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CONSEQUENCES FOR NO2 OF A SEPARATE TRADING SOLUTION FOR NSL

NO2 and NSL auctions

Statnett SF

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The aim of this project was to analyse implications of various design options for auctions to allocate capacity on North Sea Link (NSL), the 1400 MW interconnection being built between Norway (NO2) and Great Britain.

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1 EXECUTIVE SUMMARY

North Sea Link (NSL) between Norway and Great Britain is planned to be taken into operation in the end of 2021. Prior to the UK's referendum decision to leave the European Union, it was agreed that the trade on NSL would be a part of the European market coupling in the same way as current trade on Norwegian and British interconnections with other countries. However, with Brexit it is possible that the UK will not be allowed to be a part in the European market coupling.

A separate trading solution has to be implemented for NSL if the UK is not allowed to participate in the European market coupling. DNV GL has been commissioned by Statnett to assess the consequences for NO2 (the Norwegian bidding zone where NSL is connected) of a separate explicit or implicit auction for NSL.

Interactions between separate NSL auctions and other Norwegian auctions

Market coupling of day-ahead (SDAC) and intraday (SIDC) markets are cornerstones of the European integrated market. The CACM regulation includes many detailed rules regarding capacity calculation, capacity allocation and capacity management. The aim is to provide maximum cross-border capacity for SDAC and SIDC within the operational security limits.

A separate trading solution for NSL has to be designed in such a way that the compliance of CACM rules is not jeopardized. A challenge for Statnett is that the Nordic electricity market and the interconnectors to Germany and the Netherlands will operate inside the Internal Electricity Market and the design of a separate NSL auction needs to take that into account.

An explicit NSL auction means that there is an auction for the cross-border capacity itself. The auction will be open only for market players who can arrange balance responsibility both in NO2 and GB. Power exchange trade regarding NO2 will be SDAC and SIDC.

An implicit NSL auction is an extra day-ahead auction and results in a simultaneous calculation of zonal prices in NO2 and GB and cross-zonal power flows between NO2 and GB. Two NO2 day-ahead prices will be established, one NO2 price in the NSL auction and one in the SDAC auction. Market players need only to arrange balance responsibility in either NO2 or GB. Those market players who want an internal power transfer on NSL can arrange it by placing sell and buy bids in the NO2 and GB bidding zones.

Only implicit auctions or explicit auctions with automatic nomination, use-it (UI), can make NSL auction results compliant with Nordic ramping constraints.

Price formation in separate NSL auctions

The traded volume in an implicit NSL auction is not restricted to the NSL capacity. The bids concern buying or selling electricity in the two bidding zones NO2 and GB – not the cross-border capacity itself. Splitting bids between SDAC and the NSL auction can be seen as risk-reducing for fundamental participants. Trading participants will try to exploit price differences between the two auctions.

Differences in hourly prices between the two auctions can be interpreted as a forecast error of the market. The expected net forecast error over time would be zero, given clever market players. Any unexpected deviations between the two auctions would 'immediately' cause traders to seek taking advantage of the difference, such that a systematic difference will disappear.

There will be no systematic difference in NO2 prices dependent on whether NSL is within the SDAC auction or there is a separate NSL auction as long as the NSL auction results in the same power flows on NSL. The issue of efficient reservoir management in NO2 is the same.

A key difference between implicit and explicit auctions is that the product being traded is different. An implicit auction has price formation for different locations/bidding zones while an explicit auction has price formation for cross-border transfer, i.e. the price difference between two bidding zones.

For a participant wanting to execute a fundamental or physical cross-border trade, it is not necessary to acquire cross-border capacity in an explicit auction. A participant producing in one bidding zone and selling in another can manage the power transfer by placing bids in the two bidding zones. Bids for cross-border capacity itself are driven by a trading interest and will only be submitted if a participant expects a reasonable profit. In addition, uncertainty means risk costs for a trader and its required return will increase. The congestion rent will thus be lower in an explicit auction than in an implicit auction.

If the expected price difference is small, market participants are uncertain about what the profitable direction is. Under explicit auctions, such situations will reduce willingness to bid and imply low or no congestion rent. Under implicit auctions, however, such situations will imply congestion rent in all situations when the price difference is bigger than the loss factor.

