will require a review of and changes to balancing and imbalance arrangements and procedures;
 - one key initiative is the move to a 15-min imbalance settlement period which according to the Commission's Clean Energy Package should be done by 2025¹⁴;
 - another is the development of a common European platform for the exchange of balancing energy with manual activation¹⁵; and
 - the Guideline also sets the regulatory framework for imbalance netting and frequency restoration and replacement reserves;
- § the Clean Energy Package proposals.

The links between the recommendations outlined in this report and the relevant regulatory framework are mapped in more detail in Section 7.

2.2 Vision for future Nordic market design

In some markets, the policy response to plug a potential missing money gap and support investments has been to introduce capacity markets and support investment. But this

⁹ The 'Target Model' is now enshrined in the Regulations for Forward Capacity Allocation (FCA), Capacity Allocation and Congestion Management (CACM), and Electricity Balancing (EB, which is now agreed, and expected to be fully in force later in 2017).

¹⁰ Documentation available at: <https://tinyurl.com/j6fdcmg>.

¹¹ XBID is a joint initiative by the Power Exchanges and TSOs from 11 countries to create a joint integrated intraday cross-border market based on a common IT system. It is expected to commence operation in early 2018. It incorporates the functionality of ELBAS in the Nordics, but will extend to other parts of Europe as a simultaneous connected market.

¹² Reference "All TSOs' proposal for the single methodology for pricing intraday cross-zonal capacity in accordance with Article 55 of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion managements", issued for consultation by ENTSO-E on 7 April 2017

¹³ Pöyry has submitted a response to the ENTSO-E proposal, which can be found from: <https://tinyurl.com/y8ugbzwc>.

¹⁴ The Nordic TSOs are jointly investigating the costs and benefits of changing to a 15 min imbalance settlement period (Nordic project on finer time resolution).

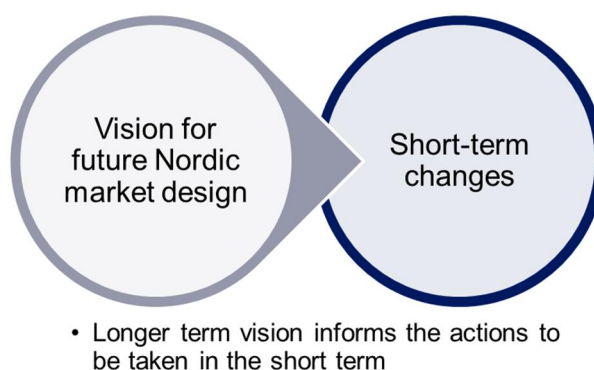
¹⁵ On April 5, 2017, 19 European TSOs signed a Memorandum of Understanding for the design, implementation and operation of a new manual frequency restoration reserve platform, called the MARI project (Manually Activated Reserves Initiative).

route is not favoured by the European Commission and brings its own set of challenges¹⁶. An alternative route exists, however.

The motivation for the proposals detailed in this report centres upon maintaining the **principles** of an **energy only market**, and strengthening the **practice** by focusing upon evolving its design such that it is better aligned to the challenges of today and the future. It is this route that we propose as the vision for future electricity market design in the Nordics.

The principal elements of the vision are outlined in Section 2.2. The vision for future Nordic market design informs actions to be taken in the short term while ensuring that the reforms are consistent with a bigger picture (as illustrated in Figure 5). This serves to provide a benchmark against which the proposed changes to market design in the later Sections can be compared. Further reforms, which are not presented in detail in this report, are discussed in the final Section.

Figure 5 – Evolution of electricity markets



The future market philosophy and the basis of the vision for future Nordic market design, is to ensure that the value of flexibility and system services is reflected in price formation and that the market provides appropriate tools for managing balancing risk. A virtuous circle exists, as shown in Figure 6, if these aims can be achieved.

The circle begins with the increase in variable generation, which in turn increases the need for flexibility. The value of flexibility needs to be appropriately reflected, including through exports, so that it can be realised by its providers. In addition, the resource needs to be shared appropriately across price zones so that there is less need to build/maintain redundant assets. **Taken together, these opportunities create urgency on finding ways of valuing and trading flexibility within and between price zones. This is a core objective of this work.**

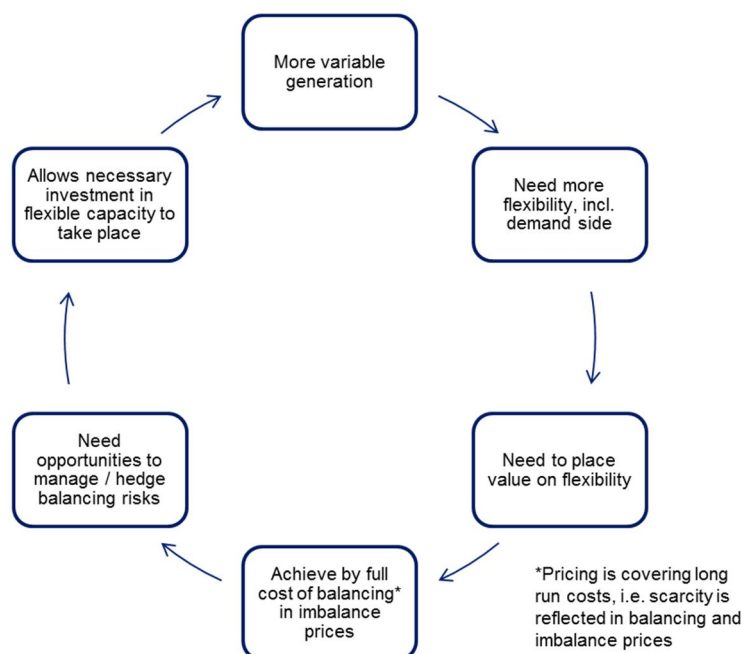
¹⁶ “Final Report of the Sector Inquiry on Capacity Mechanisms” emphasises that capacity mechanisms should be introduced only if there is a genuine need based on an economic reliability standard and they should not replace essential electricity market reforms proposed by the Commission’s Market Design Initiative.

The value of flexibility can be included within pricing by ensuring that the full cost of energy balancing¹⁷ is reflected in imbalance prices for those with inflexible assets or non-controllable demand and in the balancing prices captured by providers of flexibility.

Full cost of balancing means that the balancing market framework is able to send price signals to cover long run costs of providers in case of scarcity. In other words, it means that scarcity is reflected in balancing and imbalance prices and prices are allowed to rise up to value of lost load to reflect scarcity in the system. The full reflection of long-run marginal cost of system balancing tackles the 'missing money' problem for capacity used to balance the system.

This presents balancing risks for those less able to balance their positions, creating a requirement for appropriate products to be available to allow parties to manage and hedge balancing risks. With such products available, there is the potential for further variable generation to enter the system. Hence, the arrangements can be self-sustaining.

Figure 6 – Valuing flexibility appropriately and availability of complementary risk management tools creates virtuous circle



With the aim of delivering this virtuous circle, the vision for future Nordic market design is built around three broad categories of enhancements to the market arrangements. From the perspective of the commercial market participants who provide energy and related services, the market mechanisms must deliver a manageable revenue stream which allows necessary investment to take place, with appropriate incentives on efficient delivery. Users of the services should be able to find opportunities to change their

¹⁷ The Nordic TSOs have an on-going market design project called 'Full cost of balancing', which has similarities to the topics in this report.

behaviour and reduce their demands on the system (which may take the form of selling back flexibility which they don't need).

- § fine-tuning of aspects of wholesale electricity market itself, which reflect future priorities given the changing nature of the system;
- § creating an adaptable framework for accessing and remunerating necessary balancing and system services; and
- § focus resource adequacy efforts upon making the market arrangements work.

Several specific topics sit under each of these categories. These topics are set out in the Sections below.

2.2.1 Wholesale market arrangements

Headline message: the wholesale market needs to adapt to accommodate greater within-day variability by providing sharper incentives to balance, greater liquidity in intraday trading and by allowing flexibility to find a value.

This applies within the Nordic market and also to neighbouring markets, which opens new trading possibilities. To achieve this goal, there are actions to be taken across the wholesale market trading timeframes as follows:

Forward

In the forward trading timeframe, the focus is on having the right products available to allow for trading and risk management in a system with greater volume and price risk and to ensure that these products do not have distortionary effects on market operation and price formation in nearer-term markets. The requirements that this creates are as follows:

- § allow contracts with reference price around intraday (or other close-to-real-time) price, not just day-ahead – the nature of forward contracts should not bias towards the foreclosure of options with respect to near-real time trading;
- § enable the market to create commercial products that are better suited to the uncertainty and variability of the future system e.g. energy options; and
- § ensure cross-zonal hedging tools are adequate for market needs – this allows effective trading between markets by location and trading timeframe.

Day-ahead

Trading activity does not stop at the day-ahead stage and the importance of nearer-term markets will increase as parties seek to fine-tune positions with greater variability on the system. The day-ahead timeframe will remain an important component of the overall trading process, but the market arrangements should not give some form of de-facto primacy to the day-ahead timeframe, which could restrict the effectiveness of price formation and distort market operation. Specific requirements for the day-ahead timeframe are as follows:

- § no balancing obligations at day-ahead (or any other) stage – parties should not be bound to day-ahead positions and should instead be encouraged to trade to balance positions (or the system) right up to gate closure; and
- § consider allowing cross zone capacity allocation to reflect value of intraday and balancing –arrangements should not prevent allocation of interconnection capacity to intraday and balancing timeframes *if* the capacity has greater value in these timeframes.

Intraday

To allow parties to trade as close as possible to real-time and for them to take responsibility for balancing, suitable trading opportunities and products need to be available intraday. To provide for this, the following requirements should be delivered:

- § promote intraday liquidity e.g. through:
 - inclusion of balancing tasks hitherto managed outside the market (ramping of cables, structural imbalances around changes of the hour, grid congestion management etc.);
 - more active release and allocation of grid capacity;
 - fully enabling participation by financial players;
 - gate closure as close to real time as possible, potentially with closing auctions to pool liquidity at the end of trading periods;
- § 15-minute products to enable reduction of ramping restrictions and at a later stage to reflect the imbalance settlement period to be able to manage imbalance exposure;
 - opening auctions as a way to start trading 15-min products;
- § consider allowing cross zone capacity allocation to reflect value of intraday and balancing – as above.

Balancing

Market activities should be allowed to run for as long as possible in the time between day-ahead closure and real-time operations to allow parties the greatest opportunity to balance their own positions. Once balancing activities commence, there should be no market design barriers to allow balancing actions to be remunerated at the full marginal cost and as far as practically possible reflect the value of balancing. Specific requirements are as follows:

- § balancing market integration across borders, including price coupling;
- § shorter imbalance settlement periods – this allows for greater fine-tuning of trading to reflect variability of system conditions and allows for better targeting of balancing costs;
- § facilitate balancing by market parties;
 - gate opening for intraday as soon as possible after closure of the day-ahead process;
 - gate closure as close to real time as possible – this allows market activities to continue as long as possible;
 - increased transparency with close to real time visibility of (preliminary) prices;
- § no market design barriers to allow balancing market price to reflect full marginal cost (both for energy activation and where applicable capacity cost) – to ensure that providers of flexibility in balancing timescales receive the value of their flexibility; and
- § consider allowing cross zone capacity allocation to reflect value intraday and balancing – as above.

Imbalance

Getting the imbalance arrangements right is essential as the signals that imbalance prices provide influence behaviour and price formation in earlier trading timeframes. The key elements are that all parties should have responsibility to balance their positions and, to provide appropriate incentives to support this, imbalance prices should reflect the full marginal cost of balancing actions needed to resolve imbalances. Key requirements from this are as follows:

- § single imbalance price: under a single pricing method, imbalances are valued consistently regardless of their direction;
- § balance responsibility for all: no parties should be insulated from balancing responsibility;
 - parties will through service providers have the possible to buy these services from third parties in order to help them meet their balancing responsibility;
- § marginal imbalance price: pricing at the margin reflects the economic cost of resolving imbalance; and
- § imbalance price to reflect full marginal cost of balancing (including imbalance price to be set at VoLL in case of scarcity) – provides efficient long-term signals for users of balancing actions and efficient investment signals for providers of flexibility.

In the longer term, there might even be opportunities to permit market participants to play a role in the procurement and perhaps even the deployment of reserve. Any such changes must be consistent with secure system operation and the role of the TSOs as having 'last resort' responsibility for balancing the system. This type of future development would be facilitated by the reforms which we propose.

2.2.2 Framework for balancing and system services

Headline message: the means of securing balancing services can be more adaptable and open to non-traditional approaches, and appropriate value is paid for all system services

It is important to ensure that balancing services can be offered by a range of providers including new and old technologies. Product definitions should embrace new technologies rather than locking in old, and should not artificially exclude providers of useful services (including new or old providers who cannot completely fulfil the 'standard' product definitions). There should be competition to improve the **quality** of the services, not purely prices; especially at times of rapidly advancing technology.

To achieve this, the suggested actions are as follows:

TSO needs

TSOs need specific services to help them manage the system in real-time. But the framework of products and the means by which they are procured can be revisited. Requirements for a revised set of arrangements are as follows:

- § avoid reliance on rigidly defined standard products: rather than tightly defined products procured in silos, allow services that flex around defined product specifications to be offered, enabling the TSO to blend providers to satisfy its overall needs;

- § appropriate value paid for services: providers of services need to be remunerated based on the value of the service to the system preferably through market-based solutions; and
- § costs of forward balancing capacity procurement should feed into balancing costs: to ensure full cost balancing principles are adhered to, the costs of balancing services need to feed into balancing and imbalance prices, noting however that balancing reserves serve also in grid faults with the reserve costs thus partly covered through grid fees.

TSO incentives

TSOs should procure balancing services in a market-based way to support economic and efficient procurement and system operation. Requirements in support of this are as follows:

- § implement / strengthen TSO incentives to procure services efficiently and economically from market participants: ensure that TSOs have an interest in efficient and economic procurement without undue consideration of the TSO's own assets; and
- § incentivise overall system management costs rather than individual pots (capex, opex) to support efficient procurement overall: make sure that the incentive framework does not unduly tip the balance between opex (procurement from service providers) and capex (network investments).

Cross-zone

Balancing services activities should not be considered in national silos. Cross border assessment and procurement provides opportunities for enhanced efficiency overall. Specific underlying requirements are as follows:

- § sharing of cross-zone balancing resource: advance opportunities for balancing services to be bought and used cross border to allow more efficient procurement in aggregate;
- § wider regional assessment of balancing requirements: considering service requirements across a broader geography may allow for more efficient procurement also; and
- § efficient allocation of cross-zone capacity for regional balancing: to support efficient provision of balancing services, arrangements should allow for cross zonal capacity to be allocated for this purpose where this has positive economic value compared to its use in day-ahead or intraday energy trading.

