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Hagman Energy AB

Public
ISBN nr. 978-82-93150-84-8

Measures to support the functioning of the Nordic financial electricity market

Commissioned by NordREG

November 2015

THEMA Report 2015-35

About the project

Project number:	NRG-15-01
Project name:	Measures to support the functioning of the Nordic financial electricity market
Client:	NordREG
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About the report

Report name:	Measures to support the functioning of the Nordic financial electricity market
Report number:	2015-35
ISBN-number:	978-82-93150-84-8
Availability:	Public
Completed:	This version: November 19, 2015

About THEMA Consulting Group

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THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specializing in market analysis, market design and business strategy.

CONTENT

SUMMARY AND CONCLUSIONS

Background

A well-functioning electricity market should provide efficient means for risk hedging for market participants. Thus, the possibility for cross-border hedging is seen as an important piece in the development of the Internal Electricity Market in the EU. To strengthen the markets, new guidelines on Forward Capacity Allocation (FCA GL) will be adopted. The FCA GL implies that national regulators (NRAs) shall enable TSOs to facilitate cross-border hedging in bidding zones where scrutiny shows that hedging opportunities are lacking or insufficient.

In the Nordic market, basic price risks are normally hedged using financial contracts with reference to the system price. Physical deliveries are however settled against the price in a specific bidding zone. Remaining risk associated with the difference between the system price and area prices are hedged by means of Electricity Price Area Differences (EPADs). Cross-border trade can be hedged by combining EPAD contracts in the two bidding zones.

According to the overall feedback from market participants in the Nordic market, they do not want to replace basic hedging in the system price with basic hedging in area prices. Financial contracts in the system price are highly liquid. However, in some bidding zones EPADs are not listed, and in other bidding zones the liquidity in EPADs may be low. Lacking or low liquidity does not have to imply a lack of hedging opportunity, however. The reason may be that hedging in the system price is sufficient due to high correlation with the area price, or that market participants are hedged via bilateral contracts. Hence, the NRAs need to assess whether lacking or low liquidity implies lacking hedging opportunities before the TSO is instructed to intervene in the market.

Problem statement

In this project, we compare six different models for TSO intervention. A basic premise for efficient intervention is that missing hedging opportunities are identified as a market failure. If there is no market failure, intervention is prone to imply an efficiency loss.

Hence, the main issue of the study is:

What is the recommended model or set of principles for TSO involvement in the EPAD market, if such involvement is deemed needed in (any of the) Nordic bidding zones?

Models for TSO involvement

Alternative models for TSO involvement in the EPAD market in concerned bidding zones are

1. Support market maker function in EPAD contracts. The model implies that the TSO finances a market maker function with a sufficiently tight bid-ask spread and minimum volume.
2. Guarantee minimum spreads in EPAD contracts. The model implies that the TSO itself takes on the market maker function.
3. Auction EPAD contracts. The model implies that the TSO auction a volume of EPAD contracts, i.e. sells contracts if the cause is missing supply or buys contracts if the cause is missing demand.
4. Auction EPAD Combos. The model implies that the TSO auction a volume of EPAD contracts in combination, so that it sells in one bidding zone and buys the corresponding volume in another bidding zone.

The fallback option, according to the FCA GL, is however to

5. Auction FTR-options. The model implies that the TSO auctions FTR-options related to the interconnection between two bidding zones, according to the expected net transmission capacity between the bidding zones. FTR-options entitle the holder to the CR in one direction for each hour when it is positive.

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6. Auction FTR-obligations. An FTR-obligation is different from an FTR-option in the way that it includes the obligation for the owner to also pay the price differential for all hours when it is negative. The consequence is that the settlement of an FTR-obligation for a certain period equals the average price differential for the period. The price for an FTR-obligation will thus reflect the expected average price differential while the price for an FTR-option will reflect the expected sum for all hours with positive price differentials.

We immediately discard model 2, as it has all the features of model 1, but implies much higher costs.

Different challenges in different bidding zones

The efficiency of the different measures may be affected by the situation in the concerned bidding zone. We identify three basic situations in concerned bidding zones:

1. Bidding zones without listed EPAD contracts
2. Bidding zones with listed EPAD contracts and with a market maker
3. Bidding zones with listed EPAD contracts and a skewed supply-demand balance

Market impacts

Liquidity and hedging opportunities

The main purpose of an intervention is to mitigate lacking hedging opportunities in the concerned bidding zone(s). We find that the models that support the EPAD market, i.e. support to a market maker function or auctioning of EPAD contracts or Combos, are all likely to increase the liquidity in the concerned bidding zone(s). In a bidding zone with a skewed balance, a market maker function may however not be efficient, whereas auctioning of EPADs directly increase traded volumes. Liquidity also depends on secondary trading opportunities.

Auctioning of FTR contracts does not directly contribute to liquidity in the EPAD market. Experience from the PTR market suggests that secondary trading in FTRs may be low. If congestions in both directions are possible, an FTR-option will be less useful for fundamental hedging than an FTR-obligation. An FTR-obligation can be suitable for fundamental hedging of the day-ahead price in a specific bidding zone if it can be combined with a liquid area price contract for the other bidding zone.

However, according to a hearing organized by NordREG in 2015, market participants do not wish such a change of basic hedging from system price contracts to area price contracts. Market participants who compare EPADs and FTRs as instruments for fundamental hedging are generally in favour of EPADs.

Existing financial markets

The liquidity in financial system price contracts is seen as a particular strength of the Nordic market. As EPAD contracts are combined with hedging in the system price, the first four models do not risk splitting of liquidity and reduced trading in system price contracts. EPAD trade could however be split between different exchanges, depending on the outcome of procurement processes regarding auction platform or support to market maker function.

Auctioning of FTR contracts, on the other hand, implies introduction of a new product that is not related to the system price. Hence, there is a risk of reduced liquidity in existing EPAD contracts and system price contracts. Additionally, FTR contracts are to be auctioned at a single European allocation platform.

Strategic behaviour

We have analysed to what extent market participants can exploit the proposed instruments for strategic behaviour and if the instruments can mitigate strategic behaviour if there is market power in the concerned bidding zones. None of the models appears to have substantial impacts.

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Impacts on financial market participants' costs

Support to a market maker function reimburses the participant performing the market maker function for the associated costs. Other market participants do not incur extra direct costs.

The costs for participation in EPAD auctions are insignificant for a market participant as long as they do not require registration on a different exchange and clearing with another clearing house than their normal one.

Participation in FTR auctions imply higher costs for Nordic market participants as they have to register at the single allocation platform and have to provide collaterals to SAP as well. In the case of FTR-obligations they have to register and provide collaterals to the clearing house chosen by SAP.

Our comparison of market impacts

	Support market maker function	Auction EPAD contracts	Auction EPAD Combos	Auction FTR-options	Auction FTR-obligations
Liquidity and hedging	++	++	++	0	+
Existing markets	++	++	++	-	-
Strategic behaviour	0	0	0	0	0
Market partici-pants' direct costs	0	0	0	-	-
Overall ranking	**1**	**1**	**1**	**3**	**2**

The table presents a crude comparison of the models and should of course be interpreted with caution. One example is that support to a market maker function may be less efficient than EPAD auctions to improve liquidity in a bidding zone with a skewed balance between demand and supply.

Impacts on TSO costs and financial exposure

Administrative costs

Support to a market maker function implies a fixed cost which has to be paid by the TSO. The cost depends on the strictness of the criteria and whether the function is co-financed by the exchange. Moreover, it is probably sufficient to support only one market maker in a bidding zone.

Auctioning of EPADs and FTRs both imply auctioning costs. We expect the costs of FTR auctions to be higher as they imply contribution to the single allocation platform. EPAD auctions should be performed in cooperation with an exchange listing EPAD contracts. In addition, there will be TSO costs associated with settlement of positions.

Price risks

Involvement in financial markets may *change* the price risk exposure of the TSO. TSOs are already exposed to risks associated with price area differences in the spot market (determining congestion rents). Support to a market maker function does not change the TSOs price risk.

Auctioning of individual EPAD contracts introduces a new price risk for the TSO in terms of contract losses. However, contract losses due to changes in area price differentials will often be associated with increases in the associated congestion rent. We conclude that the change in the TSOs risk exposure depends on the correlation between the system price and the relevant area price. Normally the total risk exposure is reduced.

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Auctioning of EPAD Combos is likely to further reduce the risk of contract losses as it implies selling in one area and buying in another, and hence to reduce the total price risk exposure of the TSO.

Auctioning of FTR-options in both directions on an interconnector removes the price risk for the TSO. The TSO effectively sells the right to the congestion rent. However, auctioning of FTR-obligations in both direction does not change the risk exposure of the TSO.

Volume risks/firmness risks

In addition to the price risk, the TSO may face a firmness risk. The volume risk depends on the relationship between traded volumes and contract volumes. Without involvement in the financial markets, TSOs are exposed to volume risks related to available transmission capacity, but face no firmness risk, as congestion revenues accrue from the actual trades generated by differences in spot prices between bidding zones.

Support to a market maker function does not change the volume risk of the TSO.

For FTRs, firmness requirements in the FCA GL implies that the holders are entitled to the congestion rent on the entire contract volume, whether the actual exchange volume is as expected or not. (Looser requirements apply to DC lines.)

EPAD auction volumes should, on the other hand, be based on an assessment of the volume needed to achieve the desired liquidity in the concerned bidding zone, and not to the exchange capacity between bidding zones. Hence, although EPAD contracts are strictly firm, the volume risk associated with EPADs will vary between different bidding zones.

Risk premiums

In well-functioning financial markets, the price of financial contracts should basically reflect expected market values. If the auction does not manage to realize the expected values, however, the TSO cost will be higher. A study from 2013 reported that the payments TSOs received from PTR auctions was significantly lower than the ex-post value (i.e., the congestion rent). We expect that auctioning of EPADs or FTR-obligations exposes a TSO to lower auction risk than auctioning of FTR-options because the former instruments are more suitable for fundamental hedging.

Impacts on tariffs and TSO incentives

In general, the TSOs costs associated with intervention in financial markets due to a lack of hedging opportunities will be borne by tariff customers. The differences in TSO regulation schemes between the Nordic countries do not seem to affect this.

As TSOs can pass the costs for interventions and financial exposure on to tariff customers, the question is rather how the costs and risks of the tariff customers (finally the end-users) are affected compared to the current situation (without interventions). There should be no difference between the models when it comes to the TSOs incentives for setting of ATC values.

Regulatory risks

As with all market intervention, there are certain risks associated with poor regulatory design.

First of all, it is necessary to be careful when assessing the need for intervention in the financial markets. All models come with a cost. Hence, a clear case of market failure should be identified before the TSO is instructed to intervene. A lack of EPAD trade in a bidding zone does not necessarily mean that hedging is deficient.

Second, when choosing the model, NRAs should be aware of the underlying cause of the deficiency.

Third, if support to the EPAD market is chosen, the dosage of the model may be important. The efficiency of support to a market maker depends on the bid-ask spread and volumes required in the contract. The right level should be decided based on consultation with market participants and exchanges. The efficiency of EPAD auctions also depends on volumes and frequency of auctions.

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We do not recommend that general rules of thumb are used. Again, volumes and frequency should be determined based on the situation in the concerned bidding zone and consultation with stakeholders. We do however, not see a substantial risk of disruptive overregulation when it comes to intervention in the EPAD market. Too lenient intervention may fail to have the desired effect, and too much intervention may increase risk premiums for the TSO and thus the cost of the intervention. It should, however, be relatively easy to adjust the requirements of a market maker, and the volumes in EPAD auctions. Such changes should however be notified well in advance.

Fourth, support to a market maker function or auctioning of EPADs involve public procurement processes. The outcome of such processes are naturally uncertain in advance, and so are calculations of the costs and effects of the models. The competition criteria for the procurement process have to be carefully aligned with the objectives of the TSO involvement.

Recommendations

Based on the analysis and comparison of impacts of the different models, we conclude that FTR auctions are inferior to measures that support EPAD trading in the Nordic market. An important reason is that financial trading linked to the system price is perceived as a crucial success factor in the Nordic electricity market. While support to a market maker and auctioning of EPAD contracts will strengthen the market, introduction of FTR might weaken financial trade related to the system price. Moreover, we conclude that the measures that support EPAD trading are better suited for the Nordic market in terms of increased hedging opportunities.

Whether the TSO should be instructed to support a market maker function or auction EPAD contracts, depends on the situation in the concerned bidding zone, and should be subject to scrutiny on a case-by-case basis. In a bidding zone with a skewed balance between demand and supply, support to a market maker function may be insufficient. Auctioning of individual EPAD contracts directly increase the traded volume. However, this may expose the TSO to risks for contract losses. Auctioning of EPAD Combos has the advantage that the magnitude of possible contract losses are smaller for the TSO since an EPAD Combo combines a buy in one area with a sell in another area..

Calculations of costs and benefits of the different models are uncertain by necessity. However, all the preferred models can be implemented in such a way that they are easy to adjust or to phase out if they do not have the desired effect or they become obsolete over time. We recommend that flexibility is taken into account in the design and implementation of instruments.