Differences for Norwegian market participants

Considering the differences between explicit and implicit auctions, we have drawn the following conclusions with respect to Norwegian market participants:

- With an implicit NSL auction, Norwegian market participants are offered trading opportunities and potential impact on price formation that are as familiar as possible when comparing with e.g. NorNed or the Skagerrak connections.
- With an implicit NSL auction, the most important difference from the existing market design is that market participants will need to (or should consider to) split both buy and sell orders between two auctions – SDAC and the NSL implicit auction.
- Most Norwegian market participants have no fundamental need to place bids in an explicit auction and most of them will probably not participate. However, an explicit auction can be interesting for participants who are engaged in proprietary trading.
- Those who decide to engage in an explicit NSL auction would need to arrange for balance responsibility in two different markets, and to take positions in not only the NO2 market but also the British market.

Consequences of different timings

NSL auctions can be before, after or at the same time as SDAC (12:00). The share of fundamental bids can be expected to be much lower in explicit auctions than in implicit auctions. This means that for explicit auctions, the consequences for trading bids are essential while for implicit auctions, the consequences for both trading bids and fundamental bids are essential.

If the NSL implicit auction comes first, the participants know their positions from the NSL auction before bids are given to SDAC. Due to the expected liquidity of the SDAC, this setup seems to maximise trader participation and liquidity. For fundamental bids, a first NSL implicit auction can be seen as an alternative trading venue and provide options and diversification of risks. Bids to SDAC can be given afterwards for desired quantities not yet bought or sold.

NSL auction D-2 means that the reference scenarios for flow-based SDAC capacity calculation can be based on auction results regarding NSL power flows. However, this creates more uncertainty and probably lower liquidity compared to an implicit auction in the morning D-1. For explicit auctions D-2, the liquidity will probably not be affected as long as there is low uncertainty regarding the direction of

the power flow. Increased uncertainty of NO2 and GB prices will in such situations only affect the willingness to pay and the congestion rent.

If both auctions are at the same time, participants have to bid without knowing their position in the other auction. Fundamental bids to an NSL implicit auction are no longer options in relation to SDAC but can still provide diversification of risks. We expect that higher uncertainty for traders will result in trading bids with a larger interval around expected SDAC price (larger dead band) and include smaller quantities near the expected SDAC price, as compared to an early NSL implicit auction.

Parallel or late explicit NSL auctions are probably the alternatives with lowest liquidity overall but still high participation from traders to the extent the expected price differences are sufficiently high.

An implicit auction after the SDAC at 12:00 means that fundamental players do not need to fulfil all their needs in SDAC. They have now the option to reduce their buy bids in SDAC at prices higher than expected and reduce their sell bids at prices lower than expected and use NSL as a corrective auction. However, there will in such a case be asymmetric fundamental bids to a late implicit NSL auction – either mostly buy bids or mostly sell bids. Cleared volumes will in such a case be lower.

Market power and geographical scope of an NSL 'bidding area'

There is a risk for price impacts because of use of market power if it is poor competition in NO2. If NO2 was an isolated power market, NO2 would be considered as a market with poor competition. Statkraft has 45 % of the production capacity in NO2. However, the competition is enhanced by interconnections to the Netherlands, Denmark and other Norwegian bidding zones.

RSI (Residual Supply Index) gives information about the potential for an analysed supplier to use market power in order to impact prices. The index is calculated as the capacity of all other suppliers (including import capacities) in relation to the demand in the area. We have calculated a rough RSI for all hours during 2018. Our conclusion from these RSI calculations is that Statkraft normally has a low potential to use market power in NO2.

We have not observed any competition issues in NO2 during the latest 10 years. The competition in NO2 is enhanced by the extensive interconnections between NO2 and other bidding zones. The competition will be even better when NordLink and NSL are taken into operation. Therefore, we see no competition concerns regarding NSL auctions including only NO2 on the Norwegian side of NSL.

We see no relevant possibilities to include more Norwegian bidding zones than NO2 in explicit NSL auctions. An explicit auction is an auction for capacity between two areas.

It is conceivable to design implicit NSL auctions including more Norwegian bidding zones than NO2. However, the possible solutions mean that capacities are allocated outside the flow-based market coupling to some trade between Norwegian bidding zones. Such splitting of capacities will create inefficiencies in the price formation, and it is unclear if it is in accordance with the CACM regulation. We see no reasons that implicit NSL auctions including more Norwegian bidding zones than NO2 will give a more efficient price formation than an NSL implicit auction including only NO2 on the Norwegian side of NSL.

2 BACKGROUND

Statnett and National Grid are establishing an interconnection, North Sea Link (NSL), between Norway and Great Britain. NSL is planned to be taken into operation in the end of 2021. The NSL interconnection capacity will be 1400 MW in both directions.