2.2.3 Resource adequacy measures

Headline message: focus resource adequacy efforts upon making the market arrangements work

The final part of the vision is effectively a reinforcement of the previous two: if the wholesale markets as well as balancing and system services arrangements appropriately reward flexibility, availability and critical properties, and if the market offers tools that allow parties to efficiently manage and hedge balancing risks, there should be no need for separate resource adequacy measures in the long term. An additional condition is that there are no out of market subsidies which disturb the generation balance and tip it into overcapacity (additional interconnection outside the Nordic market mitigates this). If these

elements of the vision are achieved, the market can provide resource adequacy without additional interventions.

If there are issues in the nearer term, then consideration of a strategic reserve model is available as a resource adequacy bridge in the interim. However, this may be counterproductive to the achievement of the future vision of a market based set of arrangements unless the rules governing the activation and pricing of the strategic reserve make sure that it does not have a distorting effect on energy market prices.

2.3 Selection of focus areas

In the first stage of our study, a long list of market design topics was considered. In a selection process we together with our group of discussion partners selected to focus on specific topics based on a number of decision criteria:

- § importance;
 - what is the scale of expected benefits;
- § realistic timing;
 - can it be implemented by 2020 with results by 2025;
- § relevance;
 - is the market design change happening anyway; and
 - is it covered somewhere else adequately?

The next Sections focus on practical and pragmatic regional market design changes, based on this selection process, which are implementable before 2020. A key objective is that the proposed changes are sustainable in the longer term and serve as first steps towards the vision for future Nordic electricity market design presented in the previous section.

The proposed changes are structured around four areas:

- § Section 3: intraday market and consequences for the day-ahead and balancing markets;
- § Section 4: balancing and imbalance arrangements;
- § Section 5: system services; and
- § Section 6: strategic reserve.

In each case, we separate the market design ideas into 'recommendations' and 'further considerations'. The latter category contains ideas which were not generally accepted by our group of discussion partners as being of immediate importance, but which can potentially play a part in the enhancement of the Nordic arrangements and merit further analysis.

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3. BALANCING AND IMBALANCE ARRANGEMENTS

3.1 Role of the balancing market

Each TSO is responsible that sufficient balancing measures are available for the TSO to handle imbalances that may occur within its control area as well as potential fault situations. In the current Nordic balancing model, the BRPs are expected to balance their portfolio per hour before operational hour.

In addition to ensuring efficient short term operation, a key objective of the balancing market is ensure that the market framework – including any hedging products – can send investment signals to cover the maintenance of and investment in the right type of flexibility in the long run.

In the Regulating Power Market (RPM), generators and consumers provide a free option to increase or decrease generation or load at an activation price. TSOs activate at a sequence set by a common Nordic merit order list (relevant area limited by grid congestion only), price based on marginal pricing.

The main objectives in the current Nordic balancing market are two-fold:

- § frequency control, i.e. energy balancing, to solve energy imbalances; and
- § congestion management to solve local grid constraints

Currently, the main challenges are:

- § decreased frequency quality due to e.g. HVDC links and generators ramping around hour shifts; and
- § risk for lack of RPM bids in the multinational deficit area in the south (NO1, SE3, SE4 and DK2) and Finland.

The current challenges in system balancing are expected to increase in the future. These include¹⁸:

- § decreased access to balancing resources due to closing of thermal generation and a risk for lack of market-based resources; and
- § increased demand for balancing, i.e. larger imbalances;
 - faster, larger and more frequent changes in generation and ramping on HVDC links;
 - more variable generation in the Nordics;
 - increased interconnection to Continental Europe with significant amounts of variable generation;

This will require a re-thinking of roles and responsibilities between TSOs and the market. In the future, the market should and can help the TSO to manage the system, including:

- § incentives for BSPs and BRPs to support system balance;

¹⁸ Source: Statnett, Fingrid, Energinet.dk and Svenska Kraftnät. Challenges and Opportunities for the Nordic Power System.

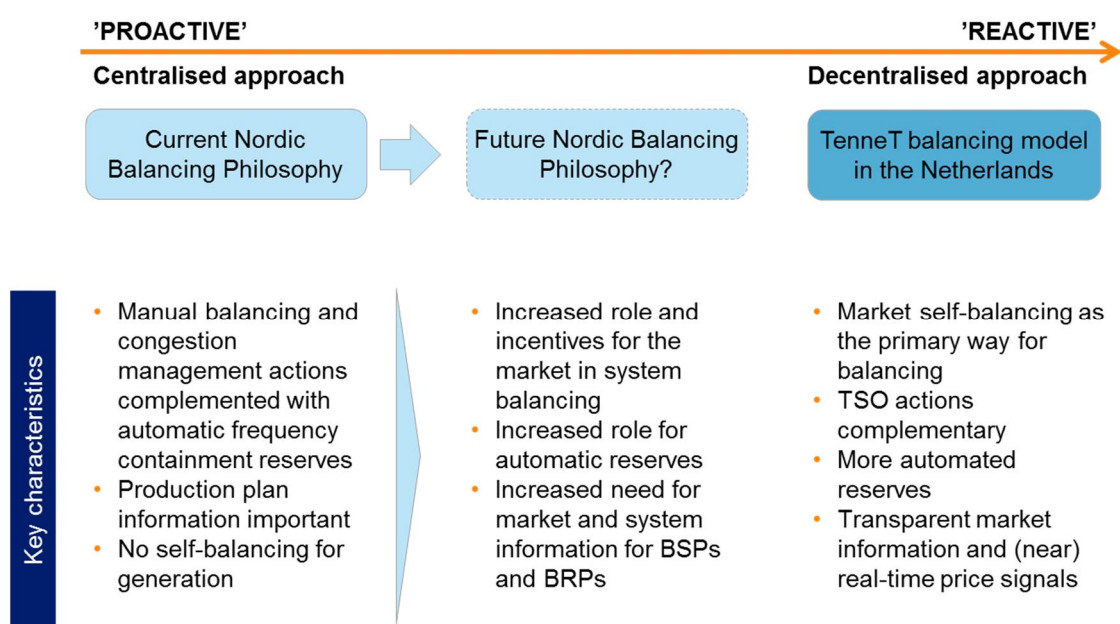
- § increased transparency on market and system situation, especially during times of scarcity; and
- § higher incentives to bid flexibility into RPM.

As a first step in this transition, a set of potential market design changes have been identified, which can be divided into two main areas:

1. Balancing and imbalance price formation: Changes to imbalance price formation to better reflect the real-time value of energy, especially during times of scarcity, provide incentives to support system balance.
2. Market facilitation: Increased transparency, shorter lead times and lower barriers for entry make it easier for market participants to support TSOs in system balancing.

The proposed changes would move the current Nordic Balancing Philosophy¹⁹ towards a more market-based approach in balancing (see illustration below).

Figure 7 – Balancing philosophies (illustrative)



3.2 Recommendations

3.2.1 Balancing and imbalance price formation

The proposed changes for balancing and imbalance price formation are presented in Table 6. Taken as a whole, these changes aim that balancing and imbalance reflect the real-time marginal value of energy, even in scarcity situations.

¹⁹ The Nordic balancing framework and process are described in a “Nordic Balancing Philosophy” documents, available at e.g.: <https://tinyurl.com/y76eg4mq>.

Table 6 – Proposed changes for balancing and imbalance price formation

| Proposed change | Description |
|---|--|
| Single price for imbalance settlement | Move to single-price and single portfolio imbalance settlement |
| Adjust price caps in the balancing market to reflect Value of Lost Load | Raise the price cap in the Nordic Regulating Power Market from 5,000 EUR/MWh to better reflect Value of Lost Load |
| Estimate any lost load in the imbalance position of the BRPs and the marginal imbalance price | In the event of involuntary load curtailments, any lost load should be estimated and included in the imbalance positions of BRPs and the calculation of the system imbalance volume and the marginal imbalance price |
| Remove link between balancing and imbalance prices with day-ahead prices | Remove the condition that the day-ahead price sets the floor for the up-regulation price and the cap for the down-regulation price, and consequently for imbalance prices (except as a backstop price in the event that there are no balancing trades, and if an intraday price cannot be used) |
| Include balancing energy exported outside the Nordics in balancing price formation | Whenever balancing energy is exported from one of the price zones in the Nordics to a price zone outside the Nordics, the exported energy should be included in the marginal price formation for balancing energy as is currently done with imported balancing energy (similarly as in day-ahead price coupling) |

The concept of single pricing is to give the right incentives for market participants to balance the system, based on transparency and sharing of information.

In addition single pricing:

- § is simple and enables participation from all available resources;
- § gives incentive to focus on the system imbalance rather than portfolio imbalances (if adequate data is made available to BRPs);
- § enables participation of resources outside standard balancing products, which are expected to become more prevalent as smart metering and demand side management evolves; and
- § lowers long-term costs and has lower administrative costs than the alternatives.

Challenges with the single pricing include:

- § for single pricing to be effective, participants must have access to accurate real-time information regarding the direction of the system imbalance and access to (at least indicative) prices; and
- § in extreme circumstances, there could be instability in the system as participants all chase expected imbalances unless there are good feedback mechanisms, perhaps boosted by regulatory limits on the extent of voluntary imbalance;

- such limits could be defined per BRP and price zone and/or there could be a process to coordinate activations with the TSO.

Raised price caps and estimating any lost load in the imbalance positions of BRPs and the marginal imbalance price apply to situations which are rare by nature, i.e. when the system is tight or load is actually curtailed, **sharper price signals during times of scarcity are a key element of the “energy only” market functioning properly.**

In addition, the benefits include:

- § incentivises providers of flexibility even with high marginal costs to bid into the RPM or support the system during the operational hour (15 min in the future) if adequate information is made available; and
- § incentivises BRPs to hedge their volume and price risk with physical or financial instruments thus creating more liquidity to trade flexibility outside the TSO markets.

The main challenge with sharper scarcity prices is that it increases the price risks for BRPs if there are no tools to hedge their position. High volatility is more difficult for smaller and non-portfolio market players which can be more exposed to individual price spikes. Moving to single-price imbalance settlement helps to mitigate this issue as market participants can then create instruments to hedge themselves against imbalance price spikes.

Linking the balancing and imbalance prices with the day-ahead prices sets a restriction on free price formation. As updated information is received on e.g. wind forecasts, the situation can change so that the marginal cost to produce energy for up-regulation can be cheaper than it was in the day-ahead stage. Removing this link can lead to situations where the imbalance price is lower than the day-ahead even during up-regulation settlement periods and might provide incentives for market participants to speculate against the imbalance prices. In the long run, free price formation should however lead to the most efficient market outcomes and is in the philosophy of the energy only market.

Currently, only actions taken to balance the Nordic system influence the imbalance prices in the Nordic RPM. However, bids in the Nordic RPM can also be used to support surrounding systems with mFRR. This means that the price coupling in the balancing timeframe differs from other timeframes: import of balancing energy impacts the price as it is considered an action to balance the Nordic system, but export does not. The inclusion of balancing energy exports is also a clear part of European balancing market integration, and should be implemented as soon as possible to provide correct marginal signals for providing balancing services across price zones.

3.2.2 *Market facilitation*

The proposed changes for market facilitation of system balancing are presented in Table 7. These changes aim to make it easier for market participants and allow a wider range of resources to support TSOs in system balancing.

Table 7 – Proposed changes for market facilitation of system balancing

| Proposed change | Description |
|---|--|
| Remove obligation to balance | Remove any balancing obligations at the day-ahead and any other stage. |
| Publish information on system imbalance and balancing and imbalance prices in real-time | Balancing activations and prices should be published as close to real-time as possible, which serves as an indication for imbalance prices |
| Balancing market gate closure closer to real-time | The gate closure to submit bids to the Regulating Power Market should be moved as close to the operating hour as possible |
| Balancing market minimum bid size to 1 MW | Reduce the minimum bid size in the balancing market to 1 MW and take electronic activation into use |

Given the increasing share of fluctuating electricity generation, a rule stipulating that balance must be ensured 12-36 hours prior to the hour of operation is contrary to the inherent characteristics of the market. Any balancing obligations at the day-ahead stage, or any other stage, should be removed and participants should instead be encouraged to balance the system.

Increased transparency on system imbalance as well as balancing and imbalance prices would provide the market participants better information and incentives to support TSOs in balancing. As part of the move to single imbalance pricing, it is important to provide transparent information to the market so that they are able to react in real-time (demand) or submit balancing bids for the next imbalance settlement period (generation). Publishing bid curves could be considered as an additional way to improve transparency, but it requires further analysis.

As has already been mentioned, unpredictability will play an even more pronounced role in the electricity system in the future with the increasing integration of variable generation. Trading closer to the hour of operation can reduce the forecasting errors by the market participants and contribute to balancing the electricity system as a whole. On the other hand, the closer trading occurs to the delivery hour, the less time there is for TSOs to plan their balancing actions to respond to imbalances and grid congestions. This is an area which requires further discussion among the Nordic TSOs, market participants and stakeholders.

A smaller balancing market minimum bid size lowers the barriers for new entrants, especially from demand-side and other distributed resources such as storage and small-scale generation. For practical reasons, electronic activation is required with a smaller minimum bid size and a larger number of bids. The new resources, which could emerge in the balancing market after reducing the minimum bid size, would be different in nature to the existing resources i.e. conventional large-scale generation. This might require a revision of current requirements to access the balancing market to make sure the requirements are fit for purpose and not overly restrictive towards smaller scale resources. On the other hand, an adequate level of system security needs to be guaranteed and

there needs to be a level playing field for different types of resources, e.g. same pre-qualification process.

3.3 Further considerations

This section consists of market design changes which could be considered in the future, if the other market design changes proposed here are considered inadequate.

3.3.1 Scarcity adder and pricing

An upfront payment for reserve products can distort (dampen) the imbalance price and may lead to the 'missing money' problem. This in turn can create a disincentive for new entrants (such as demand-side response) as energy prices and price volatility are dampened.

Within the balancing (and other spot) markets, there should ideally be no price caps or regulatory controls on bidding, and any market power mitigation should be done in ways which does not distort short term energy price formation. So, in general, any effect that reserve contracting could have on balancing and imbalance prices should be removed.