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1 INTRODUCTION

A prerequisite for a well-functioning electricity market is that there are efficient hedging opportunities for consumers, retailers and generators. In order to promote cross-border hedging opportunities in Europe, the EU is in the process of deciding a Guideline on Forward Capacity Allocation (FCA GL).[1]

The FCA GL states that hedging opportunities for market participants shall be available regardless of bidding zone borders. The reference tools for cross-border hedging are long-term transmission rights (LTTRs). These can be ether financial transmission rights (FTRs) or physical transmission rights (PTRs) with Use-It-Or-Sell-It (UIOSI) provisions. FTRs can be either FTR-options or FTR-obligations. The LTTRs are to be issued by the TSOs. However, competent NRAs of a bidding zone border can issue coordinated decisions that TSOs shall not issue LTTRs on the bidding zone border. Such decisions shall be based on an assessment which shall identify whether the electricity forward market provides sufficient hedging opportunities in the concerned bidding zones.

The Nordic market already has instruments for hedging of area prices, and trading and hedging in the forward markets is purely financial. According to overall stakeholder feedback to NordREG, market participants acknowledge the existing Nordic financial market as a well-functioning system. This is also in line with the conclusions in various studies of the Nordic market, e.g., Hagman and Bjørndalen (2011), THEMA (2013), NordREG (2014), and Armstrong et.al. (2015).[2]

The calculation of a system price and several area prices (for different bidding zones) is a distinctive feature of the Nordic market. Most of the liquidity in the forward markets is linked to the system price, but specific area prices can be hedged by using a combination of system price contracts and EPAD contracts (Electricity Price Area Differentials). EPADs can be cleared at Nasdaq OMX Commodities and are traded at Nasdaq OMX Commodities, through brokered deals or bilaterally. TSOs have no role in the forward markets.

A particular advantage of the Nordic market design is the combined Nordic liquidity in existing system price products. However, some bidding zones may not have the liquidity in EPADs that is desired by market participants. Hence, there may be a case for regulatory measures in order to support the functioning of the EPAD market and increase the liquidity and market depth. In fact, if there are insufficient hedging opportunities in one or more bidding zones, regulatory intervention will be required by the FCA GL.

The Nordic NRAs' wish to maintain and improve the current Nordic market design, while sustaining and improving the fundamental market participants' ability to hedge their risk. Such measures should however be evaluated thoroughly, in order to understand and minimize the risk for distortions of the existing market and price signals. On this background, the Nordic NRAs have commissioned THEMA Consulting Group and Hagman Energy to explore options for enabling TSOs to facilitate the EPAD market in bidding zones where inadequate hedging possibilities have been identified. The aim of the study is thus to gain knowledge of alternative models for TSO involvement in the financial electricity market.

The main issue of the study may be summarized as:

What is the recommended model or set of principles for TSO involvement in the EPAD market, if such involvement is deemed needed in (any of the) Nordic bidding zones?

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[1] The Electricity cross-border committee approved a draft regulation establishing FCA GL on the 30th of October 2015.

[2] Hagman and Bjørndalen (2011): FTRs in the Nordic Electricity Market: Pros and Cons Compared to the Present System with CfDs. Elforsk rapport 11:16.

THEMA (2013): Efficiency of Cross-Border Forward Products and the Role of TSOs. THEMA Report 2013-01.

NordREG (2014): Nordic NRAs Proposal for NC FCA Improvements.

Armstrong, Bergland, Bjørndalen, Fleten, Fortenbery, Fretheim, Galli, and Naper (2015): Hedging Possibilities and the Forward Capacity Allocation Network Code.

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The study explores alternative measures to support the functioning of the EPAD market in cases where cross-border hedging is found to be inadequate. We compare the models in terms of their efficiency in this respect, i.e.

1. What are the benefits in terms of improved hedging opportunities?
2. What direct costs do the models imply for TSOs and market participants?
3. What is the financial exposure of the TSOs, and to what extent the exposure result in costs borne by tariff customers?
4. What adverse impacts on existing markets could arise?
5. What is the risk of costs related to overregulation?

The fall-back option, if other measures are not implemented, is to introduce FTR-options or FTR-obligations. Hence, the study includes also the two FTR-models as described in the FCA GL.

The report contains the following chapters:

- Chapter 2 describes the alternative models for TSO involvement
- Chapter 3 analyzes TSO costs in terms of administrative costs and financial exposure, and the impact on grid tariffs
- Chapter 4 analyzes the market impacts in terms of hedging opportunities in concerned bidding zones, in terms of impacts on existing markets, in terms of strategic behaviour, and in terms of risk of overregulation.
- Chapter 5 presents our recommendations based on a comparison of the different models.

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2 SIX MODELS FOR TSO INVOLVEMENT

FCA GL stipulates that if an assessment (including market consultation) shows insufficient hedging opportunities in one or more bidding zones, the competent regulatory authorities shall request measures from the relevant TSOs. Such measures shall be either to issue long-term transmission rights (LTTRs) or to make sure that other long-term cross-zonal hedging products are made available to support the functioning of wholesale electricity markets.

In this chapter, we first describe four alternative models for TSO involvement to support the functioning of the EPAD market in the Nordic market area, and thereafter describe the two types of financial transmission rights that are defined in FCA GL, FTR-options and FTR-obligations. We will describe the structure and administrative implications of the different models, including what they imply in terms of the role of the TSO and the relation to other stakeholders. Extra costs for the TSOs may also imply higher grid tariffs for market participants. We come back to this issue in section 3.5.

2.1 Support market maker function in EPAD contracts

A market maker commits to continuously give buy and sale bids with a certain minimum volume and a certain maximum spread. A market maker function gives mainly two benefits for the market. The first benefit is that it will always be possible for a market participant to buy or to sell a contract. The possible deviation between the contract price and the “real” market price depends on the allowed bid-ask spread for the market maker(s) if nobody else than market maker(s) give bids. The second benefit is that it gives security for a market participant that it can exit a position if stop-loss limits are reached. The security is better, the higher the required minimum volume from market maker(s). This means that for fundamental hedgers the allowed bid-ask spreads are most important, while for speculative traders the required minimum volumes are most important.

An exchange has a commercial interest in getting market makers for its products and enters therefore into market maker agreements with compensation as payments or lower fees. Nasdaq Commodities has EDF and Vattenfall as market makers for all listed base load futures and forward contracts referring to the Nordic system price, except day futures contracts. EDF is in addition market maker for all listed peak load futures and forward contracts referring to the Nordic system price.

Regarding EPAD contracts, Vattenfall is market maker for all listed contracts referring to the four Swedish areas and the Finnish area. DONG Energy and Energi Danmark are market makers for all listed contracts referring to the two Danish areas.

If insufficient hedging opportunities are to be mitigated in one or more bidding zones in Denmark, Finland or Sweden, a TSO involvement could be to finance a market maker agreement for the concerned bidding zone(s) with stricter demands on maximum spread regarding EPAD contracts.

There is no market maker for Norwegian EPAD contracts. If there are insufficient hedging opportunities in one or more bidding zones in Norway, a TSO involvement could be to finance a market maker agreement regarding EPAD contracts for the concerned bidding zone(s).

TSO support to a market maker function can be performed as a procurement by the TSO. Specification of the obligations for a market maker should be developed after an assessment and a consultation with market participants. The selection criterion can be the demanded price for fulfilling the market maker function during the requested period of time.

Alternatively, the TSO can support a market maker function via an agreement with an exchange that organises trade in EPADs for the concerned bidding zone(s). The agreement can stipulate that the exchange shall receive a financial grant from the TSO and that the exchange shall come to a market maker agreement with the specified obligations. A combination of the interests of the exchange and the TSO should normally reduce the financial costs for the TSO and reduce its administrative procurement costs.

Interests can also be combined by including the compensation from the exchange in the contract conditions of the invitation to tender. In this case, the financial costs for the TSO should be reduced, but the TSO still has the procurement responsibility and the administrative procurement costs.

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A market participant that enters into a market maker agreement or accepts that its existing market maker obligations become stricter will of course incur extra costs. However, it will not enter into a new or changed market maker agreement unless it expects the benefits to outweigh the extra costs.

Reduced trading fees are more valuable for large traders than for medium-sized traders. If the compensation for a market maker agreement is a fixed lump-sum, the value will be the same for large traders as for medium-sized traders.

No other market participant will incur extra administrative costs if a TSO supports a market maker function as long as the support is for a market maker function at an exchange which is already used by the market participant. Otherwise, the market participant will incur extra costs if it wants to benefit from the market maker function. The extra costs relates to registration at another exchange and another clearing house and extra costs for managing collaterals at one more clearing house.

2.2 Guarantee maximum spreads in EPAD contracts

The difference between this alternative and alternative 1, is that the TSO itself performs the market maker function, i.e., continuously gives buy and sale bids with a certain maximum spread in the concerned EPAD contracts. This means that the TSO will act in the EPAD market as a market participant. Today, Nordic TSOs do not have trading departments and will therefore in this alternative have to establish and operate trading departments. The trading departments can be small but the TSOs will nevertheless incur extra costs, and will not be able to realize economies of scope since the TSO does not engage in other trading or hedging activities.

EU financial regulations stipulates that a market participant is not allowed to trade unless it has disclosed inside information. Prices in the EPAD market depends on expectations regarding power flows and allocated capacities between bidding zones. TSOs will always have inside information regarding the power system and possible future capacity restrictions.

This means that it is not possible for a TSO to continuously guarantee maximum spreads in the EPAD market unless it has created “Chinese walls” between its market maker function and its other duties. We estimate that the costs for a TSO to establish and maintain a trading department with adequate “Chinese walls” will be much higher than normal costs for establishing and maintaining a small trading department. In addition, there will be a risk that other market participants question the existing set-up and demand even stricter and costlier “Chinese walls”. Experience from other markets imply that it will always be possible to question whether “Chinese walls” are crack-proof in all situations.

No market participants will incur extra administrative costs if a TSO guarantees maximum spreads in the EPAD market.

In our opinion, alternative 2 will not yield any extra benefits compared to the benefits achieved in alternative 1. At the same time, the costs are certainly higher. Hence, alternative 2 is clearly inferior to alternative 1. In addition, implementation of alternative 2 runs the risks of reducing the trust in TSOs as neutral and independent system operators. This risk is alarming as we believe that the Nordic TSOs role as neutral market facilitators – and the trust in that role from market participants – has been very important for the successful development of the Nordic electricity market. Consequently, we will not compare alternative 2 with the other alternatives in the following sections. If alternative 2 is better than another alternative, alternative 1 will always be even better.

2.3 Auction EPAD contracts

A third alternative is that TSOs auction EPAD contracts for the bidding zone(s) which are assessed as having insufficient hedging opportunities. If a TSO sells EPAD contracts for a bidding zone, the consequence would be an increased supply of EPAD contracts and therefore increased hedging possibilities for retailers and consumers in the bidding zone. If a TSO buys EPAD contracts for a bidding zone, the consequence would be an increased demand of EPAD contracts and therefore increased hedging possibilities for producers in the bidding zone.

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The experience from the 35 quarterly auctions of Virtual Power Plant (VPP) in DK1 which were held between November 2005 and May 2015, is valuable. These VPP auctions were required by the Danish Competition Authority, and performed by Nord Pool on behalf of Elsam/DONG Energy. Another example is the auctions of European Union Allowances (EUA), which are performed by EEX on behalf of the European Commission and participating member states. Using exchange platforms for performing the auctions has been cost-effective for the sellers of auctioned instruments and administratively advantageous for the market participants bidding in the auctions.

Based on these experiences, we recommend that auctioning of EPAD contracts is not performed by the TSO itself. It is a better alternative that an exchange that lists EPAD contracts performs the auction on behalf of the TSO. Then auction trades automatically result in positions towards the clearing house and settlement and management of collaterals are made with the clearing house. After the auction, the TSO will have an open position towards the clearing house corresponding to the auctioned EPAD contracts. Market participants who buy EPAD contracts in the auction will also have the clearing house as their counterparty, and not the TSO. There will thus be no need for bilateral transactions between the market participants and the TSO.

The auctioning can be done at Nasdaq Commodities or on another exchange that lists EPAD contracts. It may be necessary to carry out a public procurement for the exchange performing auctions of EPAD contracts.

The auctioning should be done according to a predetermined plan, containing types of contracts, volumes and timing of auctions. The plan should be announced well in advance and be decided after consultation with market participants.

Contrary to alternative 2, alternative 3 requires no “Chinese walls” within the TSO. The auctioning is not affected by TSO estimations of possible area price differences. We do not recommend that the TSO should have the possibility to reduce its positions via secondary trading. Secondary trading by a TSO is questionable from a market and cost viewpoint. It can easily raise questions regarding trade based on inside information, it requires that clear criteria are established, and that such trading is announced well in advance.

The administrative costs for a TSO are only related to establishing the auctioning plan and to settlement with the clearing house, and are hence, likely to be small. There is however a possibility that the exchange will demand a payment for performing the auctioning process. However, we believe that this payment will be small or non-existent. It is in the interest of the exchange to perform the auctioning process since it will increase trade in the concerned EPAD contracts (cf. the discussion about market makers in section 2.1).