Prior to the UK's referendum decision to leave the European Union, it was agreed that the trade on NSL would be a part of the European market coupling in the same way as current trade on Norwegian and British interconnections with other countries. However, with Brexit it is possible that the UK will not be allowed to be a part in the European market coupling. The European Commission has declared that the UK will be treated as a third country after Brexit unless otherwise is agreed in a withdrawal agreement. Switzerland is so far not allowed to participate in the European market coupling.

A separate trading solution has to be implemented for NSL if the UK is not allowed to participate in the European market coupling. National Grid and Statnett are now assessing different alternative trading solutions. Both implicit and explicit auction solutions are assessed. It is important for Statnett that the chosen solution is compatible with continued Norwegian participation in the European market coupling.

DNV GL has been commissioned by Statnett to assess the consequences for NO2 (the Norwegian bidding zone where NSL is connected) of a separate implicit or explicit auction for NSL. Statnett requests a qualitative analysis of the interaction between separate NSL auctions and Norwegian auctions included in the European market coupling and the consequences for Norwegian market players of such a market design. Possible price impacts in NO2 and the competition shall be qualitatively assessed. Different timings and different geographical extensions (only NO2 or more bidding zones) of the auctions shall also be assessed.

It shall be observed that the consequences for NO2 of establishing NSL is outside the scope of this analysis. These consequences were assessed when the investment decision was taken. The issue now is to assess different alternative trading solutions if NSL cannot be included in the European market coupling.

The DNV GL project team (Jørgen Bjørndalen and Björn Hagman) has had several workshops with Statnett discussing different issues of the analysis. This report sums up our analysis.

3 SEPARATE NSL AUCTIONS IN ADDITION TO AUCTIONS INCLUDED IN EUROPEAN MARKET COUPLING

3.1 Continued Norwegian participation in the European market coupling

A new EU regulation on the internal market for electricity (2019/943) and a new EU directive on common rules for the internal market for electricity (2019/944) were finally decided in June. The aim is to ensure the functioning of the internal market for electricity and to address persisting obstacles to the completion of the internal market for electricity.

One cornerstone of the integrated market is market coupling of day-ahead and intraday markets. The EU guideline on capacity allocation and capacity management (CACM) establishes rules for Single day-ahead market coupling (SDAC) and Single intraday market coupling (SIDC). The European day-ahead market coupling comprises now 20 EU countries and Norway. Switzerland is not allowed by the European Commission to take part in the market coupling.

A market player needs for its bids to SDAC only to define its own situation in the bidding zones it is active in. Acquisition of physical cross-border capacity is no longer needed for cross-border electricity trading between markets that are coupled in an implicit auction. This creates a level playing field for the market players.

Prior to the UK's referendum decision to leave the European Union, it was agreed that the trade on NSL would be a part of the European market coupling in the same way as current trade on Norwegian and British interconnections with other countries. In such a case will day-ahead prices in Norway, UK and all other countries that take part in SDAC be established in the same implicit auction. The auction will also establish cross-border flows between all the bidding zones.

With Brexit it is possible that the UK will not be allowed to be a part in the European market coupling. The European Commission has declared that the UK will be treated as a third country after Brexit unless otherwise is agreed in a withdrawal agreement. A separate trading solution has in such a case to be implemented for NSL.

A separate trading solution for NSL has to be designed in such a way that it is compatible with continued Norwegian participation in the European market coupling. A challenge for Statnett is that the Nordic electricity market and the interconnectors to Germany and the Netherlands will operate inside the Internal Electricity Market and the design of a separate NSL auction needs to take that into account.

CACM stipulates how cross-border capacity shall be allocated within the internal electricity market (IEM). However, it does not regulate how cross-border trade between IEM and third countries can or must be organised. It can also be observed that CACM rules do not forbid additional day-ahead and intraday markets.

3.2 Interactions between separate NSL auctions and other Norwegian auctions

Separate NSL auctions can either be explicit or implicit auctions.

An explicit NSL auction means that there is an auction for the cross-border capacity itself. The cross-border trade between NO2 and GB can only be performed by market players who have acquired cross-

border capacity on NSL and the explicit NSL auction will be open only for market players who can arrange balance responsibility both in NO2 and GB. The power transfer has to be arranged by the market player in both NO2 and GB either before or after the explicit auction. It can be arranged internally, bilaterally or on power exchanges. Power exchange trade regarding NO2 will be SDAC or SIDC. Power exchange trade regarding GB will be performed outside SDAC and SIDC.