This can be achieved through various ways and here we focus on two of those:

- § an appropriate 'adder' for distributing the actual reservation fees for contracted reserve capacity procured by the TSO, included in the balancing prices, and based on expected utilisation; and/or
- § a Reserve Scarcity (VoLL/LOLP) Function for pricing reserve (when used to balance the system).

An illustration of the first approach on how the adder could be calculated for one reserve product on a marginal basis is shown in Figure 8.

Figure 8 - Illustration of an 'adder' calculation based reservation costs



The calculation of the adder can be complex for the following reasons:

- § 'Price per day':
 - different countries have different procurement periods for different reserve products (although this might be harmonised in the future);
 - Reserves are procured on pay-as-clear and pay-as-bid basis, which makes it difficult to allocate costs on a marginal or even average basis (might also be harmonised);
- § 'Expected utilisation per day':
 - certain reserve products, e.g. fast disturbance reserves, are used for different purposes (non-balancing actions) and it varies daily and annually; and
 - this could be solved by e.g. some kind of averaging based on historical years.

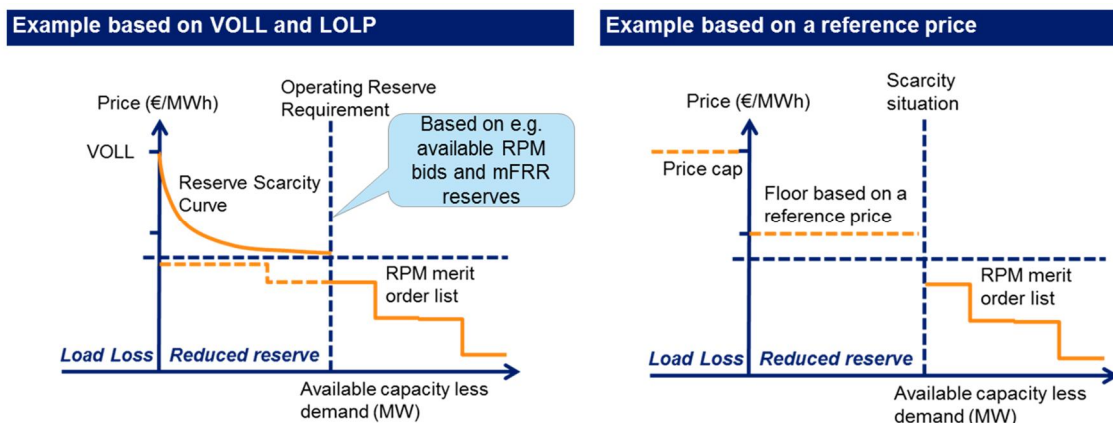
A first step would be to analyse which reserves serve which purpose and to what extent.

The latter approach, Reserve Scarcity Function, is based on Value of Lost Load (VoLL) and Loss of Load Probability (LOLP), which is a function of the available reserve capacity. Instead of actual reservation fees, the scarcity price or adder is based on the value of avoided load curtailment and the probability for that happening. Scarcity pricing will apply when there is insufficient available capacity to cover the combination of demand and the target level of operating reserve.

As LOLP can be complex to define, a simpler alternative could be to use a reference price as a floor to balancing and imbalance prices during a scarcity situation, e.g. when the reserve margin is below a certain limit. This reference price could be a multiple of the DA or ID market price. In both alternatives, if the TSO is forced to shed load, the imbalance price should be at least at the balancing energy price cap.

Illustrations of the two alternatives described above are in Figure 9.

Figure 9 – Illustrations for the calculation of an administered scarcity price



Regardless of the approach, scarcity pricing can be applied to both the balancing and imbalance prices or only to the imbalance price. Applying it to both keeps balancing and imbalance prices consistent and they provide a similar incentive to BSPs and BRPs. By applying it only to the imbalance price, there are no direct incentives for BSPs to increase supply in the balancing market, but the expectation of higher imbalance prices incentivises BRPs to trade portfolios into balance in the ID market thus increasing the value of flexibility in these market at times of (expected) scarcity

A summary of the approaches and their expected benefits and disadvantages is presented in Table 8.

Table 8 – Comparison of different approaches to reflect scarcity in imbalance (and balancing) price signals

| | Expected benefits | Risks / disadvantages |
|---|--|--|
| Calculation of adder based on expected utilisation | <ul style="list-style-type: none"> Reservation fees, at least some, reflected explicitly in the balancing and imbalance prices instead of socialised fees | <ul style="list-style-type: none"> Adder based on expected utilisation difficult and non-transparent to calculate Cost allocation difficult due to different products, procurement periods and pricing (PAB vs. PAC) in different countries |
| Scarcity pricing for balancing and imbalance price | <ul style="list-style-type: none"> Sharper marginal signals in times of scarcity reflecting the true cost of curtailments Consistent balancing and imbalance pricing | <ul style="list-style-type: none"> Possibly complex implementation, definition of VOLL can be seen as arbitrary Scarcity price may be subject to manipulation if capacity is withdrawn No explicit link between reservation fees and scarcity pricing, cost coverage still done through socialised fees |
| Scarcity pricing only for imbalance price | <ul style="list-style-type: none"> First bullet same as above No incentives for BSPs to withhold capacity to trigger scarcity pricing Expectation of higher imbalance prices should incentivise BRPs to trade their imbalances in ID market increasing the value of flexibility | <ul style="list-style-type: none"> Same as above, and in addition: Inconsistency between balancing and imbalance prices, which makes it more difficult to create hedging products |

3.3.2 Combining aFRR and mFRR activation prices

Based on the 'Agreement on a Nordic Market for Frequency Restoration Reserves with automatic activation (aFRR)²⁰:

- § the common Nordic market for aFRR balancing services will eventually include an activation market in addition to a capacity market;
- § as a first step, the aFRR market will consist only of a capacity market and bids will be activated on a 'pro-rata' basis; and
- § In a pro-rata scheme, all aFRR providing units are activated simultaneously.

This means that there is a transition period in the Nordic aFRR with two phases:

1. Without the energy activation market – short term
2. With the energy activation market, i.e. merit order list for aFRR activation – mid to long term

The expected increased role of aFRR in system balancing means that its activation price should be included in imbalance price formation. We have identified three alternatives for combining the activation prices of aFRR and mFRR (the RPM market). The expected benefits and disadvantages of these alternatives are presented in Table 9.

²⁰ Available at e.g.: <https://tinyurl.com/yc3ws3sl>

Table 9 – Comparison of different alternatives for combining activation prices of aFRR and mFRR

| Identified options | Expected benefits | Risks / disadvantages |
|---|---|--|
| A <ul style="list-style-type: none"> Balancing prices separate Imbalance price based on weighted average of aFRR and mFRR | <ul style="list-style-type: none"> Volumes of different standard products represented in correct proportion in the imbalance price | <ul style="list-style-type: none"> Inconsistent balancing and imbalance pricing → risk for arbitrage between balancing and imbalance prices |
| B <ul style="list-style-type: none"> Balancing prices separate Imbalance price based on marginal price of aFRR and mFRR | <ul style="list-style-type: none"> Sharper marginal price signals for imbalance settlement | <ul style="list-style-type: none"> Creates a surplus for the TSO which has to be re-distributed Inconsistent balancing and imbalance pricing |
| C <ul style="list-style-type: none"> Common merit order list for activation prices of aFRR and mFRR Imbalance price = marginal balancing price | <ul style="list-style-type: none"> Sharper marginal price signals Consistent balancing and imbalance pricing | <ul style="list-style-type: none"> Effectively removes the difference between the standard products when it comes to activation |

As the Nordic market for aFRR has been introduced only recently and there is little historical data available, it is premature to take a decision on the different options at this point. This should be kept under review and analysed further once there are more experiences of the dynamics of the aFRR product compared to mFRR and the energy activation market for is about to be introduced.

3.3.3 The role of market participants in reserve procurement and provision

In the longer term, there might even be opportunities to permit market participants to play a role in the procurement and perhaps even the deployment of reserve. Any such changes must be consistent with secure system operation and the role of the TSOs as having 'last resort' responsibility for balancing the system. This type of future development would be facilitated by the reforms which we propose.

The Balancing Resource Options (BROs) mechanism is a straw man concept developed by Pöyry to permit participants to hedge against balancing and imbalance prices as well as play a role in the procurement of reserve.²¹

²¹ Further description available at: <https://tinyurl.com/ybvjmky>

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4. THE INTRADAY MARKET AND CONSEQUENCES FOR THE DAY-AHEAD AND BALANCING MARKETS

4.1 Role of the intraday market

The main objective of the intraday market is to allow market participants to rebalance their portfolios before the operational hour.

The intraday market, with trading over a range of timeframes from closure of the day-ahead market to approximately 1 hour before delivery, allows resources with different degrees of flexibility to achieve different prices. It would be a reasonable expectation that although the average prices for energy traded at different times (day-ahead, intraday and balancing) should converge over time; the volatility of prices will increase as markets trade closer to physical delivery. More flexible resources would therefore be able to capture better prices from the close-to-real-time markets (to the extent that the flexibility that they offer is scarce). Therefore, the need for and provision of different types of flexibility can be rewarded in the ID as well as the balancing market.

To ensure that the flexible resources are used in the most efficient way from the perspective of the system as a whole, the range of achieved prices in different energy trading timeframes should feed back to the timeframe in which capacity is committed. It can be a waste of resources to lock in flexible capacity too early. This goes both for generation (and demand-side) capacity as well as network capacity. The allocation of capacity between timeframes should ideally be based on a view at each stage of the opportunity value on offer in future timeframes.

In the Nordic market, the intraday market has met relatively little interest up to now due to a relatively small imbalance price and volume risk, and liquidity is lacking. The role and volumes of the ID market are expected to increase, within and between the different price zones in the Nordic area and other parts of Europe, because:

- § The intraday market will have an important role in bridging hourly commitments to 15-minute imbalance settlement. The day-ahead market is, for the time being, expected to remain with hourly time resolution, and balancing to move to 15-minute resolution.
- § There will be an increasing need to adjust volume commitments related to forecast errors of variable generation.
- § In the Nordic market, rapid load and flow changes between hourly day-ahead blocks create disturbances in system frequency. Today, this ramping challenge is solved essentially outside the market through requirements placed on the generators and on maximum hourly flow changes on DC links.

We suggest that the intraday market in a few years will take a fundamentally new role as an essential part of the market sequence through:

- § more efficient use of cross-zone capacity through (in some form) capacity being made available to the intraday market;
 - if economic mechanisms for allocation of capacity across timeframes are not workable in the short term, intraday capacity may be made available through capacity release by TSOs based on recalculation of cross-zone capacities after the day-ahead trades and adjustment of flows after closure of the day-ahead market;

- § transforming volume commitments from hourly to 15-min resolution, which also enables to solve the ramping challenge of cables and stabilising system frequency at hour changes within the market.

If more impetus is to be given to intraday trading, transparency and accuracy of information is essential. Market players should have good information on their own position as well as the system as a whole. To support this, transparency of key system-wide metrics, updated frequently, is required. Another key aspect is to allow trading to occur as close to real-time as possible. The expectation is that the intraday cross-zonal Gate Closure Time (GCT) will most likely be harmonised at H-60 min at EU level as part of the XBID project. A 30 min GCT was piloted in the Nordic Elbas market in Finland and the Baltic countries between September 2016 and March 2017. Based on positive market feedback, Nord Pool continued with the 30 min GCT in these countries.

4.2 Recommendations

The proposed changes for the intraday market are summarised in Table 10. Taken together, these changes support effective intraday markets with good liquidity, the valuing of flexibility in different market timeframes and forward trading of flexibility, e.g. in the form of options of traded in advance. The changes are presented in more detail in the following Sections.

From the perspective of the group of sponsors of this study, the recommendations in this section are directionally correct in terms of the plan and vision for Nordic market design. However, there was disagreement among the group over the prioritisation and technical feasibility of individual changes, especially around gate closure time and allocation of cross-zone in the intraday timeframe.

Table 10 – Proposed changes for the intraday market and consequences for the day-ahead market

| Proposed change | Description |
|--|---|
| Intraday auctions | <p>§ A single opening auction on day D-1 (no later than 3pm CET) for all market time units for the following day as close as practically possible to the setting of day-ahead prices and recalculation of available capacities.</p> <p>§ The auction should use 15-min products.</p> <p>§ Continuous trading from the resolution of the opening auction until the gate closure time of the ID market, which could be combined with a closing auction.</p> |
| Intraday gate closure time (GCT) as close to real-time as possible | <p>§ The regional cross-zone intraday GCT in the Nordics should be as close as to the operating hour as possible, 30 min as a starting point.</p> <p>§ Shortening the GCT for intraday trading should ideally be accompanied with change to the deadline for submitting production plans.</p> |
| Information transparency between market participants and TSOs | As market participants trade closer to real time, greater transparency is needed. Market participants should provide the TSO with information which is detailed and up to date, and the TSO should provide consolidated data on the overall system position. |
| Price cap in the intraday market | In line with the change to the balancing market price cap (see Section 4.2.1 below), price cap in the intraday market should be set to reflect the value of lost load to 9999 EUR/MWh as outlined in the all NEMO proposal ²² . |
| Allocation of cross-zone capacity across market timeframes through an explicit cross-zone capacity product | Start a process to define a way to allocate cross-zone capacity across market timeframes. This report contains a proposal by Pöyry for a dynamic market based approach. There are alternative solutions which may be workable, perhaps as transitional measures. We recommend this for further exploration |

4.2.1 Intraday auctions

This section presents a proposal for intraday auctions that we believe will solve the issues at hand. At the opening of the intraday market, a range of needs will be competing for the same resources:

²² All NEMO's proposal for harmonised maximum and minimum clearing prices for Single Intra Day Coupling in accordance with Article 54(2) of Commission Regulation (EU) 2015/1222 of July 2015 establishing a guideline on capacity allocation and congestion management. 14 February 2017.

- § volume adjustments related mainly to ramping of cables and dissolution of hourly commitments; and
- § potentially, capacity bids from TSOs and market participants for later timeframes (see Section 3.2.5).

The effect of these stacked-up needs and the general complexity of simultaneously managing capacity and flow at the opening of the market could make trading in a continuous market difficult. Unless there is an opening auction, market participants will compete to push the bid entry button first. Auctions have other benefits, as well:

- § TSOs should only be allowed into continuous trading of capacity in exceptional circumstances and through specific procedures, but could be allowed into an opening auction with their bids and offers without becoming full-fledged market participants; and
- § if explicit capacity products are implemented (3.2.5), an opening auction would provide transparency of capacity valuations.