The administrative costs for market participants to prepare bids for the auctions are insignificant. However, they may encounter extra administrative costs if the auction is done on another exchange than their normal exchange for EPAD contracts. In such a case, they may incur extra registration costs. They may also encounter extra costs for registration and collaterals if the contracts traded in the auction are cleared with another clearing house than their normal clearing house.

2.4 Auction EPAD Combos

An EPAD Combo is a combination of two EPAD contracts, a sell for one area and a buy for another area. An EPAD Combo which gives the buyer a sell in area A and a buy in area B is a contract for the price difference between the two areas. A market participant with such an EPAD Combo has a hedge of the area price in area B if it has a hedge of the area price in area A. An EPAD Combo resembles in this respect an FTR-obligation for TSOs and for market participants (see section 2.6). An advantage with an EPAD Combo is that it may reduce the financial exposure of the TSO while at the same time providing flexibility to market participants, as the Combo is not a separate contract, but a combination of two EPAD contracts.

Auctioning of EPAD Combos can be done in the same way as auctioning of EPAD contracts. However, the TSO will after the auction have two positions versus the clearing house, a buy in one area and a sell in another area. The price risk for the TSO auctioning an EPAD Combo relates to the

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price difference between the area prices for the two areas while the price risk for an EPAD contract relates to the price difference between the area price for that area, and the Nordic system price (see section 3.2).

An EPAD Combo can either be a combination of EPAD contracts in two bidding zones belonging to the same TSO or two bidding zones belonging to two different TSOs. The latter case is facilitated if there is a cooperation between the two TSOs regarding the auctioning and the distribution of costs and income. However, such cooperation is not a necessity. A TSO can auction an EPAD Combo with one bidding zone belonging to another TSO instead of auctioning an EPAD contract if it is seen as reducing the price risk for the TSO, provided that such auctioning is approved by the competent NRAs.

In principle, an EPAD Combo can include two bidding zones located anywhere in the Nordic area. There is no need for geographical vicinity. The only requirement is that there are EPAD contracts listed for both bidding zones.

Bids from market participants to an EPAD Combo auction can be to sell EPAD contracts in the first area or to buy EPAD contracts in the second area. Bids can also be "block bids" for the EPAD Combo. The market participant has in such a case – if the "block bid" is accepted – sold EPAD contracts in the first area and bought EPAD contracts in the second area. An EPAD Combo auction can thus result in three different types of hedges for different market participants. Hedging of sales in area one, hedging of purchases in area two or a hedge of the price difference between the two areas.

The same considerations apply for this alternative as for alternative 3 regarding need for "Chinese walls" and regarding administrative costs for TSOs and market participants.

2.5 Auction FTR-options

An FTR-option is a financial transmission right between two bidding zones which gives the owner the right to receive the price differential each hour if it is positive in the direction of the FTR-option, but gives no obligation for hours when the price differential is negative.

FTR-options seem to be the preferred FTR model in continental markets. A main reason is probably that FTR-options will be much the same as current physical transmission rights (PTRs). The main difference with PTRs is that the owner of a PTR has a possibility to physically nominate transmission capacity instead of getting a financial settlement. However, holders of PTRs hardly ever use this nomination possibility between market coupled bidding zones. Another difference from current PTRs is that FCA GL gives stricter demands on firmness for FTR-options and demands on compensation from TSOs if there are curtailments. A third difference is that PTRs are not defined as financial instruments. However, article 2(1)(n) in directive 2014/65/EU (MiFID II) gives an exemption from the rules for TSOs *"when carrying out their tasks under those Directives, under Regulation (EC) No 714/2009, under Regulation (EC) No 715/2009 or under network codes or guidelines adopted pursuant to those Regulations".*

Rules regarding auctioning of FTR-options are given in FCA GL and these rules are binding for all TSOs auctioning FTR-options. All TSOs shall develop a proposal for harmonised allocation rules. TSOs issuing FTR-options shall offer them to market participants through a single allocation platform. The single allocation platform shall be used for registration of market participants, operation of auction procedures, and financial settlement including management of collaterals posed before the auction.

Auctioning of FTR-options means extra administrative costs for market participants in the Nordic region who buy FTR-options. They have to register at the single allocation platform, and they have to provide collaterals to the single allocation platform.

There is currently illiquid secondary trading in PTRs. FCA GL gives the possibility to transfer transmission rights from one eligible market participant to another. This can be done bilaterally or by returning the rights through the single allocation platform in a subsequent auction.

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2.6 Auction FTR-obligations

An FTR-obligation is different from an FTR-option in the way that it includes the obligation for the owner to also pay the price differential for all hours when it is negative. The consequence is that the settlement of an FTR-obligation for a certain period equals the average price differential for the period. The price for an FTR-obligation will thus reflect the expected average price differential while the price for an FTR-option will reflect the expected sum for all hours with positive price differentials.

We have so far not noticed any European market aiming for FTR-obligations as their preferred model.

Rules regarding auctioning of FTR-obligations are given in FCA GL and these rules are binding for all TSOs auctioning FTR-obligations. All TSOs shall develop a proposal for harmonised allocation rules. TSOs issuing FTR-obligations shall offer them to market participants through a single allocation platform. The single allocation platform shall be used for registration of market participants, operation of auction procedures and financial settlement including management of collaterals. The single allocation platform may have a cooperation with a clearing house if required by the rules that shall be developed for FTR-obligations.

Market participants in the Nordic region will have corresponding extra administrative costs with FTR-obligations as with FTR-options. In addition, they will incur extra costs for registration and management of collaterals at the clearing house chosen by the single allocation platform, if the single allocation platform cooperates with another clearing house than the normal clearing house for the market participant.

The rules in FCA GL regarding secondary trading apply for both FTR-options and FTR-obligations.

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3 IMPLICATIONS FOR TSOS

As we have seen in chapter 2, the different models for TSO intervention imply different administrative costs for the TSOs. The models may also imply different degrees of financial exposure for the TSOs, which in turn may imply extra risk costs. These administrative and risk costs are likely to be covered through grid tariffs, but there may also be other ways to cover the costs. The choice of model may also affect TSO incentives, depending on the regulation on TSOs and how their costs are covered, and on the TSOs risk attitude. We discuss these issues in this chapter.

3.1 Administrative costs

3.1.1 Support market maker function in EPAD contracts

The main TSO cost for support to a market maker is the fixed cost which has to be paid to a market maker fulfilling the requested obligations. It can be expected that this fixed cost will be higher if the requirements for the market maker are stricter.

We assess that the maximum allowed bid-ask spread is the most important feature for fundamental hedgers. A TSO financial support to a market maker function can therefore be expected to be more cost-efficient if it is more focused on maximum allowed bid-ask spread than on minimum bid volumes or uninterrupted market making during all the hours the exchange is open for trading.

We also expect the measure to be more cost-efficient if the TSO supports only one market maker in an area, rather than two or more market makers. The main benefit with two market makers is that the combined minimum bid volumes makes it possible to directly exit a bigger position if stop-loss limits are reached. However, regarding the bid-ask spread it is possible for two market makers to follow the bids of each other in such a way that no essential reduction in the bid-ask spread is obtained in the market.

Support to a market maker function will also imply administrative procurement costs for a TSO.

As described in section 2.1, there are different possibilities to combine the interests of the TSO and the interests of the exchange regarding support to a market maker function. Both the TSO financial support and its administrative purchasing costs can probably be reduced if it is possible to achieve such a combination of interests.

3.1.2 Auction EPAD contracts or EPAD Combos

The main TSO costs for EPAD auctions are probably risk costs associated with the financial exposure caused by TSOs contract positions after the auctioning. We discuss this issue in section 3.2.

The administrative costs of the TSO are related to the auctioning process and to administration and settlement of the positions received after the auctioning. A consequence of auctioning listed contracts on an exchange is that a TSO will only have open positions towards the clearing house after the auctioning. Administrative costs after the auctioning are therefore only related to collaterals and settlement with the clearing house.

There is also a possibility that the exchange will demand a payment for performing the auctioning process. However, we believe that this payment will be small or non-existent. It is in the interest of the exchange to perform the auctioning process since it will increase trade in the concerned EPAD contracts.

In addition, a TSO will have administrative costs related to establishing the auctioning plan. We assess that also this cost will be small.

In principle, there is no difference in administrative costs for a TSO between auctioning of EPAD contracts for one bidding zone and auctioning of EPAD Combos for two bidding zones. An EPAD Combo is formally only a combination of two EPAD contracts.

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3.1.3 Auction FTR-options or FTR-obligations

The administrative costs for a TSO will probably be higher if the TSO auctions FTR-options or FTR-obligations instead of EPAD contracts or EPAD Combos.

The FCA GL includes many methodologies and rules for FTR auctions, which must be developed and complied with. All TSOs issuing long-term transmission rights on the single allocation platform shall jointly bear the costs related to the establishment and operation of the single allocation platform. Within six months of entry into force of FCA GL, all TSOs shall propose a methodology for sharing these costs, which shall be reasonable, efficient and proportionate.

3.2 Price risks

When Nordic TSOs invest in interconnector capacity, the investment decision is based on a socio-economic analysis including expected future price differences between the interconnected bidding zones. The investment is partly financed by congestion rents and partly by the ordinary TSO tariffs. The price differences are likely to vary from year to year and may be larger or smaller than expected over time. Hence, the congestion rent is likely to vary as well. Therefore, we may say that the TSOs have a financial exposure related to investments in interconnectors. If the price differences are smaller than expected, the congestion revenue is smaller, and if the price differences are larger, the congestion revenue is higher.

The models for TSO intervention in financial markets in order to strengthen cross-border hedging, affect the TSOs financial exposure as well. We may distinguish between price risks, volume risks and firmness risks. The *price risk* is the risk that price differences are smaller than expected, whereas the *volume risk* is the risk that the traded volumes are smaller than expected. *Firmness risk* refers to whether the volumes defined in the contracts are fixed up-front (firm). The current system in Finland, Norway and Sweden implies that the TSOs are fully exposed to the price and volume risk of the congestion revenues, but has no firmness risk, as the congestion revenues accrue from the actual trades generated by hourly spot market prices and available transmission capacity. The Danish TSO Energinet.dk, however auctions PTRs on interconnections with Germany and on the interconnection between DK1 and DK2, whereas the congestion rent on the connections with Norway and Sweden are based on spot-price differences.

In this section we analyse whether the different models *changes* the price risk exposure for a TSO. The different models will be described in the opposite order from our normal order. The reason is that we will base our analysis of price risks and financial exposure from auctioning of EPAD contracts and EPAD Combos on a comparison with the price risks and financial exposure from auctioning of FTR-options and FTR-obligations. In order to simplify the analysis, we assume here that there are no volume risks or firmness risks. We will return to the issues of volume risks/firmness risks in section 3.3.

In the discussion in this section, we also assume that the markets are efficient, i.e. that they pay the expected value of the instruments. In reality, the TSOs may face different auction risks in different models. We discuss auction risks in section 3.4.

3.2.1 Auction FTR-options or FTR-obligations

By current auctioning of PTRs in many EU countries, the TSO sells the right to the congestion rent for the specified volume.

If the PTR auction is efficient, we can expect that price of the PTR reflects the value of the instrument, which is the expected congestion rent in the direction of the PTR. (In addition, we can expect that the price of a PTR reflects time to maturity, volatility of the price difference and interest rate). Let PTR_{AB} denote the value of holding a physical right to transmission capacity from area A to area B and PTR_{BA} denote the value of holding a physical right to transmission capacity from area B to area A. Let CR denote the (expected) congestion rent between the two areas A and B.

Then per definition and for a given volume, $CR = PTR_{AB} + PTR_{BA}$.

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This also implies that

$$PTR_{AB} = CR - PTR_{BA} \text{ and } PTR_{BA} = CR - PTR_{AB}$$

A change from auctioning of PTRs to auctioning of FTR-options gives the same result (provided there are no volume risks and no firmness risks).

Let $FTR\text{-}OPT_{AB}$ denote the value of holding an FTR-Option from area A to area B and $FTR\text{-}OPT_{BA}$ denote the value of holding an FTR-Option from area B to area A.

Then, given our assumptions, the TSO revenue from auctioning FTR-options in both directions will also equal the expected congestion rent from the auctioned volume:

$$FTR\text{-}OPT_{AB} + FTR\text{-}OPT_{BA} = CR$$

Auctioning of FTR-options in both directions with the same volume will thus remove the price risks for the TSO.

However, price risks arise if the auctioned volumes are not the same in both directions. A TSO selling FTR-options in only one direction gives up the right to the congestion rents in that direction, but is still exposed to the spot price difference in the other direction.

The most important difference between FTR-options and FTR-obligations is that with an FTR-option, the holder is entitled to any positive congestion rents in the direction specified by the contract but does not have to pay if the congestion rent is negative. The holder of an FTR-obligation has on the other hand a right to the average congestion rent during a specified period and in a specified direction.

This difference is very important if congestions arise in both directions. If congestions can arise only in one direction, the value of an FTR-option and an FTR-obligation in that direction will be the same. However, the value in the other direction will be zero for an FTR-option but negative for an FTR-obligation, as the holder of the FTR-obligation has to pay if the price difference goes in the other direction.