Continuous trading will solve the need of companies with weather-dependent generation or demand, as well as during capacity failures. Extra auctions in addition to an opening auction would be required if there is a relevant market related event that occurs every day. With a large-scale release of reserved capacity, for instance, a further auction could be warranted.

There may also be merit in holding closing auctions. The concept would mean that continuous trading for each market time frame is stopped during a minimum of time and as close to intraday gate closure as possible. The TSOs should then calculate remaining cross-zone capacity that together with market participants' bids and offers are settled with an implicit intraday auction, with pay-as-clear. In case congestion occurs between price zones, the TSO would collect congestion income. The general benefit of adding an ending auction is that it provides an opportunity to trade larger volumes closer to real time. It enables liquidity concentration and a transparent price reference. It should be possible for actors to automatically transfer bids in the continuous market to the auction if not matched. Within the auction time, actors should have possibilities to make new bids and offers or revise those transferred from continuous trading. However, the disadvantage is that a closing auction might drain liquidity from the continuous market, leaving participants less able to manage intraday forecast changes until very late; increasing their cost of trading out positions and foreclosing less flexible service providers.

We propose the following solution for the intraday market:

- § a single opening auction on day D-1 for all market time units for the following day as close as practically possible to the setting of day-ahead prices and recalculation of available capacities;
 - ideally this should be harmonised and coupled across Europe;
 - if this is not possible, an earlier gate opening time should be considered for the Nordics and neighbouring countries;
 - in any case, continuous trading should not be closed until the opening auction unless 14:00 or 15:00 is workable for the opening auction;
- § the auction could use 15-min products as a way to reduce ramping restrictions on interconnectors. The Nordic TSOs are aiming for 15min metering for, at least, large market participants from 2020 which would tie in with the commissioning of new cables and the introduction of 15min in the intraday. Should there be any delays in

implementation, 15min metering for domestic customers could be based on profiling (as a backup).

- § continuous trading from the resolution of the opening auction until the gate closure time of the intraday market, which could be combined with a closing auction.

We envisage the following benefits:

- § the opening auction provides a level playing for bidding for the released cross-zone capacity based on DA market outcomes. Effective allocation of capacity is required to realise the full benefits from an ID opening auction;
- § 15-min products in the auction provide a way to solving ramping restrictions on HVDC flows related to hour shifts as well as rearrangement of volume commitments from an hourly day-ahead market;
- § with a single auction, there are no material interruptions for continuous trading; and
- § the gate opening time for the auction (no later than 3pm CET) reduces the need for staffing on out of office hours.

The value of an opening auction is diminished if it is not coupled with at least with some of the countries which are interconnected with the Nordics, especially Germany which has Europe's most dynamic intraday market.

Regardless of the approach and the details of the changes, it is important that the TSOs systematically recalculate and release available capacity during continuous trading so that all possible cross-zone capacity can be utilised by the market (although this may include allocation to later timeframes, if a workable method can be agreed). This capacity recalculation process needs greater transparency. It should also be noted that the potential mechanism for explicit capacity products presented in the Section 3.2.5 would allow TSOs to buy back capacity, potentially allowing them to be less conservative in their initial allocation.

4.2.2 *Intraday market gate closure time*

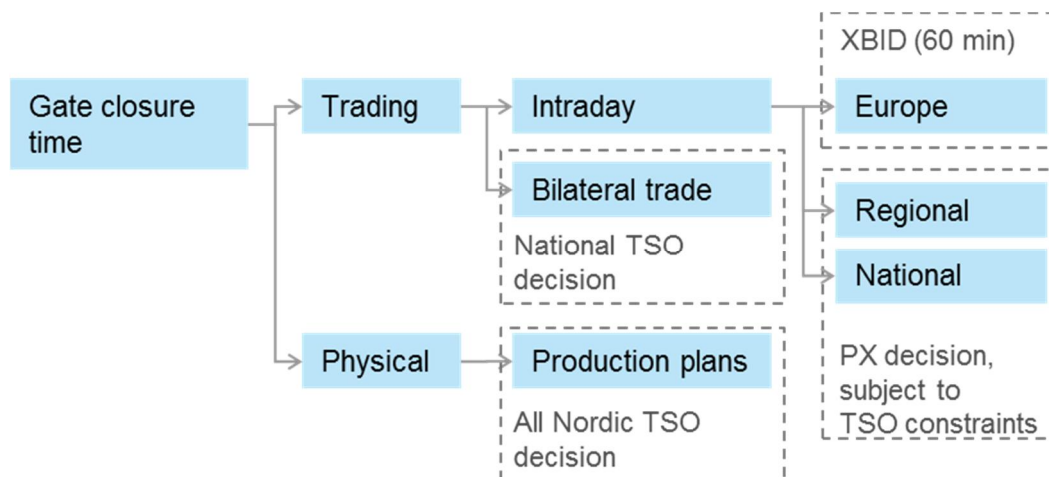
The issue of intraday market gate closure time (GCT) has several aspects which are illustrated in Figure 10. National TSOs are responsible for deciding the deadline for bilateral trade within a price zone. The deadline for submitting production plans is harmonised across the Nordics and is currently H-45. While XBID will set a gate closure time for trading in the single intraday market, there should be room for closer gate closure times regionally and nationally if the market considers them beneficial and the TSOs have enough time to plan their balancing actions. The current all TSO proposal by ENTSO-E is 60 min for a harmonised cross-zonal GCT.²³

The regional cross-zone intraday gate closure in the Nordics should be as close as to the operating hour as possible. Shortening the GCT for intraday trading should ideally be accompanied with a similar change to the deadline for submitting production plans. As with the issue of the timing of the ID opening auction, the benefits from moving the GCT are greater if it applies to cross-zone trading the Nordics and neighbouring markets.

²³ All TSOs' proposal for intraday cross-zonal gate opening and gate closure times in accordance with Article 59 of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management. 18 April 2016. Draft for consultation.

The benefits of closer gate closure are the same as for the balancing market.

Figure 10 – Different gate closure times and relevant stakeholders



4.2.3 Information transparency

As market participants trade closer to real time, greater transparency is needed. Market participants should provide the TSO with information which is detailed and up to date on their balance portfolios, and the TSO should provide consolidated data on the overall system position. For market participants, this could consist of preliminary and final production plans on a unit level above a certain size limit.

This allows the market participants to take better informed decisions on their balance portfolios and the TSOs to prepare for their actions during the balancing timeframe.

4.2.4 Price cap in the intraday market

In line with the change to the balancing market price cap, price cap in the intraday market should be set to 9999 EUR/MWh, as outlined in the all NEMO proposal, so that prices in the ID market are able to reflect the value of lost load. As the probability for scarcity is smaller in the intraday market timeframe than it is real-time

4.2.5 Allocation of cross-zone capacity across market timeframes

Allocation of cross-zone capacity across market timeframes is in our opinion a key market design element of the energy only market. Hence, we would argue that a Nordic process to define an approach and estimate the costs and benefits should be started. There are several approaches ranging from a static allocation across timeframes to a fully dynamic and market-based. A recent example in the Nordics includes the TSOs' proposal to allocate capacity for the exchange of aFRR reserves.²⁴

²⁴ Source: Agreement on a Nordic Market for Frequency Restoration Reserves with automatic activation (aFRR), Appendix 2. The Nordic aFRR Capacity Market. Available at: <https://tinyurl.com/y9qvlj6f>

This section outlines an innovative mechanism for the simultaneous pricing and allocation of capacity between day-ahead, intraday, and (potentially) balancing timeframes.²⁵

The concept needs further appraisal, and also (if the assessment is positive) detailed design work on the practical implementation pathway and its potential interaction with the ENTSO-E proposals for additional intraday auctions. We have carried out an initial screening of the concept (with expert input) for compatibility with the existing power exchange and TSO capacity calculation processes.

4.2.5.1 Objectives for the intraday capacity pricing and allocation mechanism

In terms of economic efficiency, the primary purpose of a price is to maximise welfare (socio-economic value) by allocating scarce resources to where value is highest.

The present arrangements for capacity allocation and day-ahead market coupling allow TSOs (or capacity holders) to capture congestion revenue from cross-zonal infrastructure based on day-ahead price differentials. However, this underestimates the value of the asset for two reasons:

- § firstly, any capacity which remains unallocated at the day-ahead stage (including capacity in the reverse direction) is awarded to the market without charge; and
- § secondly, because the intraday value is not considered, the day-ahead capacity may itself be systematically undervalued²⁶.

However, the lost revenue is not the only motivation for the need to price intraday (and balancing) capacity. Instead, capacity should be appropriately allocated across timeframes, and the market valuations should determine this allocation.

4.2.5.2 Outline of proposed methodology for intraday capacity pricing and allocation

The proposed methodology consists of the following elements:

- § A new explicit capacity product for capacity between bidding zones is introduced in the day-ahead market.
- § All available capacity is released for the day-ahead market.
- § TSOs may bid in the market for the capacity they deem to be necessary for balancing purposes. The price of their reservations will then be transparently available for other market participants.
- § Allowing participants to bid to hold capacity to intraday or balancing timeframes if they bid sufficiently to justify deferring a firm energy trade.
- § A similar explicit capacity product is introduced in the intraday market and traded in the opening auction and in the subsequent continuous market.
 - In the opening auction of the intraday market, the TSOs may adjust their reservations by offering reserved capacity to the market or through buy-back.

²⁵ The concept is presented in more detail at: <https://tinyurl.com/y92l5ehr>

²⁶ There may be further distortions on the day ahead pricing and any congestion revenue as a knock-on consequence of the inefficient allocation of network capacity between timeframes.

- Market participants that have bought capacity may offer their capacity in the market through the opening auction or in the continuous trade as explicit capacity or embedded in trades that are closed to others.

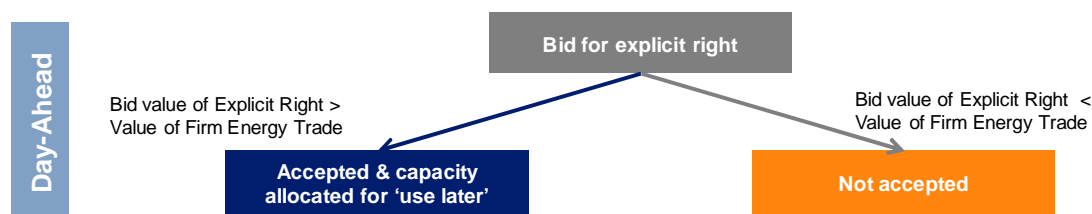
If there are implementation barriers arising from the operation of EUPHEMIA (with or without Flow Based Market Coupling) or XBID, then we would advocate the (transitional, as required) use of mitigating measures.²⁷

Purchase of explicit intraday products in day-ahead auction

At the Day-Ahead stage, TSOs and market participants would be given the opportunity to submit bid prices to buy explicit, directional capacity rights between pairs of price zones (adjacent zones in the NTC case and any two zones in the flow-based case). These products would be additional to the products listed for firm energy in each zone.

The orders submitted for these explicit capacity rights would compete with the implicit capacity value from the flows emerging from energy orders in each zone. Capacity allocation will depend on the relative value as revealed in the market orders for energy flow and for later use. The market value of capacity will be visible first in the day-ahead auction and then in the intraday markets.

Figure 11 – Purchase of explicit capacity rights at the day-ahead auction



Product definition

The precise nature of the explicit intraday rights needs further definition. Ideally the explicit capacity products would take the form of options; e.g. a one-way contract on the price differential between the two price zones at the expiry time (intraday or balancing). The expiry time for the options could be defined as a point before intraday gate closure, or perhaps to coincide with an intraday auction (e.g. as defined in the ENTSO-E proposals); or to expire in the balancing timeframe. The holder would be able to exercise the rights as physical trades against the prices in the intraday (or potential balancing) market.

The proposed initial product is in reality also an option on the value between price zones. Its formulation depends on whether the capacity allocation in the day-ahead algorithm is applied as flow-based or not. In an NTC application, it will be possible to bid price-dependently for explicit capacity between *adjacent price zones*. In a flow-based application, explicit capacity could be allocated between *any two price zones which might not be adjacent*.

²⁷ The detail of this needs closer discussion with the power exchange operators to understand how much of the intent of the proposal could be accommodated. Potential mitigations presented at: <https://tinyurl.com/y92l5ehr>

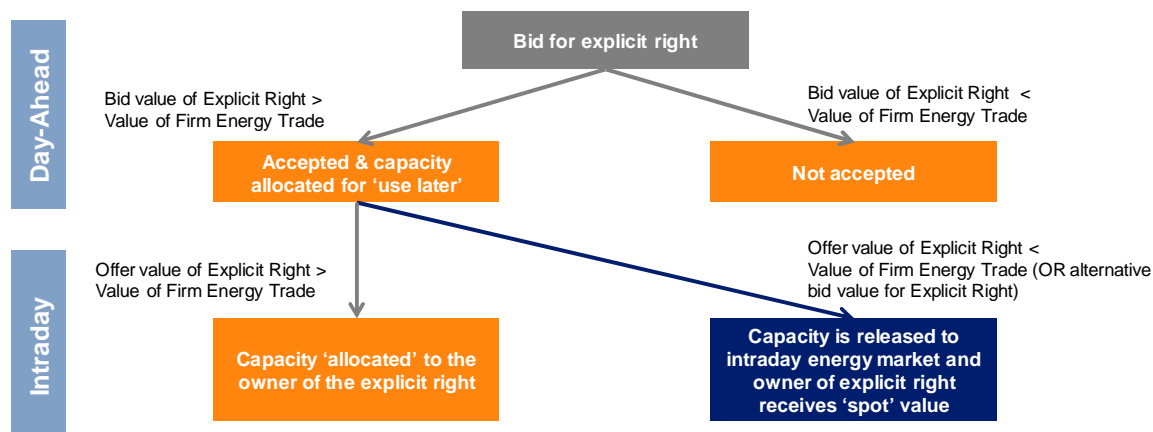
Sale and purchase of explicit intraday products in the continuous intraday market

In the ideal model, these explicit intraday capacity products would also be integrated in XBID and the associated intraday Capacity Management Module (CMM).²⁸ During the subsequent continuous intraday market, the holder of explicit capacity products would (be obliged to) offer the capacity to the intraday market at an offer price. If, during the continuous trading, the intraday price spread rises to reach the offer price for the intraday capacity products, then:

- § the explicit intraday capacity would be released;
- § the pair of matching energy trades in the intraday continuous market would be executed; and
- § the holder of the intraday capacity rights would realise the congestion revenue based on their offer price (with the money coming from the prices of the energy trades in the two zones).

This is also shown schematically in Figure 12Figure 12.

Figure 12 – Sale of explicit capacity right in the intraday market



This would also give a mechanism to buy back capacity which had already been released to the market. This could be done by TSOs if they had released too much capacity, or (subject to appropriate transparency restrictions) if they wished *ad hoc* to buy cross-zonal capacity for use in balancing. The buy-back mechanism would also be open to market participants who valued the intraday capacity option above the price differential between the price zones. If a participant bid a high enough price for the explicit rights (i.e. sufficient to pay for a counter-trade between the two price areas based on the orders in the market at that time), then:

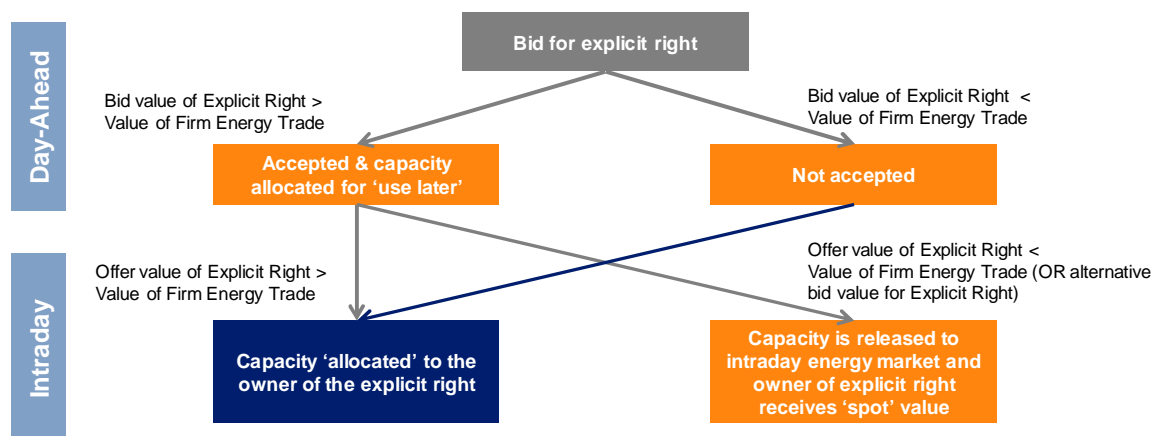
- § the pair of matching energy trades in the intraday continuous market would be executed (in this case a sale in the low price zone and a matching purchase in the high price area);

²⁸ Potential mitigations presented at: <https://tinyurl.com/y92l5ehr>

- § the buyer of the intraday capacity right would pay for these energy trades (essentially a countertrade, whose cost must be less than or equal to the amount that they offered to pay); and
- § in return for which the buyer would take ownership of the intraday capacity right, which they could later sell.

This is also shown schematically in Figure 13.

Figure 13 – Purchase of explicit capacity right in the intraday market



Sale and purchase of explicit intraday products in intraday auctions

An opening auction will most likely be introduced in the intraday market. At any auction, holders of explicit intraday capacity could offer sell prices for their capacity. If the asking price were reached by the implicit value of cross-zonal energy trades, the capacity would be released, the energy trades would be executed and the holder would receive the congestion revenue; based on the marginal clearing prices in the two zones.

Similarly, there could be bids to buy capacity between price zones. As in the continuous intraday model; if the prices bid were high enough to trigger energy counter-trades then the trades would be executed and the intraday capacity right would be released to the successful bidder.

Regulatory oversight

Any discussion of explicit capacity rights results in discussion of capacity hoarding. Our proposals could be accompanied by any number of restrictions which would limit the potential impact of market power, such as:

- § a requirement that any explicit capacity rights must be offered to the intraday market with a price, so that the market could use (and pay for) the capacity at any time when the intraday price differential matched the asking price;
 - this could be further strengthened by applying price caps, or perhaps maximum mark-ups on the sale price of explicit rights in absolute or relative terms compared to the price paid;
- § fixed expiry times for the products (a type of use-it-or-lose-it), which would force them to be sold and the capacity utilised even with a zero price differential at that time (which is similar to the existing treatment day-ahead, but at a later time);

- § a limitation on the maximum amount of capacity which could be allocated to intraday or balancing, irrespective of the prices offered:
 - this might be zero on some zone pairs, as today;
 - as an example, the Nordic aFRR market opens with a maximum allocation of 10% of the estimated DA capacity for aFRR balancing²⁹;
- § a limitation on dominant market participants within any price zone from buying cross zone capacity in one or other direction.

We anticipate that any such regulatory restrictions would be a matter for the local regulatory authorities.

²⁹ Source: Agreement on a Nordic Market for Frequency Restoration Reserves with automatic activation (aFRR), Appendix 2. The Nordic aFRR Capacity Market. Available at: <https://tinyurl.com/y9qvlj6f>

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5. SYSTEM SERVICES

5.1 System service capabilities in the Nordics

System services are services essential for the functioning of the power system and hence determine the quality of the supply of electricity. System services are listed in Table 11.

Table 11 – Categorisation of system services

| | |
|------------------------------|---|
| Frequency control | § inertia; |
| | § primary, secondary and tertiary response (FCR and FRR); |
| | § ramping; |
| Voltage control | § reactive power control; |
| | § short-circuit current; |
| Restoration of supply | § black start capability; |
| | § island mode operation; |
| System management | § congestion management (re-dispatch); |
| | § fault ride through; |
| | § emergency control actions; |
| | § etc. |

The capabilities (critical properties) to provide these services are built into power plants.³⁰ In the Nordics, the current capabilities and challenges for system services are largely the same as has already been discussed previously on balancing:

- § Most of the time, abundance of flexibility in some areas of the market provides relatively cheap system services within the synchronous system.
 - The availability of these resources is mainly limited by grid constraints, seasonal effects and dry year situations.
 - In addition, reactive power does not transport well and is more of a localised product.
- § This means that costs (market prices) in general will be low, and that shortage/contingency situations where extra assets are required are rare.

The same is expected to apply to future development:

- § Increased need for but reduced access to flexibility, in this case reserve capacity, due to increase in RES and HVDC capacity and decrease in thermal capacity and decreased use of reservoir hydro power in hours with high RES generation and low demand, which also leads to a decrease in inertia.
- § As thermal capacity is operating fewer hours or is decommissioned, the supply of different system services reduces.

³⁰ Set out by the Guideline for System Operation (SO) and Requirements for Generators (RfG)

- This means that services, which were previously considered as ‘automatic’ by-products of electricity generation, might become scarce.
 - For example, this was a focus of the Danish market design project Market Model 2.0 as it is not clear where these services will come from in the future.
- § There is an increased need for transmission capacity for reserves due to geographically unbalanced volumes of primary reserves (FCR) in the synchronous system.
- § New components with higher rated power, such as new power plants and interconnectors, could challenge system stability in the event of disconnection, which is exacerbated with the decrease in inertia levels.

In the future, the system requirements will be different and more complex. In addition, new technologies with different performance parameters to incumbent technologies will enter the system – incentives to provide reserves and other system services will also need to be accessible for these sources.

5.2 General principles for market design of system services

System services are provided by TSOs and market participants, through procurement by the TSO or as stipulated in supply and grid connection requirements.

The elements and options for different procurement approaches are described in Table 12. The objective should be to move away from the ‘No payment’ approach and towards a more market-based approach.

Table 12 – Framework for defining the procurement approach

| | Role of the central buyer | Requirements on market participants | Remuneration and competition |
|-------------------|---|-------------------------------------|--------------------------------|
| Less market based | Central requirement | Mandatory provision ¹ | No payment |
| | Central requirement | Mandatory provision ¹ | Regulated payment ² |
| | Central requirement | Voluntary provision ³ | Regulated payment ² |
| | Central requirement | Voluntary provision ³ | Market payment |
| More market based | Decentralised obligation ⁴ | Voluntary provision ³ | Market payment |
| | Decentralised (voluntary) procurement: TSO as the buyer of last resort ⁵ | Voluntary provision ³ | Market payment |

1) E.g. through a requirement in the grid connection code

2) Based on e.g. a cost+ approach (cost of delivery for the service provider)

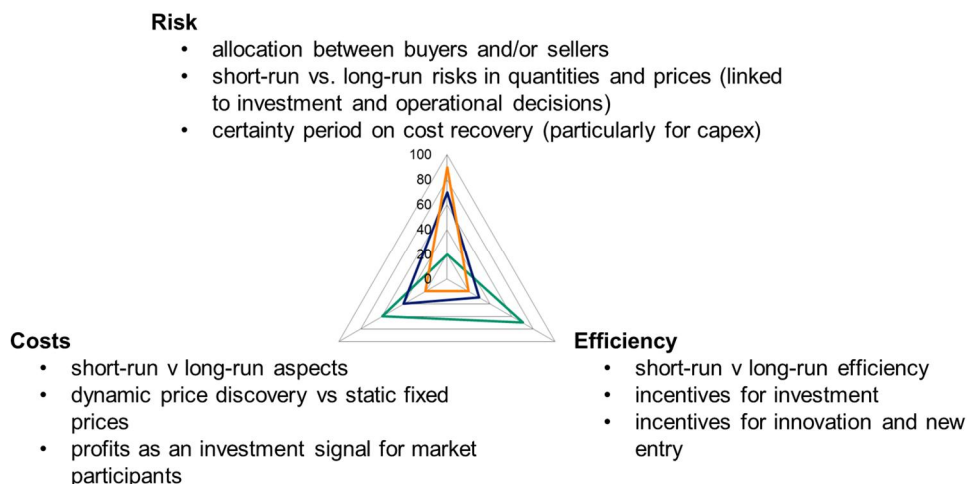
3) There might still be a requirement for the capability even though delivery is voluntary

4) TSO places an obligation on market, comparable to e.g. green certificates

5) This requires a product that the market participants can trade with each other. The TSO acts as the buyer of last resort and secures outstanding system requirements.

The main objective of exposing products to competition is to reduce the overall cost and ensure long-term availability of the system services in the long term. Competition ideally secures the lowest prices and hence the most social welfare over time, provided that there are enough potential service providers. Any procurement approach contains trade-offs between risks, costs and efficiency in the long run (see Figure 14). These trade-offs may vary by different types of system services.

Figure 14 – Trade-offs between procurement approaches



As some of the needs for system services can be very local or infrequent, pre-conditions for effective competition may not be met for all system services. The decision on procurement approach needs to be informed by a sound understanding of the supply and demand characteristics for system services (see Figure 15).

Figure 15 – Pre-conditions for effective competition

| | |
|--|---|
| Many suppliers and buyers, without market power? | <ul style="list-style-type: none"> • the TSO is the single buyer • concerns about supply market power |
| Lack of barriers for entry or exit? | <ul style="list-style-type: none"> • investment costs for new entrants vs. sunk costs • impact of product definitions on innovation; • mandatory provision |
| No economies of scale/scope? | <ul style="list-style-type: none"> • investment costs may be significant • possible to co-produce different system services |
| Homogeneity | <ul style="list-style-type: none"> • demand for some products is very local (voltage control) |
| Good/symmetric information | <ul style="list-style-type: none"> • scope for asymmetry knowledge (e.g. system or plant constraints) |
| Low transaction costs | <ul style="list-style-type: none"> • testing quality of different technologies (Synch. Generators/RES Generators/Demand/FACTS) must be confirmed |
| No externalities | <ul style="list-style-type: none"> • scope for externalities in system service provision |

The objective of defining procurement approaches is to ensure that value for the services can be revealed and that there is no discrimination when the same services are provided by market participants and TSO assets. In other words, commercial provision of services should not be undermined by TSOs owning uneconomic assets if there are more cost-efficient services available from commercial providers. To the extent that TSOs can offer the service more cost-efficiently, there should be ways to do that. However, it lies beyond

the scope of this report to discuss whether TSOs should own assets which compete with private market participants.

In addition, there needs to be a continuous process to evaluate future system needs and capabilities of service providers given the changing technology mix in the system and developments in technology. These needs assessments should be transparent and with a clearly defined methodology, comparable to system adequacy assessments.

Thought should be given to ensuring that product standardisation does not limit competition or block innovation among potential providers. This concept is explained in more detail in Section 5.4.1.

This topic is addressed in the Clean Energy Package draft proposal by the European Commission as well. It states³¹ that the procurement of system (ancillary) services is “transparent, non-discriminatory and market-based” “unless justified by a cost-benefit analysis”, and that there is “non-discrimination as between system users or classes of system users, particularly in favour of its related undertakings”.

The Clean Energy Package also states that the procurement “ensures effective participation of all market participants” - including RES, DSR, energy storage and aggregators - by requiring regulatory authorities or TSOs in close cooperation with all market participants to define the conditions for participation based on the technical requirements of these markets and the capabilities of all market participants.

In addition, TSOs should not own assets that provide system services unless:³²

- § other parties, following an open and transparent tendering procedure, have not expressed their interest to own, control, manage or operate such facilities offering storage and/or non-frequency ancillary services to the TSO;
- § such facilities or non-frequency ancillary services are necessary for the TSOs to fulfil their obligations for the operation of the transmission system and they are not used to sell electricity to the market; and
- § the regulatory authority has assessed the necessity of such derogation taking into account the conditions of the points above and has granted its approval.

5.3 Recommendations

Following on from the principles presented in the previous section, we have identified a set of recommendations for the market design of system services in the Nordics. These are presented in Table 13.

³¹ Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity (recast). Article 40. COM(2016) 864 final/2. 23.2.2017.

³² Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity (recast). COM(2016) 864 final/2. 23.2.2017.