Let $FTR\text{-}OBL_{AB}$ denote the expected value of holding an FTR-Obligation from area A to area B and $FTR\text{-}OBL_{BA}$ denote the expected value of holding an FTR-Obligation from area B to area A. The expected values of $FTR\text{-}OBL_{AB}$ and $FTR\text{-}OBL_{BA}$ can then be calculated as

$$FTR\text{-}OBL_{AB} = PTR_{AB} - PTR_{BA} = FTR\text{-}OPT_{AB} - FTR\text{-}OPT_{BA}$$

$$FTR\text{-}OBL_{BA} = PTR_{BA} - PTR_{AB} = FTR\text{-}OPT_{BA} - FTR\text{-}OPT_{AB} = - FTR\text{-}OBL_{AB}$$

The TSO revenue from auctioning of FTR-obligations in both directions is thus zero:

$$FTR\text{-}OBL_{AB} + FTR\text{-}OBL_{BA} = FTR\text{-}OBL_{AB} - FTR\text{-}OBL_{AB} = 0$$

Such an auction will thus leave the TSO fully exposed to the spot market congestion rent and give no hedge of the congestion rent, if that is seen as valuable. If the value of an FTR-obligation in one direction is positive, the value of an FTR-obligation in the other direction will be the same, but negative.

The TSO revenue from auctioning of FTR-obligations in only one direction can be calculated as

$$FTR\text{-}OBL_{AB} = PTR_{AB} - PTR_{BA} = CR - PTR_{BA} - PTR_{BA} = CR - 2 \times PTR_{BA} \quad (\text{since } PTR_{AB} = CR - PTR_{BA})$$

This means that the TSO revenue from auctioning of FTR-obligations in only one direction will be the total congestion rent in both directions minus the double congestion rent in the opposite direction. Such an auctioning can give a significant hedge of congestion rents if the congestions in the other direction are comparatively small. It will give a full hedge of congestion rents if the congestions in the other direction are non-existent. However, such an auctioning will not give a significant hedge of congestion rents if the congestions in the other direction are of the same size or bigger.

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Armstrong et.al. (2015)[3] show two examples of the difference in pay-offs between the PTRs and the two FTR contracts in a three-period, two area market, see table 3.1 in facsimile below. The example illustrates the theoretical results above. They study two different cases, Case 1 in which the price difference goes both ways and the average price difference is zero, and Case 2 in which Price B is consistently higher than Price A.

Table 3.1 Comparison of FTR-obligations and FTR-options

Note: All values are EUR/MWh						Payoff for contract from A to B			Payoff for contract from B to A		
	Period	Price A	Price B	Difference, B minus A	Congestion revenue	PTR w/UIOSI	FTR Option	FTR Obligation	PTR w/UIOSI	FTR Option	FTR Obligation
Case 1	1	20	33	13	13	13	13	13	0	0	-13
	2	20	20	0	0	0	0	0	0	0	0
	3	20	7	-13	13	0	0	-13	13	13	13
Average price or payofl		**20**	**20**	**0**	**8,67**	**4,33**	**4,33**	**0**	**4,33**	**4,33**	**0**
Accumulated payoff					**26**	**13**	**13**	**0**	**13**	**13**	**0**
Case 2	1	20	26	6	6	6	6	6	0	0	-6
	2	20	27	7	7	7	7	7	0	0	-7
	3	20	25	5	5	5	5	5	0	0	-5
Average price or payofl		**20**	**26**	**6**	**6**	**6**	**6**	**6**	**0**	**0**	**-6**
Accumulated payoff					**18**	**18**	**18**	**18**	**0**	**0**	**-18**

Source: Armstrong, et.al. (2015)

In Case 1, the price difference goes in different directions in period 1 and period 3, and the average price difference is zero.

The case shows that the FTR-obligation offsets the corresponding position in the physical market for the market participant. Let us assume that a consumer in B enters into a purchase contract with a generator located in A. The average price level in the two areas is expected to be the same, but prices in B are much more volatile and uncertain than prices in A. By purchasing an FTR-obligation, the consumer makes sure that if the average price in B turns out to be higher than expected (all other prices equal), the loss is countered by a corresponding gain from the FTR-obligation. E.g. if the price in period 1 turns out to be 35 in area B, he must pay 35 in the wholesale market, but is also entitled to the congestion rent of 15 according to the FTR. If prices are as expected in period 2 and 3, he must pay 13. The increased cost in B (= 2) is offset by the increased revenue from the FTR-obligation.[4] The example also shows that even though the expected pay-off to the FTR-obligation is zero, it has a risk mitigation value for the holder.

So what about the financial exposure of the TSO? The TSO collects congestion rents in both directions (whenever there is a bottleneck). In Case 1 the total congestion rent is 26. The FTR-obligation from A to B implies that the holder of the FTR-obligation is entitled to the congestion rent in period 1. Hence, the TSO's revenue in period 1 is zero. In period 3, however, the TSO earns the congestion rent from B to A *and* collects the congestion rent from the holder of the FTR-obligation. The TSO's net revenue is equal to twice the congestion rent in in period 3, unless it has sold an FTR-obligation in the opposite direction as well.

Table 3.2 shows the TSO' revenue if it has sold FTR-obligations in one direction or in both directions in Case 1.

[3] See footnote 1.

[4] The same holds if the price increases in period 3 instead. He must then pay a higher price in market B, but this cost is offset by a smaller payment according to the FTR-obligation.

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Table 3.2 TSO revenues when selling FTR-obligations, Case 1

	Period 1	Period 2	Period 3	Total
Price A	20	20	20	
Price B	33	20	7	
CR	13	0	13	26
FTR-OBL_{AB}	13	0	-13	0
FTR-OBL_{BA}	-13	0	13	0
TSO revenue – both directions	13	0	13	26

The TSO is fully exposed to the spot price differences if it auctions FTR-obligations in both directions. Hence, auctioning FTR-obligations in both directions does not provide any hedge for the TSO. In other words, FTR-obligations do not change the TSOs price risk exposure in this case.

In Case 2, see table 3.3, prices are consistently higher in B than in A, and the value of an FTR-obligation is the average congestion rent from A to B. Hence, the TSO should be paid the expected value, which is the expected congestion rent, and has traded the uncertain expected congestion rent with the certain revenue from the FTR-obligation.

Table 3.3 TSO revenues when selling FTR-obligations, Case 2

	Period 1	Period 2	Period 3	Total
Price A	20	20	20	
Price B	26	27	25	
CR	6	7	5	18
FTR-OBL_{AB}	6	7	5	18
FTR-OBL_{BA}	-6	-7	-5	-18
TSO revenue – both directions	6	7	5	18

In Case 2, the value of an FTR-obligation from A to B is equal to the value of an FTR-option from A to B. This is the case as long as the price in A is never higher than the price in B. Moreover, in Case 2 the value of an FTR-obligation from B to A is -18 while the value of an FTR-option from B to A is zero.

3.2.2 Auction EPAD contracts or EPAD Combos

As we have seen in chapter 2, auctioning of EPAD contracts and EPAD Combos implies that the TSO takes a market risk.

Let us first analyse the situation where the TSO auctions EPADs separately in area A and area B. For the sake of argument, we assume that area B is a deficit area where consumers lack sufficient hedging opportunity towards the area price difference and that area A is a surplus area. The expected price in area B is higher than the system price. The consumers would like to hedge their cost of electricity in area B (buy EPADs) to avoid having to pay a higher price difference towards the system price than the expected one. We assume that the expected price difference between area A and area B is 8 (€/MWh), and that the price in B is expected to be 4 higher than the system price (hence, the price in area A is expected to be 4 lower than the system price). For simplicity, we assume initially that there are only two price areas in the market, and that all volumes are equal (EPADs and physical trade flows). We also assume that market participants are already hedged towards the system price.

A TSO selling EPADs in area B ($EPAD_B$) obtains an open position related to the difference between the system price and the area price in B. The price of $EPAD_B$ is equal to the expected price difference

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between the system price and the price in area B, i.e. 4 in our example. The consumer in area B now has a perfect hedge (assuming it is already hedged in the system price). We assume that the TSO also buys the same volume of EPADs in area A ($EPAD_A$).

In order to understand the TSOs financial exposure, we analyse what happens when prices in the delivery period *do not* turn out as expected. The first observation is that if all prices increase or decrease by the same amount, the congestion revenue stays the same, and so does the difference between the system price and the area price. Hence, the TSOs revenue also stays the same.

The TSO will make a *loss* on $EPAD_B$ if the difference between the system price and the area price in B is larger than expected, for example by 6 instead of 4, i.e. 2 higher. This can occur for two reasons:

1. *The area price in B is higher than expected*
    a. If the system price is as expected, the TSO loses 2 on the $EPAD_B$ contract. However, if the price in area A is as expected, the congestion rent between A and B, earned by the TSO, also increases by 2 compared to expectations (see Case 2a in table 3.4).
    b. However, if the system price is as expected and the area price in B is higher than expected, it is also likely that the price in A is lower than expected. The Congestion rent then turns out to be even higher, but the TSO loses 2 on the $EPAD_A$ contract (see Case 2b in table 3.4)
2. *The system price is lower than expected*
    a. If the price in B is as expected and the system price is 2 lower than expected, the TSO loses 2 on the $EPAD_B$ contract. In this case, if the price in A is as expected, the congestion rent is also as expected but the TSO gains 2 on the $EPAD_A$ contract (see Case 3a in table 3.4).
    b. However, if the system price is lower than expected and the price in B is as expected, it is likely that the area price in A is also lower than expected. Thus, the congestion rent is higher than expected but there is no gain or loss on the $EPAD_A$ contract (see Case 3b in table 3.4).

The results from these examples are summarized in Table 3.4 below. The table shows that compared to the expected congestion rent, the TSO may gain or lose from auctioning of single EPADs. However, EPAD Combos yield the expected congestion rent in all the cases.

Table 3.4 TSO revenues from EPAD auctions

		Prices			Revenues			Total TSO revenue		
		Price A	Price B	Sys.price	EPAD A	EPAD B	CR	EPAD A	EPAD B	Combo
Case 0	Expected	10	18	14	0	0	8	8	8	8
Case 1	All prices 2 higher	12	20	16	0	0	8	8	8	8
Case 2a	B price higher	10	20	14	0	-2	10	10	8	8
Case 2b	B higher + A lower	8	20	14	-2	-2	12	10	10	8
Case 3a	Sys lower	10	18	12	2	-2	8	10	6	8
Case 3b	Sys lower + A lower	8	18	12	0	-2	10	10	8	8

We can show mathematically that it is a general result that by auctioning EPAD combos, the TSO will earn the expected congestion rent, under the assumptions that

a. the contracted price difference for the EPADs is the expected price difference,
b. the price expectations are unbiased, and
c. the price in B is never lower than the price in A.

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We denote the expected difference (numerical value) between area prices and the system price P_{CA} and P_{CB}, the realized prices P_{sys}, P_A and P_B, and the congestion rent $CR = P_B - P_A$. Then we have the following equations for the TSOs revenue in the different cases, including the congestion rent:

1. The TSO does not engage in EPADs, i.e. the revenue is equal to the realized congestion rent.

   TSO revenue = $CR = P_B - P_A$

2. The TSO only sells EPADs in area B.

   TSO revenue = $P_{CB} - (P_B - P_{sys}) + (P_B - P_A) = P_{CB} + P_{sys} - P_A$

3. The TSO only buys EPADs in area A.

   TSO revenue = $P_{CA} + (P_A - P_{sys}) + (P_B - P_A) = P_{CA} - P_{sys} + P_B$

4. The TSO auctions EPAD combos (sells in B and buys in A)

   TSO revenue = $(P_{CB} + P_{sys} - P_A) + (P_{CA} - P_{sys} + P_B) + (P_B - P_A) = P_{CB} + P_{CA}$

$P_{CB} + P_{CA}$ is equal to the expected congestion rent. Hence, an EPAD Combo is a perfect hedge for the price risk in the congestion rent, i.e., the TSO always earn the expected congestion rent if it buys EPADs in A and sells EPADs in B, as long as the price in B is never lower than the price in A.

We see that the TSO loses on the EPAD in B if the realized price difference ($P_B - P_{sys}$) is larger than the expected price difference, P_{CB}, i.e., if the system price is lower than expected and/or the area price in B is higher than expected. However, rearranging the equations reveal that the result does not depend on the price in B, but on the outcome of the system price and the price in A. The reason is that with an EPAD in B, the TSO's revenue depends on the difference between P_B and the system price (the value of the EPAD), and the difference between P_A and P_B (the congestion rent). Now, we see immediately that the TSO loses if the system price goes down and if the price in A goes up. If A is a low price area, as is assumed, it is however, not very likely that the system price goes down when the price in A goes up. If the price in A goes up due to reduced supply or increased demand in A, it is likely to also increase the system price. And if the system price goes down due to a stronger balance in other bidding zones, it is likely to also increase the price in A. Hence, as long as there is a positive correlation between the price in A and the system price, the loss in an EPAD is likely to be at least partly offset by an increase in the congestion rent.