Table 13 – Proposed changes for system services

| Proposed change | Description |
|--|--|
| Remove requisitioning of services without remuneration through supply and grid connection conditions | Wherever generators are required to provide system services without remuneration or at below market rates, there should be a transparent needs assessment whether there is a demand for the service in the system. If there is, a market-based procurement approach should be developed. At minimum, there should be a regulated remuneration and equal requirements for all technologies. |
| Level playing field between TSOs and market participants providing the same services | Service providers should compete with TSO assets providing system on an equal footing. Minimum requirement is to increase transparency on the system, cost levels of TSO assets and market participant compensation when they are providing the same services as TSO assets. |
| Marginal pricing of availability fees of reserve products | Marginal pricing should be used for pricing the availability fees of all reserve products (FCR, aFRR and mFRR). |

5.3.1 Requisitioning of services through supply and grid connection conditions

There is an on-going process in Denmark to go through all requirements for non-frequency system services³³ and assess them based on the following criteria:

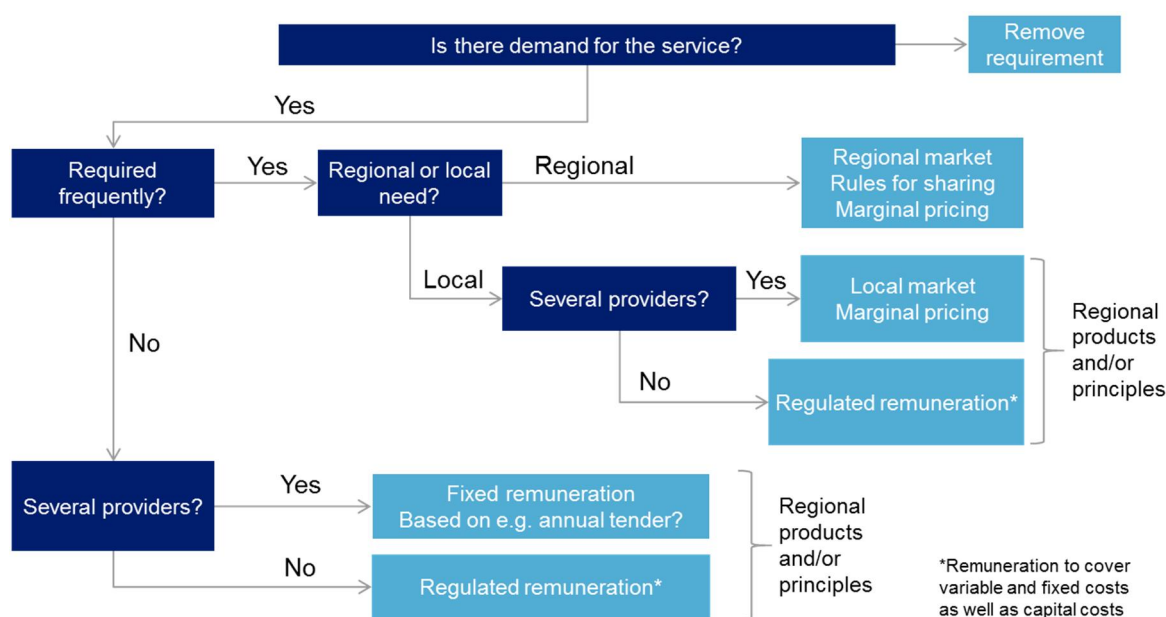
- § What is the current and future need in the system?
 - If there is no need, the requirement should be removed.
- § If there is a need, can a product be defined and market created?
 - Are there several potential providers of the service, including the TSO's own assets?
 - How local is the need for the service?
 - Can current requirements be relaxed in order to make it easier for different parties to offer the service, e.g. could voltage support be provided with an asset further from where it is needed?
 - Is the need frequent enough to justify the transaction costs of setting up a market?
- § If a market cannot be created, what should be the remuneration mechanism for providing the services?

³³ An example of a non-frequency service is the provision of reactive power. In Denmark, the TSO has currently the right to order power plants to run to ensure an adequate level of voltage control. The power plants are remunerated for this. The TSO also has the right to ask power plants to change the set-point for reactive power. They are not remunerated for this, and there is an on-going discussion about if and how remuneration should be set up in these situations.

- Is there a reference price which can be defined based on e.g. cost of providing the service by a service provider or the TSOs own assets?
- § Are different technologies treated equally or are e.g. renewable energy sources exempted from certain requirements?
- If there are exemptions, requirements should be made equal for all technologies or the difference in requirements to be remunerated.

We recommend a similar coordinated process to be adopted and started in the Nordic area to ensure that all generation technologies are treated equally and are remunerated for providing services which have a value to the system. This process is illustrated in Figure 16. The procurement approach should move as fast as possible, with interim steps if necessary, towards market-based procurement where adequate competition exists.

Figure 16 – Decision tree to define market design concepts for system services



5.3.2 TSOs and generators providing the same services

Article 54 of the proposal for the Electricity Directive states that TSOs shall not be allowed to own, manage or operate energy storage facilities and shall not own directly or indirectly assets that provide system services. It does leave room for derogations for individual countries based on a set of conditions that were introduced in Section 5.2.

If derogations are made, there should be a level playing field between TSOs and market participants providing the same services. If a power plant can provide the same service more cost-effectively, then it should be used instead of the TSO assets. The system need and cost of providing services by TSO assets should be transparent to reduce information asymmetry between TSOs and market participants. Furthermore, the use of TSO assets should be transparent and provide a price signal and remuneration to market participants providing the same service.

In addition, the TSOs should perform an assessment, at regular intervals, of the potential interest of market parties to own the assets in case they can provide the service in a cost-effective manner as also mentioned in the Directive.

5.3.3 *Marginal pricing of availability fees of reserve products*

Marginal pricing for all balancing services, energy and capacity, ensures that service providers receive the full marginal value of the service they are providing. Pay-as-clear pricing is used already in the most relevant market for balancing energy, the Nordic Regulating Power market. However, there are differences between countries and products how availability of reserve capacity (EUR/MW) is priced. Currently pay-as-bid pricing is used at least in:

- § FCR markets in Sweden and Denmark;
- § the Nordic aFRR capacity market; and
- § fast disturbance reserve (mFRR) in Finland.

We recommend that the basic principle for all standard products should be marginal pricing. Pay-as-bid may be justified if there is flexibility in the product definitions formally or in practice³⁴, in which case the practice of doing this should be made transparent to all service providers.

5.4 Further considerations

5.4.1 *Granular reserve products*

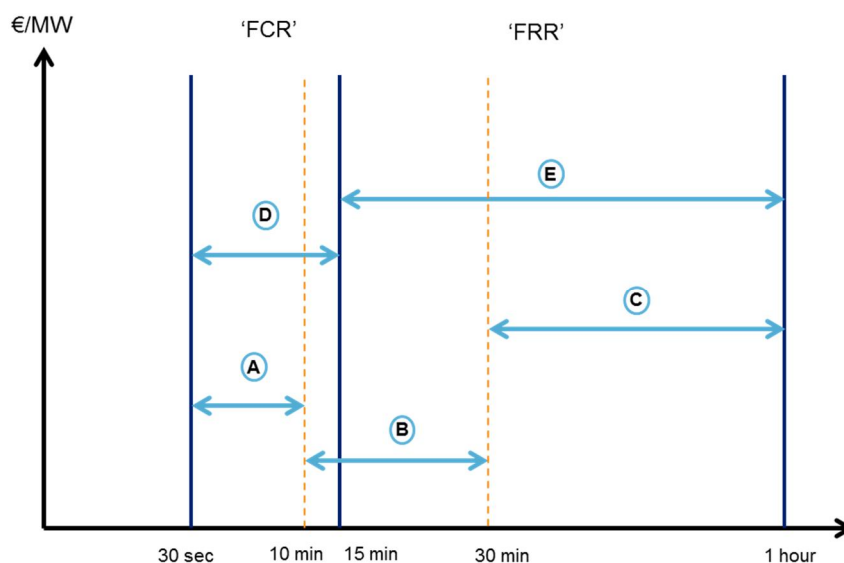
TSOs need specific services to help them manage the system in real-time. As mentioned in Section 2.2, the framework of products and the means by which they are procured can be revisited to avoid reliance on rigidly defined standard products. Rather than tightly defined products procured in silos, services could be flexed around defined product specifications to be offered, which permits the TSO to blend providers to satisfy its overall needs.

The full spectrum of capabilities of service providers is not taken into account with strictly defined standard products. These providers could still be in a position to offer a valuable service and help meet the overall TSO requirements with a lower cost.

This is illustrated by the simplified example shown in Figure 17, which defines services in terms of their speed of response, duration and price. The solid blue lines show the strict definitions of two products (i.e. FCR and FRR) as well as the capabilities of providers D and E. The dotted orange lines, on the other hand, show the capabilities of providers A, B and C. The price at which each provider offers the service is defined by the y-axis, whereas the speed and duration is defined by the x-axis. For example, provider A can respond in 30 seconds and last for 10 minutes. Under the strict definitions of the two products (FCR and FRR), a TSO would procure the required service from providers D and E that fully meet the predefined requirements (in terms of duration, ramp rates etc.) of each product. However, a TSO could meet the same overall requirement at a lower cost by procuring from providers A, B and C.

³⁴ For example, a bid with an activation time of 20 min is accepted even though the formal requirement is 15 min.

Figure 17 – Non-standard products for reserve procurement



As a means of future proofing, one alternative is allowing providers declare their own capabilities to meet an overall reserve requirement set out by the TSO. Reserve products have two essential attributes: the speed of response and the maximum duration of delivery. As plant operators have very different capabilities and do not conform to one set of standard parameters, it makes sense to be less prescriptive. This would encourage 'non-standard' providers (demand side resources, energy storage) to compete on an equal footing.

Meeting the reserve requirement in such a way may however come at the expense of liquidity that a small number of standard products would create. There is a clear trade-off between accommodating a lower cost solution through more complex structures and liquidity arising from the use of small number of reserve products. Price discovery could be helped by reporting prices on products that approximate to standard products ('synthetic' products). There is also an uncertain impact on risk as there would be reliance on a greater number of units but also a more diversified mix of providers.

At minimum, the product definitions should be revisited on a regular basis against the capabilities of different service provider and system needs. In order to secure liquidity of the reserve markets, the basic products need to be defined at the European level and traded on European-wide platforms, as required by the European Commission's Guideline on Electricity Balancing.

5.4.2 Inertia

Inertia in a power system is connected to the rate of change of frequency. With insufficient inertia, frequency drops can be too rapid, causing the frequency to reach the load-shedding value before reserves have reacted sufficiently. Higher volumes of RES,

phasing out of nuclear units, and high imports through HVDC connections³⁵ all reduce inertia levels in the Nordic system.³⁶

The Nordic TSOs are currently running a project to define if there might be problems with the adequacy of inertia in the future. If the results show that there could be an issue with inertia and there is value in providing inertia to the system, the following principles should be used in designing the remuneration and procurement:

- § temporal variation of inertia value to be recognised (i.e. payments made at times deliver when a lot of non-synchronous generation is on and inertia in the system is low);
- § the value to reflect the full cost of inertia (i.e. not hiding costs of starting units for inertia);
 - otherwise correct price signals will not form with a knock-on effect regarding missing money (e.g. for synchronous compensators or upgrading hydro plants or wind power turbines to rotate electrically);
- § inertia is a system-wide property and a regional mechanism for remuneration and procurement to be used as a starting point.

A market for providing inertia is one option, but there are other products which may be needed instead (e.g. faster responding FCR), as there is a trade-off between the level of inertia and the rate of response from frequency containment reserves (subject to constraints given by rate-of-change of frequency (RoCoF) relays). Again, the same principles apply that the choice of market design should be informed by a sound understanding of the system needs and the capabilities of current and future service providers.

5.4.3 Nordic FCR-N market

The Regulating Power Market (RPM) and the Nordic aFRR market operate currently on a regional basis whereas FCR-N is procured based on national procurement setups (e.g. frequency of procurement and product durations). Providing FCR-N across price zones is based on bilateral TSO-TSO agreements.

A Nordic FCR-N market could lead to lower overall costs of providing frequency response reserves through a more effective use of resources across price zones. This topic was not considered in detail in this study, but should be kept under review for future development as there are already blueprints from other types of balancing products.

³⁵ HVDC cables can provide, or can be retrofitted to provide, 'synthetic' inertia.

³⁶ Source: Statnett, Fingrid, Energinet.dk and Svenska Kraftnät. Challenges and Opportunities for the Nordic Power System.

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6. STRATEGIC RESERVE

6.1 What is a strategic reserve?

Strategic reserve is generation capacity that is kept outside the market, and is activated by a decision or a predefined stress signal linked to forecasted inadequacy of capacity or another indicator of high risk of power supply failure.

As mentioned in Section 2.2., the first line of action before considering any type of strategic reserve would be to improve the functionality of the market through:

- § Market design improvements to improve pricing structures that will provide incentives to keep and develop relevant capacities, including demand response and grid capacity.
- § Development of market products in the day-ahead, intraday, and balancing markets that will increase market participation and flexibility of bidding, including from consumers.

Only when these measures are exhausted, and there still is a significant risk of market failure, should strategic reserves be considered. Since the existence and use of such reserves generally have a negative impact on market behaviour, the size of the reserve and the activation frequency should be kept at a minimum.

6.2 Peak load capacity and dry-year reserve

The Nordic market is not homogeneous. In areas dominated by hydropower generation, the main concern is shortage of energy, whereas in other areas, lack of peak load capacity will remain the main worry despite grid development. The dry-year reserve in the Nordic market used to be mostly flexible Finnish and Danish thermal plants, the same plants that are now closing due to reduction in annual operation time and lower prices. In response to an energy deficit in the region, Statnett established two reserve power plants in NO3 price zone. A new transmission line in 2016 solved this deficit and these plants are now being decommissioned.³⁷

Although a lack of peak load capacity and energy shortage in a dry year are different conceptually, their occurrence and the appropriate action to take to avoid the effects overlap. The resources that provide market-based dry-year reserve (in the future mainly interconnectors and demand-side response) will also be able to provide peak load capacity. The main difference between dry-year and peak load reserve is the way the reserve is activated.

With the present energy surplus, only extremely dry inflow years could see an energy deficit. In the future, the energy balance will be established through export of surpluses to the Continent and Britain. If Nordic cooperation works well in tight supply situations, the market should be able to cope. Dry-year reserves in the form of e.g. back-up generation or options to take parts of energy intensive industry out of operation for a period should not be required. Peak load constraints should also be manageable with the development of price signals, grid development and ordinary market operations.

Given that peak load and dry-year reserves exist, regulators and TSOs should see these resources together across national borders and use them in a way that distorts the market as little as possible. It is also important to activate reserves in an optimal way for each

³⁷ Source: <http://www.statnett.no/en/Market-and-operations/Reserve-Power-Plants/>

type of crisis, independently of the purpose for which the reserves were created. Activation prices should always be high enough and output volumes small enough to avoid more interference than necessary with imports and ordinary price response from generators and consumers.

6.3 Recommendations

To ensure that the rules governing the activation and pricing of the strategic reserve does not have a distorting effect on energy market prices, we have identified a set of recommendations for the market design of strategic reserve in the Nordics. These are presented in Table 14.

Table 14 – Proposed changes for strategic reserve

| Proposed change | Description |
|--|---|
| Activation and pricing principles to better reflect the value of avoided scarcity | Activation of the strategic reserve should happen in the last market possible, the regulating power market, even though the capacity requires a longer warm-up time and the notification for a start-up is given earlier. If the strategic reserve is actually used to solve an energy shortfall, and not only warmed up, the activation should be reflected in imbalance prices at Value of Lost Load (e.g. balancing market price cap). |
| An explicit target level for power adequacy to define the dimensioning of strategic reserves | The size of strategic reserve should be defined, based on: <ul style="list-style-type: none"> § an explicit target level of power adequacy based on the Value of Lost Load (VOLL, EUR/MWh); § cost of capacity (EUR/MW per year); and § a probabilistic analysis on Expected Unserved Energy (EUE, MWh/a). |
| Regional cooperation to utilise strategic reserves more efficiently across countries and transparent protocols to handle scarcity situations | Adequacy assessments should be done on a regional basis and based on a common methodology. Strategic reserves in different countries should be seen together and considered as a common strategic reserve, including harmonised activation principles. The Nordic TSOs should have coordinated and transparent protocols to handle scarcity situations and how cross-zone flows are managed these situations. |

6.3.1 Activation and pricing principles

Activation of the strategic reserve should happen in the last market possible³⁸, the regulating market. Resources participating in the strategic reserve are typically older

³⁸ The definition of strategic reserve in the Clean Energy Package is that it is "a capacity mechanism in which resources are only dispatched in case day-ahead and intraday markets have failed to clear, transmission system operators have exhausted their balancing resources to establish an equilibrium between demand and supply, and imbalances in the

condensing plants, which require a long warm-up time and the notification for a start-up is given earlier³⁹. This is why the DA market is currently used as the market place where peak load generation capacity is activated.

The activation should be priced at the price cap of the regulating power market, if the strategic reserve is used to solve an actual energy shortfall. The activation of the Finnish peak load capacity in the DA market will be priced at the DA market price cap, 3000 EUR/MWh, for the next peak load capacity period starting in July 2017. When resources in the peak load capacity are activated in the balancing market, it is not priced at the balancing market price cap but instead the price is the highest of:

- § 3000 EUR/MWh;
- § variable costs of the provider; or
- § the highest voluntary bid in the balancing market.

In Sweden, the activation price is the respective market price added with a 0.1 EUR/MWh technical component.

If the strategic reserve is actually used to solve an energy shortfall, the activation should be reflected in the imbalance price at Value of Lost Load (e.g. balancing market price cap). At minimum, there should be a correction to ensure that any precautionary but unnecessary activation of strategic reserve does not artificially damp balancing prices by reducing balancing volumes. The activation also serves as a signal to the market that the system is tight. In the few cases, where peak load capacity has been activated in the Nordics, this has led to a market reaction resulting in the TSO using down-regulation during the operational hour.

6.3.2 Level of power adequacy

Strategic reserves are transitional arrangements by definition. An explicit target level of power adequacy increases transparency when deciding the size of strategic reserve. Currently, there are no official target levels in use in Finland and Sweden where peak load capacity is procured.

The size of strategic reserve should be defined based on:

- § a target level of power adequacy based on the Value of Lost Load (VOLL, EUR/MWh);
- § cost of capacity (EUR/MW per year); and
- § a probabilistic analysis on Expected Unserved Energy (EUE, MWh/a).

A probabilistic adequacy assessment against an explicit reliability standard would reduce the risk of over procurement and provide a clear signpost when strategic reserves are no longer needed. This is also the direction of future European studies coordinated by ENTSO-E.

market during periods where the reserves were dispatched are settled at the value of lost load”

³⁹ For example, in Finland the start-up time for power plants participating in the peak load capacity is 12 h.

6.3.3 Regional coordination

One of the services provided by the Nordic Regional Security Coordinator (RSC)⁴⁰ is the analysis of power adequacy. This analysis should form a natural basis for the assessment of the strategic reserve dimensioning. This ensures that the same methodology is used across all countries and e.g. cross-zone flows are modelled in a similar way and with the same assumptions.

Generation resources mainly linked to dry-year situations (like the Norwegian gas turbine back-up was) and resources related to peak load contingencies (Finland and Sweden) should be seen together and considered as a common strategic reserve for both purposes. The activation of peak load capacities in Finland and Sweden is already coordinated by the respective TSOs. This should be expanded to cover a joint assessment of the need for strategic reserve on a regional and locational basis.

Coordinated and transparent TSO protocols, set out by the Network Code on Emergency and Restoration, in scarcity situations provide transparency to the market on what will happen if the system gets tight. Commercially agreed exports and imports should always be valid even in tight situations, with a possibility for opposite trades in the intraday and balancing markets to cover possible deficits.

6.4 Further considerations

In the common Nordic market, regulators and TSOs should cooperate to reduce the size of strategic reserves as much as possible and improve policies, criteria, and procedures for procurement and activation. In other words, each country should not design their system independently and later check that interconnections improve their security margins, but instead regional studies should decide the aggregate system need. This is to reduce the spare backup capacity that is not really needed in a country when analysing the mutual support that interconnected systems can provide to each other. This is not only a matter of technical tools development, but a political decision to rely on neighbouring countries under adverse conditions.

6.4.1 Demand-side participation

The current peak load capacity schemes in Finland and Sweden allow for demand-side resources to bid for participation. Sweden currently has a significant amount of industrial DSR in its peak load capacity, 334 MW out of 1000 MW during the winter period 2016-2017, and a minimum amount of 25% is required by law. The current availability requirements during winter effectively block industrial DSR from participation in the Finnish peak load capacity.⁴¹

Political decision-makers, regulators and TSOs should consider incentivising demand-side to support power adequacy by reviewing the rules for participation in the strategic reserve or potentially by incentivising consumer participation through separate mechanism(s). For example, as an alternative and a complement to the strategic reserve, consumers could promise to bid a volume into the day-ahead or the balancing market, or choose to curtail their load in real-time, whenever the TSO finds it necessary. TSOs would then pay an annual fee to cover fixed preparedness cost. In an effective energy-only market, demand-

⁴⁰ Scheduled to start their operation in Dec 2017.

⁴¹ For the next period from July 1st 2017 to June 30th 2020, 22 MW out of total 729 MW of peak load capacity consists of demand-side resources which are heat pumps.

side should respond to energy prices without extra incentives, but this type of approach could work as a potential transitional measure for demand-side activation.

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7. CONCLUSIONS AND A WAY FORWARD

7.1 Conclusions

The motivation for the proposals detailed in this report centres upon maintaining the **principles** of an **energy only market**, and strengthening the **practice** by focusing upon evolving its design such that it is better aligned to the challenges of today and the future. It is this route that we propose as the vision for future electricity market design in the Nordics. This route also enables efficient market-based trading of energy and other energy-related services with other European regions.

Ultimately, price formation in the future energy market can only be free of regulatory constraint and political control if markets are competitive. Historical views of energy only electricity markets, assuming price-inelastic demand, rely on periodic incidences of actual scarcity (rationing) for a number of hours per year, and pricing at the value of lost load. This brings obvious potential for heavy-handed intervention to protect consumers, from both the rationing and the price consequences of scarcity; especially in an industry which has traditionally operated under high degrees of market concentration by producers. Under such intervention (perceived or actual), it is simple to trace a route to under-recovery of capital costs and the need for capacity mechanisms or other interventionist measures.

This paradigm can change. In the near future, fuelled by advances in technology (such as smart metering and access to real time markets), demand side resources can participate directly in the markets. The old-world mechanism of rationing can become one of electing not to consume (or selling back contracted energy to the market), in response to volatile prices. Our vision is one which is consistent with the active participation of demand in the formation of market outcomes.

This work has focused on regional market design changes, which are implementable before 2020. We see that the proposed changes are sustainable in the longer term towards the vision for future Nordic electricity market design presented in Section 2 and will also help to resolve shorter term issues.

The principal elements for change are:

- § ensuring the free formation of prices for balancing energy, ultimately allowing prices and imbalance settlement to reflect scarcity up to the value of lost load;
 - this ensures that balancing prices are in principle capable of rewarding long-run as well as short-run costs of balancing energy and balancing capacity;
- § increased role for the market to help the TSO to manage the system in balancing and close to real time;
 - incentives for market participants to support system balance through single imbalance pricing;
 - increased transparency, shorter lead times and lower barriers for entry which make it easier for market participants to support TSOs in system balancing;
- § more effective intraday markets with good liquidity, permitting the valuing of flexibility in different market timeframes and supporting the forward trading of flexibility in different forms;
- § as a minimum cost-reflective, and to the maximum extent possible, market-based remuneration for all system services provided by market participants; and

- § ensuring that strategic reserves do not have a distorting impact on energy market prices or investment.

We have also identified a set of market design concepts for further consideration, which would require further analysis and/or re-evaluation once the immediate set of changes is implemented and the need for longer term market reform can be evaluated.

7.2 Implementation plan

We see that the recommendations fit in well with the on-going work on market design in the Nordics and at a European level. There are some areas where a common European solution might not be fit for purpose for the Nordic market area needs. In these cases a regional solution should be sought after where possible. National solutions should be used only as a transitional measure or if a common Nordic solution cannot be agreed upon.

On a high level, the parties primarily responsible for implementing changes for the four areas are as follows – this largely depends on whether changes are required in laws, regulations, TSO agreements or product definitions:

1. the intraday market: TSOs and power exchanges (Nord Pool, EPEX Spot);
2. balancing and imbalance arrangements: TSOs, policy makers and regulators;
3. system services: TSOs, policy makers and regulators; and
4. strategic reserves: TSOs, policy makers and regulators.

In addition, market participants (including potential entrants and financial players) are an important stakeholder group when discussing the changes to market design and choosing between different options.

There are various on-going market design projects and pilots in the Nordics that provide a natural channel to bring the recommendations presented in this report into discussion and influence the market design choices. As these projects have already started, we see that several of the recommendations can be implemented by 2020. However, momentum needs to be maintained and progress monitored.

A Nordic forum should be established with a remit to promote and drive forward Nordic market design

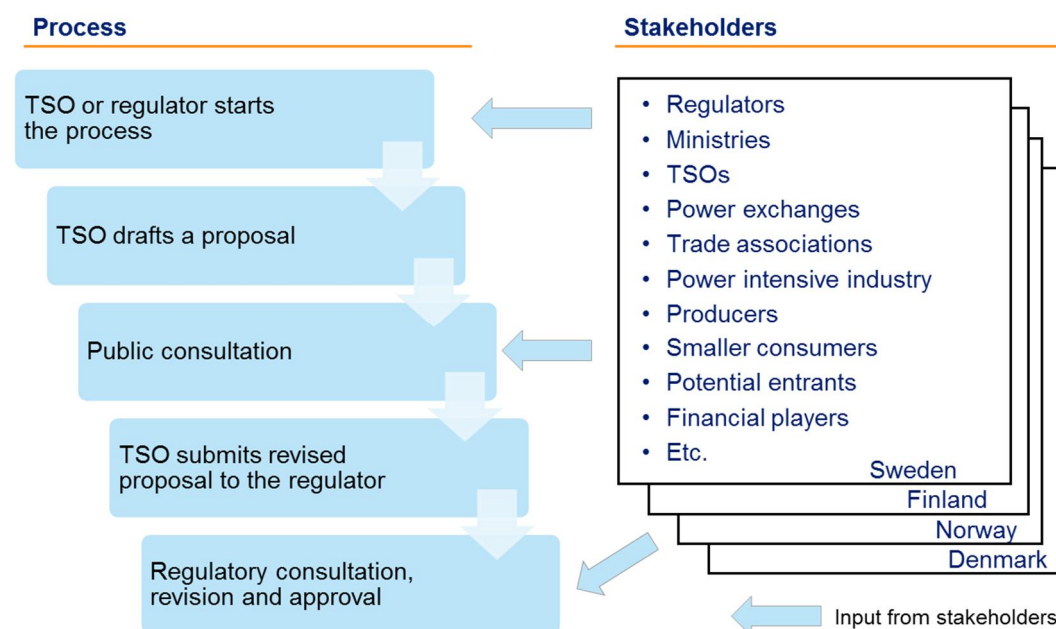
- § The forum should bring together ministries, market participants and financiers, regulators, power exchanges and TSOs as well as other appropriate entities such as the EU Commission.
- § The purpose of the forum should be to promote common discussion and then implementation of solutions to regional market design challenges.
- § The remit of the forum should be to initiate regional discussion of market design issues and drive development of the regional electricity market.
 - As an example, the forum would monitor and follow up on progress on implementation of the market design changes including those outlined in this report, alongside other topical market design issues.
 - The forum would update the list of market design topics as new information came to light and proposals are made for investigation.
 - The forum would be a platform where different national initiatives could be brought together and discussed.

A political Nordic electricity market forum has been proposed in a report by Mr. Jorma Ollila on how to further develop the Nordic energy cooperation that was published in June 2017, which focuses on Nordic electricity market co-operation on a policy level.⁴² We see the forum proposed here as complementary feeding into the policy-level forum proposed by Mr. Ollila on topics related to electricity market design.

An example process for implementation is depicted in the figure below. This example applies to TSO agreements (e.g. balance service agreements), the contractual frameworks between the TSOs and market participants. The figure also contains a list of the key stakeholder groups which should be involved in the process. The example emphasises the importance of a Nordic process where the structure of the stakeholder discussions could take a form similar to the Pentalateral Energy Forum⁴³. This is to ensure that stakeholder views are taken into account from all countries and stakeholder groups.

The detailed plans for implementation of the proposed changes in Sections 3-6 are explained in the following subsections.

Figure 18 – Process for implementation and key stakeholder groups



⁴² The report can be downloaded from: <https://tinyurl.com/y7cqjggl>.





⁴³ The Pentalateral Energy Forum is the framework for regional cooperation in Central Western Europe (BENELUX-DE-FR-AT-CH) towards improved electricity market integration and security of supply. This cooperation is formalized through the Memorandum of Understanding (MoU) of the Pentalateral Energy Forum. MoU available at: <https://tinyurl.com/y7dqw4mn>

7.2.1 Balancing and imbalance arrangements

Plan for implementation

The proposed actions for implementation are summarised in Table 15. Several of the proposed changes are already considered as part of different Nordic market design projects and/or as part of the European balancing market harmonisation required by the Guideline for Electricity Balancing. While a Nordic solution is preferred here as well, we see some room for an implementation path where countries implement some of the changes at different times. This way experiences can be shared between countries.