This case analysis indicates that the risk exposure of the TSO when auctioning EPADs is likely to be muted by the simultaneous effect on congestion rents. Figure 1 shows the results from an extended analysis including 20 cases. Sometimes the TSO will make a profit from the EPAD and sometimes it will lose. However, in five of the seven cases when the TSO loses on the EPAD sold in B, the congestion rent changes in a direction which is beneficial for the TSO. The two cases when this does not happen, are the cases when the price difference between A and B does not change (the congestion rent is as expected), and the system price changes in a direction which is not beneficial for the TSO (the price difference between the system price and the price in B is higher than expected). How likely these cases are, is an empirical question, and probably varies from price area to price area.

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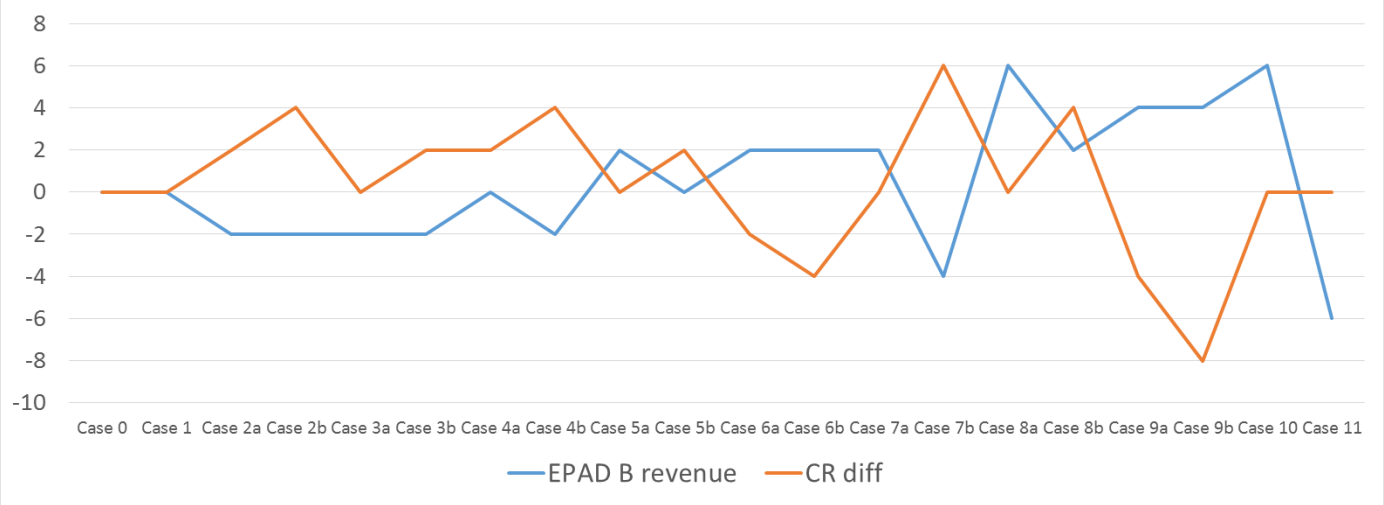
Figure 1 EPAD B revenues vs. difference between expected and realized congestion rent between A and B



We note that the results hold because the EPAD Combo implies that the TSO sells EPADs in one area and buys EPADs in another area. If an EPAD Combo implies that the TSO sells or buys EPADs in both areas, the combination does not mitigate the TSO's financial exposure. This case is equivalent to buying or selling individual EPADs. If the TSO offers EPAD contracts only in A or only in B, it is exposed to additional risks, as the example shows.

Even when only auctioning only one EPAD contract, the variability of the total TSO revenue is most often reduced compared to the full exposure to the spot congestion rent. To what extent the risk exposure is muted, depends on the relative price movements. By unilaterally buying EPADs, the TSO becomes exposed to the system price, whereas without EPADs the TSO is only exposed to the difference between the area prices, as with FTRs and congestion rents. The financial exposure is lower if there is a high correlation between the area prices, and between the system price and the area prices. (In a two-area market this will always be the case). With more price areas, the correlation between the system price and the two relevant area prices may be much weaker and sometimes non-existent. The size of the areas also plays a role.

Our conclusion is thus that the change in TSO risk exposure if auctioning only one EPAD contract will depend on the correlation between the system price and the relevant area prices. Normally the risk exposure will be muted, but poor correlation can even increase the risk exposure.

A more general case occurs when congestions between A and B can also be opposite of the expected price difference. In such cases will the realized congestion rent be higher than the financial exposure because of auctioning EPAD Combos. The reason is that the realized congestion rent is the sum of price differences in both directions. In other words, the TSO makes an extra revenue when price differences occur also in the opposite direction. The extra revenue is equal to twice the realized congestion rent in the opposite direction.

3.2.3 Support market maker function in EPAD contracts

This model does not change the TSO financial exposure. The payment to the market maker is fixed by the agreed contracts and for the period for which the market maker is contracted. The payment is not affected by realized spot prices.

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3.3 Volume risks/firmness risks

3.3.1 Auction FTR-options or FTR-obligations

Auctioned volumes of FTR-options or FTR-obligations are directly linked to the exchange capacity between the relevant markets. If TSOs are unable to collect the congestion rents for volumes matching their obligations towards FTR contracts, they face firmness risks. The firmness risk is associated with curtailment of the transmission capacity that the FTRs are related to.

There rules for current auctioning of PTRs are no harmonised and the rules are different in different auctions. However, there are no strict firmness rules. PTRs are curtailed if the ATC is lower than the auctioned volume. Compensation often equals the amount initially paid for the PTRs.

One of the main issues in the development of FCA GL has been the issue of firmness. Market participants have asked for strict firmness, while TSOs have asked for exception to firmness rules and caps on compensation.

The firmness provision in FCA GL is that all TSOs shall be entitled to curtail long-term transmission rights to ensure that operation remains within operational security limits prior to the day-ahead firmness deadline. The holders of curtailed transmission rights shall be compensated with the market spread. Financially, this is equivalent to strict firmness.

The concerned TSOs on a bidding zone border may propose a cap on the total compensation to be paid to all holders of curtailed transmission rights in one calendar year. The cap shall not be lower than the total amount of congestion income collected by the concerned TSOs on the bidding zone border in the relevant calendar year. We believe that this cap will only be relevant in exceptional cases. Strict firmness will therefore apply financially on most bidding zone borders.

However, FCA GL gives much looser firmness rules for DC interconnectors. For DC interconnectors, the cap may not be lower than the total congestion income collected in the relevant calendar *month*. This means that long outages of DC interconnectors may result in low firmness for market participants holding FTR-options or FTR-obligations regarding that interconnector.

Correspondingly, TSOs normally have full firmness risks on FTR-options and FTR-obligations, but may have reduced firmness risks on DC interconnectors if they propose such a cap on compensations.

3.3.2 Auction EPAD contracts or EPAD Combos

Unlike the volume of FTRs, the volume of EPADs to be auctioned should, not be determined by the interconnector capacity between bidding zones, but by the volume needed to yield sufficient hedging possibilities in the relevant bidding zones. If the adequate volume is smaller than the expected and realized flow, the TSO will be hedged for a part of the interconnector capacity, i.e. receive a part of the expected congestion rent if it auctions an EPAD Combo. For the remaining capacity, it will be exposed to the full market risk, as it is today.

If the auctioned volume of EPADs is larger than the physical flow between the bidding zones, however, the TSO is exposed to the following risk on part of the EPAD volume:

$$\text{TSO revenue} = P_{CA} - (P_{sys} - P_A) + P_{CB} + (P_{sys} - P_B) = P_{CA} + P_A + P_{CB} - P_B = (P_{CA} + P_{CB}) - (P_B - P_A)$$

This is equal to the difference between the expected congestion rent and the realized congestion rent. This means that the TSO incurs a net loss if the realized price difference between A and B is larger than the expected price difference. We note that this situation is similar to the situation with firm FTRs: The TSO's financial exposure is fully related to the EPAD contracts, and not to the actual trade flows. To what extent the TSO faces such a "firmness" risk, does however depend on how the volume of EPADs is determined, on the interconnector capacity between the market and the variations in ATC values (available transmission capacity).

If the markets are liquid and the price expectations unbiased, the revenue over time, and the financial exposure should however be close to zero.

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3.3.3 Support market maker function in EPAD contracts

There are no volume risks or firmness risks associated with this alternative.

3.4 Auction risks and counterparty risks

In section 3.2, when we discussed price risks, we assumed that the markets are efficient, i.e. that they pay the expected value of the instruments. In reality, the TSOs may face different auction risks in different models.

Bjørndalen and Naper (2013)[5] presents an empirical analysis of PTR auction results from 2007 to 2013 for 13 European interconnectors. In annual auctions the TSO received a payment that was on average 27% lower than the ex-post value (i.e., the congestion rent) while the payment in monthly auctions was on average 14% lower than the ex-post value. The results indicate that the TSOs (and finally the grid customers) have paid a costly premium for hedging the congestion rent risk. The study did however not distinguish between different firmness regimes and different curtailment rules.

We suspect that the presented results reflect that bids for the studied PTR auctions have been mostly bids by speculators, not by fundamental hedgers. A speculator shall of course include a risk premium in its bid. It will have to leave the business if it is unable to deliver a competitive yield in the long run. It is also natural that the risk premium is lower in monthly auctions than in yearly auctions since the risks for a speculator are bigger in a yearly timeframe than in a monthly timeframe.

There is one important difference between future auctions of FTR-options and current PTR auctions. Stricter firmness demands reduce the firmness risk for speculator and hedgers. A reduced firmness risk should imply a reduction in the demanded risk premium and thus reduce the auction risks for TSOs. On the other hand, however, the firmness risks for TSOs increase.

FTR-obligations, EPAD Combos and EPAD contracts are more suitable for fundamental hedging by retailers and consumers since they are related to average price differences – not hourly price differences. If auctioning of these instruments attract more fundamental hedgers, the auction risks should be lower. If there is a skewed market structure with a high demand for hedging, there is even a possibility that hedgers are willing to pay a risk premium to the TSO in the auction.

The TSOs should have no counterparty risk related to auctioning of FTR-options. The single allocation platform shall demand collaterals from auction participants covering the option premiums that are to be paid as a result of the auction. When auctioning FTR-obligations the TSO faces a counterparty risk. Like EPADs, FTR-obligations are not fully paid up front. Revenues and payments accrue according to the difference between the contracted price difference and the realized price difference in the delivery period.

There are examples in the US of TSOs having severe counterparty losses from FTR-obligations. The counterparty risk will however be managed if the single allocation platform has a cooperation with a clearing house. Auctions of EPAD contracts or EPAD Combos result in no open positions for the TSOs and the only counterparty risk for the TSO is related to the clearing house.

3.5 Impact on tariffs and TSO incentives

3.5.1 Tariffs

In general, the direct costs related to TSO obligations, for instance administrative costs and risk costs, are financed through grid tariffs.

This principle applies to all the Nordic countries regardless of the TSO regulation, even if the costs in question should be considered controllable opex. In Denmark, the tariff base is increased automatically due to the de facto rate-of-return regulation of Energinet.dk. In Norway, the increase

[5] Bjørndalen, J., and L. R. Naper (2013): Profit or loss from sale of LTRs? Regulated TSO´s as issuers of LTR? Report for Statnett SF. ECgroup.

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is subject to the level of Statnett's cost norm (currently 100 per cent, which means that any cost increase will be passed through in the tariffs). In Finland and Sweden, inclusion of the costs in the tariff base is subject to regulatory approval, at the latest at the start of the next regulatory period.

This means that the introduction of new tasks for TSOs is likely to lead to an increase in allowed TSO revenues. Thus, the grid customers will carry the costs of the financial exposure of the TSOs.

The tariff base is also affected by congestion revenues. The tariff base is equal to the total costs minus revenues. This applies to congestion revenues from both cross-border interconnectors and from bottlenecks between internal bidding zones. This means that the grid customers (and finally the end-users) already face uncertainty and bear the risk of variations in the congestion revenues.

The consequence of this is that the TSO does not face financial risks related to congestion rents. If congestion revenues are higher than expected, the tariffs will be reduced in the next period. If congestion revenues are lower than expected, the tariffs will be increased in the next period.

As far as we understand Article 58 in the FCA GL, all TSO measures to improve hedging opportunities, and implemented according to the guideline, may be treated equally*: "Costs assessed as reasonable, efficient and proportionate shall be recovered in a timely manner through network tariffs or other appropriate mechanisms as determined by the competent regulatory authorities."*

This means that the NRAs can decide that the financing of all six models shall be done via grid tariffs. Hence, the question is not really TSO financial exposure and their possible risk costs, but rather how the costs and risks of the end-users are affected by a TSO intervention, compared to the current situation. We come back to the issue of market impacts in chapter 4.

3.5.2 TSO incentives

Determination of ATC values (available transmission capacity) and the use of countertrade and redispatching affect market prices and congestion rents. One might therefore worry that the TSOs conduct in these respects can be affected by the different models for TSO interventions.

The above reasoning implies however that the TSO should not have any financial incentives to deviate from their current practices in order to influence the market outcomes, as the costs may be directly passed through in network tariffs.