Table 15 – Implementation plan for proposed changes to balancing and imbalance arrangements

| Balancing and imbalance arrangements |  Proposed changes  Owner(s): Nordic energy forum | |
|--------------------------------------|--|--|
| | <ul style="list-style-type: none"> • Single price for imbalance settlement • Raise price caps in the balancing market • Estimate any lost load in the imbalance position of the BRPs and the marginal imbalance price • Remove link between balancing and imbalance prices with day-ahead prices • Include balancing energy exported outside the Nordics in balancing price formation • Remove obligation to balance • Publish information on activations and balancing and imbalance prices in real-time • Balancing market gate closure closer to real-time • Balancing market minimum bid size to 1 MW | |
| |  Next steps |  Other comments |
| | <ul style="list-style-type: none"> • Input to Nordic TSO 'Full cost balancing project' • Input to Nordic TSO project on reducing minimum bid sizes • Input to work on balancing power market co-operation between the Nordic and Baltic countries | <ul style="list-style-type: none"> • Balancing price publication could be done first on a zone-by-zone basis when there is congestion and balancing zones are separated • The main dependency is the integration of balancing markets and harmonisation of imbalance settlement rules between Nordics and Baltics, and on a European level as part of EB GL implementation |

Main challenges

- § The move to single pricing for imbalance settlement is seen as a connected issue with the move to 15-min imbalance settlement.
- We would highlight that while a shorter imbalance settlement period helps to realise more of the benefits from single pricing, all benefits are not directly related to it. Hence, their implementation should not be seen as directly connected.
- § Changes to price formation and price caps could lead to higher risks faced by BRPs and potentially lead to higher collateral requirements. A specific issue is the risk from plant trips for large individual units. We see the following mitigation tools as relevant:
- Increased price volatility should lead to the development of hedging tools, e.g. through the trading of options, which are a key element for the investibility of the energy only market. Section 7.3 contains further discussion on this.

- Single imbalance pricing allows for options referenced to the balancing and imbalance prices, which paves the way to BRPs to hedge against imbalance risk.
- § Real-time publication of balancing prices might lead to volatile market reactions and cause issues for grid management in congested areas.
- As a transitional measure, this can be implemented on a price zone basis when there is congestion in the cross-zone capacity in the balancing timeframe and Nordic balancing zones are separated. This way, price zones with fewer congestion management issues and potential issues with balancing capacity scarcity can implement this first and gather experience of potential drawbacks to address in further development.
 - Publishing the price also provides a level playing field for all market participants whereas now activation of balancing bids can provide an indication to activated BSPs of the upcoming balancing and imbalance period in that operational hour.

Regulatory review

We have also performed a preliminary regulatory review of key European regulation related to the proposed changes in this reports, focusing on the Commission network codes and proposals of the Clean Energy Package.

When it comes to the changes to balancing and imbalance arrangements, all of the changes are allowed within the current EU regulation, and most are supported or even required.

Table 16 – Regulatory review for proposed changes to balancing and imbalance arrangements

| Proposed change | Reference | Status |
|---|----------------------------|--------|
| Single price for imbalance settlement | EB GL: Article 52 | ✓ |
| Raise price caps in the balancing market | EB GL: Article 30 | ✓ |
| Estimate any lost load in the imbalance position of the BRPs and the marginal imbalance price | - | ✓ |
| Remove link between balancing and imbalance prices with day-ahead prices | - | ✓ |
| Include balancing energy exported outside the Nordics in balancing price formation | EB GL: Article 30 | ✓ |
| Information on activations and balancing and imbalance prices closer to real-time | CEP Regulation, Art. 5(10) | ✓ |
| Gate closure closer to real-time | CEP Regulation, Art. 5(5) | ✓ |
| Balancing market minimum bid size to 1 MW | - | ✓ |





EB GL refers to Electricity Balancing Guideline
CEP refers to the Clean Energy Package

7.2.2 Intraday

Plan for implementation

The proposed actions for implementation are summarised in Table 17. We recommend a Nordic process to look at these issues together as part of a joint effort to improve the functioning of the intraday market and the trading of flexibility.

Table 17 – Implementation plan for proposed changes to the intraday market

| Intraday |  Proposed changes |  Owner(s): Nordic energy forum |
|----------|--|---|
| | <ul style="list-style-type: none"> • Intraday opening auction with 15-min products, possibly closing auctions • Intraday gate closure time (GCT) as close to real-time as possible • Better information transparency between market participants and TSOs • Price cap in the intraday market to 9999 EUR/MWh • Start a process to define an approach and test the feasibility of allocation of cross-zone capacity across market timeframes | |
| |  Next steps |  Other comments |
| | <ul style="list-style-type: none"> • Start a Nordic process to implement improvements to the intraday market • Input to Nordic TSO 'Finer time resolution' project where ID auctions are discussed as an option to trade 15-min products | <ul style="list-style-type: none"> • Possible transitional implementation steps: <ul style="list-style-type: none"> ◦ Pilots for ID auctions and/or allocation of cross-zone capacity on a single border to test feasibility • Dependencies <ul style="list-style-type: none"> ◦ Start of XBID in 2018 ◦ ENTSO-E proposal on ID capacity pricing |

Main challenges

We see the following challenges related to the proposed changes in the intraday market:

- § Introducing an intraday opening auction is a structural change to how trading is done in the ID market with additional transaction costs to set up an extra auction.
 - As this is already discussed on a European level, e.g. in light of the intraday auction in Germany for 15-min products, the discussion should be started in the Nordics and ideally considering cross-zone interconnection between the Nordics and other countries as well.
 - Auctions should be a supplement to the continuously traded market with an aim of creating more flexibility and liquidity.
- § Allocation of cross-zone capacity across market timeframes is a large structural change to how energy is traded currently, and requires a thorough cost-benefit analysis and stakeholder involvement process before a decision on the details of the design can be made.
 - We see this as an important market design element of the energy only market and argue that the process for the cost-benefit analysis and detailed design of this methodology should be started in the short term.

- § European development – XBID, flow-based market coupling and a methodology to price ID capacity – might set boundary conditions for market design, which might not fully serve the needs of the Nordic market.
- The possibility for regional solutions in the Nordics, and if possible, with neighbouring areas should be kept an option if the Europe-wide solutions are not fit for purpose the Nordic market needs.
 - Nordic views need to be brought forward in the European discussion; the above mentioned forum would provide a platform to do so.
- § Shortening the gate closure time brings challenges from an operational point of view for the management of the Nordic system.
- These challenges and possible ways to mitigate should be discussed among the Nordic TSOs, market participants, regulators and other stakeholders.

Regulatory review

Topics related to the intraday market are currently subject to processes driven by TSOs and NEMOs. Some of the proposed changes in this report are in contrast to what is proposed in all TSOs' proposals related to ID auctions and cross-zone gate closure times. The change to the intraday price cap is in line with the current all NEMO proposal.

Table 18 – Regulatory review for proposed changes to the intraday market

| Proposal | Reference | Status |
|--|--|--------|
| Intraday opening auction with 15-min products, possibly closing auctions | Partly: All TSOs' proposal for the single methodology for pricing ID cross-zonal Capacity (CACM Art. 55) | Open |
| Intraday gate closure time (GCT) as close to real-time as possible | All TSOs' proposal for intraday cross-zonal gate opening and gate closure times (CACM Art. 59) | × |
| Price cap in the intraday market to 9999 EUR/MWh | CACM Article 9(12) All NEMO proposal and Energy Regulators' amendment request CEP Regulation, Article 9-10 | Open |
| Start a process to define an approach and test the feasibility of allocation of cross-zone capacity across market timeframes | CEP Regulation, Article 15 EB GL Article 41 | Open |

CACM refers to Capacity Allocation and Congestion Management Guideline
 CEP refers to the Clean Energy Package
 EB GL refers to Electricity Balancing Guideline





7.2.3 System services

Plan for implementation

The Nordic markets have an opportunity to spur investment, innovation and be a first mover in regional markets for system services⁴⁴. The Nordic markets have ample experience in common market rules and harvesting the efficiency gains of market arrangements. By implementing the changes proposed here the Nordics will be better prepared for the energy transformation and harvest the efficiency gains that come with the internal market.

Changes to system services market design should be looked at as a coordinated Nordic process to allow the use of common frameworks and the same principles in all countries. Harmonisation should on the other hand not get in the way of moving each market forward and doing pilot arrangements. We would also highlight that this should not be a one-off project, but instead a regular process to revise the market design in light of expected system needs and the capabilities of service providers.

Table 19 – Implementation plan for proposed changes to system services

| | | |
|-----------------|---|---|
| System services |  Proposed changes |  Owner(s): Nordic energy forum |
| | <ul style="list-style-type: none"> Remove requisitioning of services without remuneration through supply and grid connection conditions Level playing field between TSOs and market participants providing the same services Marginal pricing of availability fees of reserve products | |
| |  Next steps |  Other comments |
| | <ul style="list-style-type: none"> Start a coordinated Nordic process among the stakeholders to go through system services and ways of remuneration Later, input to further development of the Nordic aFRR market and other system services products | <ul style="list-style-type: none"> The aim should be to move all services further along the spectrum toward a market-based approach The main dependency is the implementation of the Clean Energy Package on how system services should be remunerated and what are the rules around TSO ownership of assets that provide system services |

Main challenges

§ TSO role as a single buyer and provider of services creates a structural asymmetry for competition.

- The involvement of policy makers in the process is important to ensure that the roles of the TSO and market participants in providing system services are clear and changes are made if necessary.

§ Product definitions and defining a price signal can be difficult.

⁴⁴ Taking into account the experience from the Danish Market Model 2.0 process and other countries with markets for system services,

- If a fully market-based solution is not possible, e.g. due to a rare need for the service, it is recommended to make a model of a regulated payment. The aim should be to move all services further along the spectrum towards a market-based solution.

Regulatory review

Even though the Requirement for Generators gives TSOs the right to define grid connection requirements, there is nothing in the regulation that explicitly forbids implementing the changes proposed in this report. As mentioned in section 5.2, the Clean Energy Package also promotes the market-based procurement of system services.

Table 20 – Regulatory review for proposed changes to system services





| Proposal | Reference | Status |
|--|-------------------------------|--------|
| Remove requisitioning of services without remuneration through supply and grid connection conditions | CEP Directive, Art. 40 | ✓ |
| Level playing field between TSOs and market participants providing the same services | CEP Directive, Art. 40 and 54 | ✓ |
| Marginal pricing of availability fees of reserve products | - | ✓ |

CEP refers to the Clean Energy Package

7.2.4 Strategic reserve

Plan for implementation

Table 21 – Implementation plan for proposed changes to strategic reserve

| | | |
|-------------------|--|---|
| Strategic reserve |  Proposed changes |  Owner(s): Nordic energy forum |
| | <ul style="list-style-type: none"> • Activation and pricing principles to reflect the value of avoided scarcity • An explicit target level for power adequacy to define the dimensioning of strategic reserves • Regional cooperation to utilise strategic reserves more efficiently across countries and transparent protocols to handle scarcity situations | |
| |  Next steps |  Other comments |
| | <ul style="list-style-type: none"> • Input to on-going TSO project to harmonise activation rules • Start a process to harmonise methodologies and principles of cooperation | <ul style="list-style-type: none"> • Possible transitional implementation steps <ul style="list-style-type: none"> ◦ Harmonise pricing principles of Finnish and Swedish peak load capacity and make activation time as late as possible • Main dependencies are the ENTSO-E work on a common methodology for security of supply and the Commission's views on CRMs |

Main challenges

- § Governments and consumers might be concerned that pricing the activation strategic reserve at VoLL could lead to unacceptable risks. However, we see that:
- Prices that reflect the true value of electricity can provide signals for new investment in the reliable and flexible capacity needed to deliver secure electricity supplies.
 - Such price risks can be managed by the market itself, e.g. through long-term hedging contracts, in the wholesale and retail markets.
 - Furthermore, we would also argue that some of the other changes in this report, e.g. through improving price transparency and reducing bid sizes, allow demand-side to be more active in the market and protect themselves against price spikes.
- § Security of supply is seen as a national issue.
- The target level for security of supply can vary nationally, but the use of common methodologies and an explicit target on a national basis increases transparency and provides a more predictable signal to the market.
 - As with all market integration, if strategic reserves in different countries are considered as a common strategic reserve, there is room for more efficient use of resources across borders and lower overall costs to society.

Regulatory review

In general, the proposals in the Clean Energy Package are well in line with proposed changes in this report.

Table 22 – Regulatory review for proposed changes to strategic reserve

| Proposal | Reference | Status |
|--|---|--------|
| Activation and pricing principles to reflect the value of avoided scarcity | CEP Regulation, Art. 2 (definition of strategic reserve) | ✓ |
| An explicit target level for power adequacy to define the dimensioning of strategic reserves | CEP Regulation, Art. 19-20 | ✓ |
| Regional cooperation to utilise strategic reserves more efficiently across countries | CEP Regulation, Art. 34 promotes Regional Operation Centers | ✓ |

CEP refers to the Clean Energy Package

7.3 Further considerations

In Sections 3-6 we covered a set of additional potential market design changes under the label of 'further considerations'.

The first set contains those deemed by the study members that could be of relevance for the future but should not be a priority for implementation in the near term.

Table 23 – Further considerations

| | |
|---|---|
| Balancing and imbalance arrangements | § Scarcity adder and pricing; |
| | - Inclusion of reservation costs in balancing and imbalance pricing; and/or |
| | - Administered scarcity price function or adder; |
| | § Combining aFRR and mFRR activation prices; and |
| | § Role of market participants in reserve procurement and provision |
| System services | § Granular reserve products; |
| | § Inertia and/or the need for faster responding frequency containment reserves; and |
| | § Nordic FCR-N market |
| Strategic reserve | § Further Nordic cooperation to reduce the size of strategic reserves as much as possible and improve policies, criteria, and procedures for procurement and activation |
| | § Demand-side participation |

7.3.1 Additional topics important to delivering the vision of the Nordic market

In addition to the areas covered in Sections 3-6 there are additional areas to address that we consider important for the vision of future Nordic market design presented in Section 2. Those that were not covered in detail in this report consist of the following:

- § Forward trading timeframe
 - allow contracts with reference price around intraday (or other close-to-real-time) price, not just day-ahead – the nature of forward contracts should not bias towards the foreclosure of options with respect to near-real time trading;
 - enable the market to create commercial products that are better suited to the uncertainty and variability of the future system e.g. energy options; and
 - ensure cross-zonal hedging tools are adequate for market needs – this allows effective trading between markets.
- § TSO incentives
 - implement / strengthen TSO incentives to procure services efficiently and economically: ensure that TSOs have an interest in efficient and economic procurement; and
 - incentivise overall balancing costs rather than individual pots (capex, opex) to support efficient procurement overall: make sure that the incentive framework does not unduly tip the balance between opex and capex solutions.

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