However, Article 58 also states that it is up to the competent NRAs to assess whether the costs are reasonable, efficient and proportionate, and can also use "other appropriate mechanisms" to finance the measures.

We assume and recommend that the choice of measure and the level of intervention are defined by the NRAs in cooperation with TSOs and relevant stake-holders. As the measures are not left to the discretion of TSOs, and will be guided and reviewed by NRAs, we assume that the costs will be reasonable, efficient, and proportionate (se also chapter 5).

Moreover, we strongly recommend that NRAs, if they decide not to finance measures via grid tariffs, design financing mechanisms that do not adversely affect TSOs incentives in terms of ATC values and redispatching/countertrading.

In principle, we may have three main scenarios for TSO risk exposure:

1. Full pass-through – TSO costs (and revenues) are automatically offset against the tariffs paid by the customers
2. No pass-through – TSO has to carry the entire net cost
3. Partial pass-through – for instance with delayed update of cost base under a revenue cap regulation

With full pass-through: TSO has no incentive to set ATC values in order to minimise risk exposure. The incentive to set ATC values to influence risk of outages and counter-trading costs may still exist (for TSOs subject to a revenue cap), but that is a general incentive and independent of the TSO intervention model.

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With no pass-through/partial pass-through: TSO may have an incentive to adjust ATC values in order to minimise risk exposure (price, volume and firmness risks, cf. section 3.2-3.4).

If the risk exposure is considered part of controllable opex (and hence subject to incentives), the TSO would also need tools to influence the risks. Depending on TSO tools available, the role and neutrality of the TSO may be compromised. According to Thema (2013)[6] the TSOs can reduce cross-border market risks by

- Investments in the grid (reduced price differences)
- Countertrade – give more cross-border capacity to the market and reduce price differences, and the number of bidding zones
- Provision of efficient algorithms for calculation of available cross-border capacities
- Provision of transparency – criteria for bidding zone delimitation, on capacity calculation and allocation – predictability

If exposed to market risks, the risk attitude of the TSO may affect the outcome as well. Some TSOs may have a higher willingness to accept the risk of compromising the security of the grid than the willingness to pay for losses related to interventions. However, the TSOs also have other incentives and requirements that limit to what extent they will and can compromise security margins.

The risk attitude may also imply that a TSO cares more about visible risk costs than invisible decreases in congestion revenues. Such an attitude is not socio-economic efficient and should be avoided.

Hence, it is clear that the logical solution would be to treat the net TSO costs as a pass-through element. The NRAs should take extra care so as to prevent inefficient risk attitudes and not adversely affect TSO incentives.

[6] See footnote 1.

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4 MARKET IMPACTS

4.1 Fundamental hedging in the Nordic market

A prerequisite for a well-functioning electricity market is that there are efficient hedging opportunities for consumers, retailers and generators.

Traditionally, bilateral physical contracts were used for buying and selling electricity. Fixed-price contracts transferred the price risk from consumers to retailers. Retailers transferred their price risks to generators, either as internal transactions within an energy group or as external bilateral transactions with major generators. There was also physical trade between generators on a case-by-case basis. Acquisition of cross-border capacities was a prerequisite for cross-border trades. The drawback was that the electricity market was not efficient, transparent and non-discriminative.

The rise of day-ahead spot markets has opened up for other buying and selling strategies from participants in the electricity market. Consumers and retailers can buy their electricity in the spot market and generators can sell electricity in the spot market. Physical trade in the spot market instead of bilateral physical contracts enables competition on equal terms and cost reductions for most participants since all participants in the spot market meet the same spot price independent of their size. The drawback is that volatile spot prices give substantial price risks.

These price risks can be seen as unacceptable by external capital providers or by internal management and thus be a barrier for the use of the spot market unless the price risks are mitigated. Price risks in the Nordic market can be mitigated by the use of financial contracts. Financial trades with a hedging purpose are done according to a risk management strategy in order to reduce risks. They are not done according to expectations of future prices in order to seek profits. The purpose of hedging is not to eliminate all risks, it is reduce the risks to an acceptable level. Hedging means normally that a premium is paid in order to reduce a risk.

Basic price risks in the Nordic market are normally hedged by means of financial contracts with reference to the Nordic system price. These contracts are base-load contracts for weeks, months, quarters and years. There are also day contracts and peak-load contracts but these contracts are normally not used for hedging purposes. This means that risks because of volume variations within a week are normally not hedged while volume variations within longer time frames are usually hedged.

The Nordic system price states the common Nordic price that would have been achieved with only one bidding zone for the whole Nordic area. The system price can be interpreted as a price for a virtual Nordic zone, but it is not by any means a price for a physical point of delivery. Physical deliveries are settled against the price for a specific bidding zone. The consequence is a remaining risk for a difference between the system price used for basic hedging and the physical bidding zone price.

Such price area risks can be hedged with EPAD contracts for months, quarters and years. An EPAD contract is a financial base-load contract regarding the average difference between a bidding zone price and the Nordic system price.

The overall feedback in studies of the Nordic market is that none of interviewed market participants want to replace the basic hedging in system price contracts with basic hedging in different area price contracts.[7] The combined liquidity in system price contracts is seen as essential and they fear fragmented liquidity if there are different area price contracts. Market actors in *all* price areas benefit from the high liquidity in the financial contracts linked to the system price.

[7] NordREG (2010): The Nordic financial electricity market, NordREG report 8/2010. Energimarknadsinspektionen (2013): Områdesprissäkring och den nordiska marknadsmodellen (Ei R2013:16). Hagman and Bjørndalen (2011) and THEMA (2013), see footnote 1.

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The Nordic bidding zones have for many years been market coupled and available cross-border capacities have been given to the spot market auction instead of being auctioned. If a market participant has purchased or sold electricity physically in another bidding zone than its own physical location, the necessary cross-border transfer has been executed in the day-ahead auction. A retailer/consumer gives a sell bid in the bidding zone where the electricity is purchased and a buy bid in its own bidding zone. The electricity cost can be hedged by a combination of EPAD contracts in the two bidding zones. Similarly, a generator gives a buy bid in the bidding zone where the electricity is sold and a sell bid in its own bidding zone and can hedge its income by a combination of EPAD contracts in the two bidding zones. Thus, no cross-border contracts are needed in the Nordic market, neither for the physical transfer nor for the financial hedging of costs or revenues.

In recent years, market coupling has been expanded to most of Europe. Market coupling of day-ahead markets cover now 20 European countries with about 2 800 TWh in total yearly consumption. This means that Nordic market participants can purchase or sell electricity physically in 16 countries outside the Nordic region without acquiring cross-border contracts. Hedging of purchases and sales in these 16 countries can be arranged to the extent that there is a functioning financial market in the other country.

4.2 Bidding zones with insufficient hedging opportunities

The Nordic electricity market is characterized by a very liquid day-ahead market and a very liquid financial market for system price contracts. However, in many bidding zones the system price contracts have to be combined with EPAD contracts in order to provide an adequate hedge against the volatility of the day-ahead price of the concerned bidding zone. Insufficient hedging opportunities may result in market participants choosing bilateral contracts instead of the day-ahead market. Another possible consequence is less retail competition if independent retailers fear that they cannot compete on equal terms.

The FCA GL gives demands for an assessment by regulatory authorities whether there are sufficient hedging opportunities in considered bidding zones. The assessment shall include at least a consultation and an evaluation. The evaluation shall analyse:

- Whether the products or combination of products offered represent a hedge against the volatility of the day-ahead price of the concerned bidding zone. A product or combination of products shall be considered as an appropriate hedge against the risk of change of the day-ahead price of the concerned bidding zone where there is a sufficient correlation between the day-ahead price of the concerned bidding zone and the underlying price against which the product or combination of products are settled.
- Whether the products or combination of products offered on forward markets are efficient. Indicators to be assessed for this purpose are at least trading horizon, bid-ask spread, traded volumes in relation to physical consumption and open interest in relation to physical consumption.

In this project, we do not analyse to what extent there are Nordic bidding zones with insufficient hedging opportunities. It is an extensive task to make an evaluation according to the above mentioned demands in the FCA GL. However, we have tried to list possible characteristics of bidding zones with insufficient hedging opportunities as one starting-point for our task to compare possible market impacts of the different models.

Bidding zones without listed EPADs

For bidding zones where EPADs are currently not listed, the NRA needs to assess whether an appropriate hedge can be achieved by just a system price contract or by a combination of a system price contract and an EPAD contract for another bidding zone. The conclusion for the concerned bidding zone will otherwise be that there are insufficient hedging opportunities. The possibility to introduce EPAD contracts will then be one possibility to assess.

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Bidding zones with listed EPADs

A combination of a system price contract and an EPAD contract will by definition give full hedge of the average day-ahead price for bidding zones with listed EPAD contracts. For bidding zones with EPAD contracts can appropriate hedge thus be achieved and the next step will be to analyse whether the hedging product or the hedging combination is efficient. This analysis shall include at least trading horizon, bid-ask spread, traded volumes in relation to physical consumption, and open interest in relation to physical consumption.

Currently, Nordic EPAD contracts have a trading horizon of 3-4 years after the current year, and we would be surprised if such a trading horizon will be assessed as too short. The trading horizon for most of current European PTRs is one year ahead.

Bid-ask spread, traded volumes in relation to physical consumption and open interest in relation to physical consumption are different indicators of the liquidity in a contract. Liquidity can be defined as the degree to which an asset can be bought and sold in the market without affecting the price of the asset and without incurring significant transaction costs.

Different types of market participants are essential for creating a liquid market. Especially speculators have an important role making sure that prices adjust very quickly to new information. Speculators buy when prices are too low and help lifting these prices, and sell when prices are too high, thus helping to lower these prices. A higher frequency of trade reduces the bid-ask spread.

Nordic system price contracts are among the most liquid financial electricity contracts in the world. One explanation is that these contracts combine liquidity from the whole Nordic area. EPAD contracts are naturally less liquid since they are differentiated per bidding zone. In its study of the Nordic financial electricity market in 2010, NordREG reported that EPAD contracts[8] are more important than often perceived.[9] EPAD contracts have a much higher share of total open interest in Nordic financial electricity contracts than of total turnover. Such contracts made up 30 % of the total open interest at year-end 2009 and 8 % of total turnover in 2009. This indicates an extensive hedging in EPAD contracts but small short-term trading in such contracts.

The smaller short-term trading in EPAD contracts reflects the experience that “liquidity gives liquidity”. Speculators are normally not active in EPAD contracts. Nevertheless, these contracts are very important for fundamental hedging in the Nordic market. One reason why liquidity is not as important in EPAD contracts as in system price contracts is that the volatility in Euro/MWh is significantly lower for EPAD contracts. Hedging of the area price differential risk is thus not as urgent as hedging of the basic system price risk.

We have identified some reasons for significant differences in liquidity between EPAD contracts for different bidding zones:

- Difference in size.
- Different demand for hedging. Norwegian retailers have e.g. less demand since the share of fixed price contracts for end-users is much lower in Norway compared to Denmark, Finland or Sweden.
- Skewed market structure. Some bidding zones have little generation in relation to consumption, while others have little consumption in relation to generation. Such unbalances can mean that in one bidding zone, participants wishing to buy EPAD contracts will find few willing EPAD sellers, while in another bidding zone participants wishing to sell EPAD contracts will find few willing EPAD buyers.
- Dynamic bidding zone delimitation in Norway gives uncertainties for market participants regarding how appropriate EPAD contracts are to hedge area price risks. Hedge of area price

[8] EPAD-contracts were earlier called CfD-contracts (contracts regarding the difference between a certain area price and the system price).

[9] See footnote 6.

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risks is therefore often done with bilateral contracts referring to the difference from system price in the site for the consumption or generation.

4.3 Impacts on liquidity and hedging opportunities

4.3.1 Support market maker function in EPAD contracts

The impacts on liquidity and hedging opportunities of a market maker function depends on the reason why there are insufficient hedging opportunities in the bidding zone.

Supporting a market maker may be an effective measure for a bidding zone where appropriate hedging cannot be achieved. A market maker function facilitates the listing of EPAD contracts for the concerned bidding zone.

Supporting a market maker may also be effective for a bidding zone with listed EPAD contracts but no market maker.

The issue is different if there is already a market maker for EPAD contracts in the concerned bidding zone, but the evaluation shows that the hedging combination is not effective.

Support to a market maker agreement with a stricter demand on bid-ask spreads has the potential to be effective if the conclusion is that there is a lack of liquidity because of too high bid-ask spreads.

Support to a market maker agreement with a stricter demand on bid-ask spreads also has the potential to be effective if the basis for the conclusion is too small turnover or too small open interest and there is a balanced market structure within the bidding zone. Tighter bid-ask spreads from a market maker can in such a bidding zone be a lubricant for a smoother trade in EPAD contracts.

It is more doubtful if this TSO measure will be effective if there is a skewed market structure within the bidding zone. A basic strategy for a market maker is to minimise its open position. If a market maker is hit on one side, it transfers normally its bid-ask spread in such a way that it is more probable that it the next time will be hit on the other side and thus reduce its open position. This strategy is difficult to execute in a bidding zone with much higher consumption than generation or the opposite. A market maker has in such a bidding zone an incentive to bias its bid-ask spread in such a way that minimal trades are made with the dominating side in the bidding zone. In bidding zones with a skewed market structure, TSO measures that include auctioning of contracts are probably therefore more effective than support to a market maker function.

It is also doubtful whether TSO support to a market maker function can increase the liquidity in bidding zones where there is low demand for fundamental hedging of area price differences. TSO measures that include auctioning of contracts are probably more effective in such bidding zones. However, in such bidding zones, the market consultation should show that there is no need to increase liquidity in EPAD contracts, since market participants do not demand such contracts for fundamental hedging.

4.3.2 Auction EPAD contracts or EPAD Combos

Auctioning of EPAD contracts gives a direct increase in the traded volume.

The TSO is committed to sell the auctioned volume at whatever price. This means that an inelastic supply from the TSO meets an elastic demand from the market participants. The price in the auction will be the intersection point and will only be dependent on the demand from market participants.

The possibility to get a contract at a lower price than the “real” market price will of course also attract traders, not only market participants with a fundamental hedging need. Traders who have bought contracts in the auction have two alternatives, to keep the contracts until delivery or to resell the contracts.

The market for secondary trade is larger if the auctioned EPAD contract is exactly the same as exchange-traded EPAD contracts and cleared at the same clearing house. In such a case will it after

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the auction be no difference between an EPAD contract acquired in an exchange and an EPAD contract acquired in an auction. Both can be included in the same secondary trade on the exchange.

In the preceding section, it was concluded that in bidding zones with a skewed market structure, auctioning of EPAD contracts is probably more effective to increase liquidity than TSO support to a market maker function. In bidding zones where consumption and generation are more balanced, TSO support to a market maker function will probably be sufficient to increase liquidity.

Auctioning of EPAD Combos also gives a direct increase in the traded volume.

An EPAD Combo is a combination of two EPAD contracts, a buy for one area and a sell for another area. Auctioning of EPAD Combos can be done in the same way as auctioning of EPAD contracts. Bids from market participants to an EPAD Combo auction can be to sell EPAD contracts in the first area or to buy EPAD contracts in the second area. Bids can also be “block bids” for the EPAD Combo. The market participant has in such a case – if the “block bid” is accepted – sold EPAD contracts in the first area and bought EPAD contracts in the second area.

Auctioning of EPAD Combos means that the auctioned buy volume in one bidding zone is the same as the auctioned sell volume in another bidding zones. Another possibility is that auctioning of EPAD Combos is combined with auctioning of individual EPAD contracts, thus enabling different auctioned volumes in the concerned bidding zones.

4.3.3 Auction FTR-options or FTR-obligations

Auctioning of FTR-options or FTR-obligations gives a direct increase in traded volume in the same way as auctioning of EPAD contracts or EPAD Combos.

However, the possibility that secondary trading will increase hedging opportunities in EPAD contracts is lower. The reason is that auctioning of EPAD contracts or EPAD Combos results in EPAD contracts that can be directly traded on the exchange. An FTR-obligation is in many respects similar to an EPAD Combo but it does not result in a contract that can be directly traded on the exchange. An FTR-obligation can be used as a hedge for trading in EPAD contracts but it means that the trader has to submit collaterals to both the clearing house for the single allocation platform and to the clearing house for EPAD contracts.

If congestions in both directions are possible, an FTR-option will be less useful for fundamental hedging than an FTR-obligation. A consumer or retailer wants to hedge the average day-ahead price in a specific bidding zone, To pay a big option premium for a right to congestion income is perhaps profitable from a speculative point of view, but it is not a preferred alternative if the purpose is fundamental hedging.

An FTR-obligation can be suitable for fundamental hedging of the day-ahead price in a specific bidding zone if it can be combined with a liquid area price contract for the other bidding zone. However, we do not expect such use of FTR-obligations and area price contracts to be a preferred hedging alternative in the Nordic market. It is more complex than the combination of EPAD contracts and system price contracts since it includes open positions and collaterals with two clearing houses.

NordREG organised a hearing on the NC FCA on 20 April 2015.[10] Participants who compared EPADs and LTTRs as instruments for fundamental hedging were generally in favour of EPADs. Notably, representatives for Norwegian and Swedish large industrial consumers said that LTTRs are not interesting as a hedging instrument for a large consumer. A representative for Swedish independent retailers saw no need for LTTRs. Finnish Energy Industries stated that the interest in LTTRs as a hedging product is very low among Finnish market participants. Energy Norway declared that EPADs are better hedging instruments than LTTRs. Dong Energy said that EPADs are the preferred hedge. LTTRs could be seen as a complement to EPADs, but not as the main hedging solution.

[10] NordREG (2015) Minutes from the FCA seminar, April 20 2015.

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4.4 Distortion of price signals in existing financial markets

As reported in section 4.1, the overall feedback in studies of the Nordic market is that the market participants do not want to replace the basic hedging in system price contracts with basic hedging in different area price contracts. The stakeholders see the combined liquidity in system price contracts as essential for the efficiency of the Nordic market, and they fear fragmented liquidity if there are different area price contracts. The common view is that market actors in *all* price areas benefit from the high liquidity in the financial contracts linked to the system price.

Distortion of price signals in existing financial markets may arise if the liquidity in system price contracts is split between system price contracts and some area price contracts. Consequences of reduced liquidity are less traders and less trading, increased bid-ask spreads and more difficult price discovery. These consequences sum up to a less efficient financial market and higher hedging costs.

Another possible distortion is that the same contracts will still be traded but they are split between different exchanges connected to different clearing houses. Formally, an open position with one clearing house can only be secondary traded with a member of that clearing house. A market participant wishing to trade on several exchanges have therefore to be a member of these exchanges and their connected clearing houses. This results in extra fees, extra IT costs and extra collateral costs. An alternative is that the market participant chooses to be an under-customer to another big market participant and ceases to be a direct participant in the market.

To some extent, this change has already started. Nordic system price contracts can be traded on EEX and German financial contracts can be traded on Nasdaq. However, only a small part of the trading in these contracts have moved to the competing exchange. Our conclusion is that this reflects that liquidity is a very important factor when exchanges compete. Most of the trading on the competing exchange seems to be performed by their normal members who also want to be able to trade contracts in another region on the same exchange. There are of course also trading by big traders who are members of both exchanges and try to profit from arbitrage.

The consequences may be more evident if contracts that already are illiquid are split between different exchanges and different clearing houses. Also such split of contracts may sum up to a less efficient financial market and marginally higher hedging costs although there is a competition between exchanges.

FTR-options and FTR-obligations risk to give a push for area price contracts since they are not related to the Nordic system price. FTR contracts also mean that cross-border hedging is split with another platform since FTR-options and FTR-obligations will be auctioned on the single allocation platform.

TSO involvement as support of a market maker function or auctioning of EPAD contracts or EPAD Combos does not risk to split the liquidity in Nordic system price contracts. However, there is a possibility that such involvement will result in a split of rather illiquid EPAD contracts between different contracts.

4.5 Impact on strategic behaviour

Questions related to strategic behaviour and intervention to increase hedging opportunities in some bidding zones are:

1. Can market participants exploit the proposed TSO interventions for strategic behaviour?
2. If there is market power in the concerned bidding zones, can the TSO interventions mitigate such strategic behaviour?

Generally, a bidding zone is more exposed to strategic behaviour if there are frequent congestions, few or one dominant supplier, demand is inelastic, and/or the market players have asymmetric information.

In principle, the reason why there is a lack of hedging in some bidding zones, may be that the market structure is disposed to strategic behaviour, e.g., if there is one dominant supplier in the market.

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Strategic behaviour increases the risks for other participants, and this may deter speculators from the instruments. Therefore, it has been suggested that introducing long-term contracts and derivatives may mitigate strategic spot market behaviour.

For example, Kamat and Oren (2004)[11] show that, in a two-node network with a single forward contract, market power (in a duopoly model) may substantially reduce forward trading if there is even a small probability of congestion between the nodes. This result does however, not seem very relevant for the Nordic market as the trade in system price contracts, i.e. financial contracts covering all Nordic bidding zones, is generally quite robust.

Asymmetric information may expose a bidding zone to strategic behaviour in financial contracts, by manipulating market expectations via behaviour in the spot market. In some of the Nordic bidding zones, hydropower is the dominant (or only) generation type. A study by Munthe, et.al. (2007)[12], finds however that " … a dominant hydro producer with storage capacity and superior private information has incentives to manipulate expectations about future electricity prices via strategic hydro scheduling, and thus gain an extra profit in the corresponding financial market". The key is that the dominant player has private information and that his spot market behaviour affects other market player's expectation of future prices. Moreover, the behaviour is more attractive the more liquid the market is, the more adaptive expectations are, and the more market power the large producer has.

4.5.1 Support market maker function in EPAD contracts

A market maker introduces increased trading opportunities in the market. Moreover, the market maker places both bids and asks in the market, and is quite flexible in its pricing within the spreads and volumes required by the market maker contract. Hence, it is difficult to see that a market maker function could be exploited for strategic behaviour.

Could a dominant hydropower producer with private information exploit the market maker function? As we have seen above, however, the possible incentive to abuse market power found by Munthe et.al. (2007) indicates that this is attractive in liquid markets. One is led to conclude that if a hydropower producer were in a position to exploit this opportunity, it would have done so already, hence, playing a voluntary "market maker function" in the market.

We do therefore not expect new problems with strategic behaviour if a dominant producer becomes a market maker. Other market participants would probably not accept to perform a market maker function in such an area without correspondingly high compensation.

If market power is already an issue in the concerned bidding zone which explains a lack of trading, a market maker function may provide the market participants with valuable hedging, but would not change the fundamental problem. All in all, we conclude that support to a market maker function is unlikely to neither mitigate nor exacerbate challenges related to strategic behaviour.

4.5.2 Auction EPAD contracts or EPAD Combos

We discuss the impacts of EPAD contracts and EPAD Combos together, since an EPAD Combo is formally a combination of two EPAD contracts.

Auctioning of EPAD contracts would increase the supply of and/or demand for EPADs in the concerned bidding zones, and directly increase the traded volume. It is difficult to see how an EPAD auction can be exploited by a dominant player. If the EPADs are unreasonably priced, speculators should enter the market. Typically, the TSO will offer EPADs in a deficit area, where there is a lack of supply, and buy EPADs in a surplus area, where there is a lack of demand.

[11] Kamat and Oren (2004): Two-settlement systems for electricity markets under network uncertainty and market power. Journal of Regulatory Economics, v25-1.

[12] Munthe, Sandsmark and Tennbakk (2007): Is there a scope for exploiting the interplay between physical and financial electricity markets? Molde University College, Working Paper 2007-04.

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If a dominant hydropower producer with private information is in a position to exploit market power, the increased volume and market liquidity may increase the incentives to exercise market power, however. EPAD auctions may increase the return to strategic behaviour, but the reason for strategic behaviour is not the EPAD auction, but the fundamental market structure.

4.5.3 Auction FTR-options or FTR-obligations

Auctioning of FTR-obligations and FTR-options are likely to give much the same impacts as auctioning of EPAD contracts or EPAD Combos. However, there are some differences. It will probably be easier to exploit FTR auctions than auctions of EPAD contracts. The reason is that the market for secondary trading in these instruments is probably much smaller. There is probably also less fundamental hedgers taking part in the auctions.

We have not analysed to what extent these differences give other implications for possible strategic behaviour.

4.6 Risk of overregulation

Even if a lack of hedging opportunity is identified in some bidding zones, which merits intervention, the intervention may not produce the desired result, or may induce market distortions if it is not carefully designed. The first step is, however, to clearly identify that there is a indeed a problem and what the cause of the problem is. As discussed above, the reason for missing EPAD trading may be that there is no demand for hedging in that bidding zone. In that case, intervention cannot improve the situation and merely implies regulatory costs.

Moreover, when considering regulatory interventions regarding bidding zones with insufficient hedging opportunities, NRAs have to take into account that there may be different reasons why there are no EPADs or inadequate EPAD trading in some bidding zones. They also have to observe that each of analysed measures may be designed or implemented in different ways, and that there may be different challenges related to the level or dosage of the measures.

The efficiency of support to a market maker depends on the bid-ask spread and volumes required in the contract. The right level should be decided based on consultation with market participants and exchanges. If the bid-ask spread is too wide, the market maker function will not provide sufficient hedging or increase liquidity. And if the bid-ask spread is unnecessary narrow, the required market maker compensation may be higher than necessary. The exchanges do however use market makers already, and should have experience in finding the right levels through consultation with market participants. Hence, such consultation should be made on a case-by-case basis. As mentioned, support to a market maker is not likely to be effective in a bidding zone with a skewed market structure.

The efficiency of EPAD auctions probably depends on the auction volumes and the frequency of auctions. Even in this case, we do not recommend that general rules of thumb are used. Even in this case, volumes and frequency should be determined based on the situation in the concerned bidding zone and consultation with stakeholders. We do however, not see a substantial risk of disruptive overregulation when it comes to intervention in the EPAD market. Too lenient intervention may fail to have the desired effect, and too much intervention may increase risk premiums for the TSO and thus the cost of the intervention. Moreover, it shouldbe relatively easy to adjust the requirements of a market maker, and the volumes in EPAD auctions. Such changes should however be notified well in advance.

Support to a market maker function and auctioning of EPADs involve public procurement processes. The competition criteria for the procurement process have to be carefully aligned with the objectives of the TSO involvement.

The outcome of such processes are naturally uncertain in advance, and so are calculations of the costs and effects of the models.

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5 CONCLUDING REMARKS AND RECOMMENDATIONS

The purpose of our study has been to conclude on a recommended model or set of principles for TSO involvement in the EPAD market, if such involvement is deemed needed in (any of the) Nordic bidding zones.

The two main questions to be answered are:

- Which models are most beneficial if introduced?
- Should we have one common solution for the Nordic region, or rather a set of common principles, i.e. a Nordic tool box?

If the evaluation and the market consultation show insufficient hedging opportunities in one or more bidding zones, regulatory intervention regarding TSO involvement is required by the FCA GL. The stipulated fall-back option, if other measures are not efficient or not implemented, is to auction financial transmission rights. Hence, it makes sense to compare TSO measures related to the EPAD market with TSO auctioning of FTRs as described in the FCA GL. We have therefore analysed the following six models for TSO involvement:

1. Support a market maker function in EPAD contracts
2. Guarantee maximum spreads in the EPAD market
3. Auction EPAD contracts
4. Auction EPAD Combos (an EPAD Combo is a combination of two EPAD contracts, a buy for one area and a sell for another area)
5. Auction FTR-options
6. Auction FTR-obligations

We have found that model 2 is inferior to model 1 and have therefore not compared it with the other models. If model 2 is better than another model, model 1 will always be even better.

5.1 Comparison of the different models

We have analyzed the implications for the TSO in terms of administrative and financial costs in chapter 3, and the market impacts in chapter 4. Our main findings are the following.

5.1.1 Impacts on liquidity and hedging opportunities

These impacts are the most important. The reason why TSO involvement after all can be considered is that it is required by FCA GL if there are insufficient hedging opportunities in a bidding zone.

Support to a market maker function may be an effective measure for a bidding zone where appropriate hedging cannot be achieved because of a lack of listed EPAD contracts. A market maker function facilitates the listing of EPAD contracts for the concerned bidding zone. Supporting a market maker may also be effective for a bidding zone with listed EPAD contracts, but no market maker.

The issue is different if there is already a market maker for EPAD contracts in the concerned bidding zone, but the evaluation shows lacking liquidity. Tighter bid-ask spreads from a market maker can in such a bidding zone be a lubricant for smoother trade in EPAD contracts if there is a balanced market structure. We see it as more doubtful if a market maker will be effective if there is a skewed market structure within the bidding zone (some Nordic bidding zones have little generation in relation to consumption, while others have little consumption in relation to generation).

Auctioning of EPAD contracts, individually or as EPAD Combos, give a direct increase in the traded volume whatever the reasons for current insufficient hedging opportunities. Especially in bidding zones with a skewed market structure, auctioning of EPAD contracts is probably more effective to increase liquidity than TSO support to a market maker function. In bidding zones where consumption and generation are more balanced, support to a market maker function will probably be sufficient to increase liquidity.

Auctioning FTR contracts also gives a direct increase in traded volumes. However, the auctioned instruments are not EPADs, and it is less likely that secondary trading will increase hedging

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opportunities. Models 5 and 6 can therefore be assessed as the models that give least benefit in terms of liquidity and hedging opportunities. This is also in accordance with statements in a hearing organized by NordREG in April 2015, where market participants were generally in favour of EPADs as instruments for fundamental hedging of area price differences.

5.1.2 Market impacts

Liquidity split

The overall feedback in studies of the Nordic market is that market participants do not want to replace the basic hedging in system price contracts with basic hedging in different area price contracts. Stakeholders see the combined liquidity in system price contracts as essential for the efficiency of the Nordic market, and they fear that liquidity will be fragmented if there are different area price contracts.

Auctioning of FTR contracts risk to give a demand for various area price contracts instead of system price contracts since FTRs are related to another area price, not the Nordic system price. They mean also that cross-border hedging is split between different platforms since FTR-options and FTR-obligations have to be auctioned on the European single allocation platform.

Models 1, 3 and 4 that aim at strengthening the liquidity in EPAD trade, do not risk to split the liquidity in Nordic system price contracts. However, there is a possibility that they will result in a split of rather illiquid EPAD contracts between different exchanges. Neutrality in the public procurement of a market maker function or a platform for auctioning is legally necessary, but may result in a split of the liquidity if another exchange gives the best bid according to the purchasing criteria.

Strategic behaviour

We have analysed to what extent market participants can exploit the proposed instruments for strategic behaviour and if the instruments can mitigate strategic behaviour if there is market power in the concerned bidding zones. None of the models appear to have substantial impacts. Neither a market maker function nor EPAD auctions are likely to have any impact on strategic behaviour. In theory, however, increased financial liquidity could be exploited by a dominant player with private information. When it comes to FTR auctions, there could be a risk that the auction may be exploited if there are few market players, due to entry costs (single allocation platform) and lack of secondary trading.

5.1.3 Impacts on TSO costs and financial exposure

Administrative costs

Support to a market maker has the highest administrative costs. The main cost is the fixed cost which has to be paid to a market maker fulfilling the requested obligations. The fixed cost will be higher if the requirements for the market maker are stricter. We assess that the maximum allowed bid-ask spread is the most important feature for fundamental hedgers. We also expect the measure to be more cost-efficient if the TSO supports only one market maker in an area, rather than two or more market makers. Support to a market maker function will also imply administrative procurement costs for a TSO. The interests of the TSO and the interests of the exchange regarding support to a market maker function can be combined in different ways. Both the TSO's financial support and its administrative purchasing costs can probably be reduced if it is possible to utilize such a combination of interests.

Auctioning of EPADs probably has the lowest administration costs. The administrative costs of the TSO are related to the auctioning process and to administration and settlement of the positions received after the auctioning.

Auctioning of FTR contracts probably yields higher costs than auctioning of EPAD contracts. The FCA GL includes many methodologies and rules for FTR auctions, which must be developed and complied with, and the TSO must co-finance the single allocation platform.

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Price risks

When analysing the TSO's price risk, it should be taken into account that the TSOs are already exposed to cross-border price risks via the income from the congestion rent. Hence, we have analysed how the models change the TSO's financial exposure.

Support to a market maker function does not imply any change in the financial exposure or price risks for the TSO. The payment to the market maker is fixed by the agreed contracts and for the period for which the market maker is contracted. The payment is not affected by realized spot prices.

All the other models do however imply financial exposure for the TSO.

Auctioning of individual EPAD contracts imply the highest risk for contract losses. However, situations with contract losses are likely to be associated with higher congestion revenues. In such situations the net effect on the TSO economy can even be positive.

Auctioning of EPAD Combos reduces the risk for contract losses since it includes a sell in one area and a buy in another area. It is therefore an interesting alternative to auctioning of individual EPAD contracts if the TSO has a high risk aversion against contract losses.

Auctioning of FTR-options in both directions gives a total change from the current Nordic situation where TSOs are fully exposed to variations in congestion revenues, to a situation where the TSO is not exposed to price risks regarding the sold volume. Auctioning of FTR-obligations does not change the current situation if the same volumes are auctioned in both directions.

Volume risks/firmness risks

Support to a market maker function does not imply any financial exposure in terms of volume risks for the TSO.

The other models do however imply financial exposure in terms of firmness risks for the TSO. In practice, the FCA GL implies strict financial firmness for FTR contracts, with an exception for FTRs on DC interconnectors. While the volume of FTR contracts is directly related to the exchange capacity between the concerned bidding zones, the volume of EPAD contracts is not. The EPAD volume should be adapted to the market's hedging need. This means that the EPAD volume may be smaller or larger than the FTR volume. A smaller volume implies a smaller volume/firmness risk, and a larger volume a higher volume/firmness risk for EPAD auctions.

Auction risks

Auction risk is the risk that auction payments are less than the expected value of the instruments, and that the TSO must bear a risk premium.

Auctioning of FTR-options has the highest auction risk. A study from 2013 reported that the payments TSOs received from PTR auctions was on average 27 percent lower than the ex-post value (i.e., the congestion rent), while the payment in monthly auctions was on average 14percent lower than the ex-post value. In this respect, FTR-options are likely to have much the same features as PTRs.

Auctions in models 3, 4 and 6 are more attractive for fundamental hedgers and can therefore be expected to have lower auction risks. An auctioned sell of EPAD contracts in an area with little generation and much demand can even result in full payment of the expected value.

5.1.4 Impact on tariffs and TSO incentives

According to FCA GL, NRAs can decide that for all six models, the associated costs may be financed via grid tariffs. There is in this respect no difference between the different models. The regulation of TSOs implies that costs related to intervention in financial markets, including financial exposure due to implementation of the relevant measures, will ultimately be borne by the tariff customers. Hence, the question is rather how the costs and risks of the tariff customers (finally the end-users) are

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affected compared to the current situation (without such intervention). The TSOs incentives regarding ATC values and countertrade/redispatching should not be affected.

5.2 Regulatory challenges

As with all market intervention, there are certain risks associated with poor regulatory design. Moreover, the risks may differ between the different models. In general, however, no interventions should be implemented unless a problem is clearly identified. Intervening where there is no problem implies costs and a risk of distorting the market.

If there is a deficiency, not all models will be equally effective. For example, a market maker function is not likely to be effective in a bidding zone with a skewed balance between supply and demand.

Next, the dosage of the measure affects the efficiency of the measures:

- The efficiency of support to a market maker depends on the bid-ask spread and volumes required in the contract. The right level should be decided based on consultation with market participants and exchanges.
- The efficiency of EPAD auctions also depends on volumes and frequency of auctions. Again, volumes and frequency should be determined based on the situation in the concerned bidding zone and consultation with stakeholders.

However, if the dosage is not right, it should be relatively easy to adjust the requirements of a market maker, and the volumes in EPAD auctions. Such changes should however be notified well in advance.

Finally, support to a market maker function or auctioning of EPADs involve public procurement processes. The competition criteria for the procurement process have to be carefully aligned with the objectives of the TSO involvement.

The outcome of such processes are naturally uncertain in advance, and so are calculations of the costs and effects of the models.

5.3 Recommendations

Our conclusion from the comparison of the different models is that in the Nordic market, auctioning of FTR-options and FTR-obligations are inferior to the measures supporting the EPAD market. One important reason is that introduction of FTRs can lead to a split of liquidity between system price contracts and area price contracts. Another reason is that the FTR-models are assessed as the models that give least impacts on liquidity and hedging opportunities.

From the comparison of the different models, we conclude that, in the Nordic market, auctioning of FTR-options or FTR-obligations are inferior to the measures supporting the EPAD market. One important reason is that introduction of FTRs can lead to a split of liquidity between system price contracts and area price contracts. Another reason is that we assess that the FTR-models improve hedging opportunities in the Nordic market less than the EPAD models.

The other models give direct support to the EPAD market in different ways. None of the three models is generally superior or inferior to the other two models. We recommend therefore that models 1, 3 and 4 are included in the toolbox. However, the models have different pros and cons.

Support to a market maker function may be an effective measure for a bidding zone where appropriate hedging cannot be achieved because EPAD contracts are not listed. Supporting a market maker may also be effective for a bidding zone with listed EPAD contracts but no market maker, and even in bidding zones where there is already a market maker, but the evaluation shows lacking liquidity. Tighter bid-ask spreads from a market maker can facilitate smoother trade in EPAD contracts in a bidding zone with a balanced market structure.

We doubt however, that support to a market maker function will be effective if there is a skewed market structure within the bidding zone (little generation in relation to consumption or the opposite). For such bidding zones we recommend auctioning of EPAD contracts or EPAD Combos.

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The costs and benefits are more difficult to calculate in advance for support to a market maker function than for the other models. We recommend therefore that a definitive choice of model is not taken too early and that the framework should provide flexibility to change to auctioning of EPAD contracts as long as possible.

Auctioning of individual EPAD contracts has many advantages. There is however a risk that TSOs may dislike it because of the risk for contract losses. However, our analysis of price risks indicates that contract losses occurs mostly in situations which also imply higher congestion revenues. Visible risk costs associated with EPADs should not be more important than invisible risks related to decreases in congestion revenues.

Auctioning of EPAD Combos has the advantage that the magnitude of possible contract losses are smaller for the TSO since an EPAD Combo combines a buy in one area with a sell in another area. In fact, in terms of price risk, EPAD Combos are in the longer run likely to yield a revenue corresponding to the expected congestion rent for the TSO. It can therefore be a preferred model by the TSO, and it should give the same essential improvements in hedging opportunities as auctioning of individual EPAD contracts.

As said above, calculations of costs and benefits of the different models are uncertain by necessity. However, all the preferred models can be implemented in such a way that they are easy to adjust or to phase out if they do not have the desired effect or they become obsolete over time. We recommend that flexibility is taken into account in the design and implementation of instruments.

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