An implicit NSL auction means that there is a simultaneous calculation of zonal prices in NO2 and GB and cross-zonal power flows between NO2 and GB. This requires a common matching of bids from NO2 and GB. An implicit NSL auction means therefore an extra day-ahead auction in NO2 alongside the SDAC auction and two NO2 prices will be established, NO2(SDAC) and NO2(NSL). An implicit auction results in a more level playing field for smaller market players in competition for export/import possibilities. Market players need only to arrange balance responsibility in either NO2 or GB. Those market players who want an internal power transfer on NSL can arrange it by placing sell and buy bids in the two bidding zones.

There are several possible interactions between a separate explicit or implicit NSL auction and other Norwegian SDAC or SIDC auctions.

CACM includes many rules regarding capacity calculation, capacity allocation and capacity management. The aim is to provide maximum available cross-border capacity within the operational security limits and Norway has to comply with these rules.

There is now an ongoing work in order to implement flow-based market coupling in the Nordic capacity region. Separate NSL auctions mean that the reference scenario for SDAC and SIDC capacity calculation has to also include a forecast of power flows within NO2 because of expected power flow on NSL. The consequences for capacity allocation are an important issue to assess when choosing trading solution for NSL. It is important to find a solution that results in efficient day-ahead capacity allocation and is transparent and in line with the EU competition regulations. It is important to also consider the requirement to recalculate capacities before the intraday auctions which are included in SIDC.

Forecast accuracy regarding the power flow on NSL depends on whether the flow is known before the SDAC and SIDC capacity calculations. At present, the planned timetable is that SDAC capacities shall be reported by Nordic TSOs to the Regional Security Coordinator before 19:00 D-2. Updated SIDC capacities shall be reported before 19:00 D-1. This means that results from NSL auctions can be included in SDAC capacity calculations only if they are performed D-2 and can be processed before 19:00. The timing of an NSL auction during D-1 is of no significance for SADC capacity calculation. The results can be included in the updated SIDC capacity calculation as long as they can be processed before 19:00.

Ramping and losses can be arranged for within an implicit NSL auction. The results from an implicit auction are firm for all parties.

An explicit auction regarding transmission rights is firm for the TSOs but not firm for the market players. They can later choose if they want to nominate or not. Explicit auctions are currently most known in the market for long-term transmission rights, where long-term means e.g. a year or a month. The auctioned transmission right is a block covering all hours during the calendar period. A buyer can differentiate between the hours within the calendar period only in a nomination at a later stage. A nomination at a later stage means also that the buyer has a possibility to act on new information after the auction but before the nomination.

Use-it-or-sell-it (UIoSI) long-term transmission rights are auctioned on many European borders. Bought UIoSI rights are considered sold to SDAC unless they are nominated before the closure of the nomination gate which is before the day-ahead market gate closure time. Nearly all UIoSI rights are not nominated

and thus sold to SDAC. The owner of a not nominated UIoSI right is then compensated with the price difference between the two zones in the bought direction (minus the loss factor if applicable). However, selling the capacity to SDAC is not possible if the UK is not a part of SDAC.

Another alternative is use-it-or-lose-it (UIoLI) transmission rights. This alternative means that market participants are required to nominate the transmission capacity in a second step or lose the right to use the capacity. Holders that do not nominate have no right to receive a pay-out. Traders will only participate in a UIoLI auction if they believe they are able to manage the physical positions that arise in both bidding zones after a nomination. In an explicit auction of UIoSI or UIoLI rights, the algorithm cannot take ramping constraints into consideration since the nomination of the rights are not known in the auction. TSOs have instead to manage ramping constraints by countertrade.

Only implicit auctions and explicit auctions with automatic nomination, use-it (UI), can make the auction results compliant with ramping constraints. Accepted bids in a UI auction are physically firm both for the TSOs and the market participants (automatic nomination). The main advantage of UI compared to UIoLI is that UI is very cost-effective for managing ramping constraints. Another advantage is that no systems, routines and resources are needed for managing nominations. This reduces costs and risks for faults. No fall-back rules, systems routines and resources are needed for managing faults in nomination systems. A third advantage is that the power flow is known immediately after the auction and can be used for SDAC and SIDC capacity calculations. Traders can be expected to prefer UIoLI over UI. However, the three listed advantages of UI are so important that we strongly recommend UI if explicit auctions are chosen for NSL.

4 CONSEQUENCES OF TYPE OF SEPARATE NSL AUCTIONS

4.1 Price formation in different auction formats

It is useful to understand the economics of different auction formats from both participant and auctioneer (or societal) perspectives. To do so, we will explain differences in price formation using traditional price/quantity diagrams known from economic literature. We start with explaining implicit auctions, first assuming there is no uncertainty and then introducing uncertainty before repeating the same scheme for explicit auctions.

It is important to bear in mind that there anyway will be two sets of auctions for at least the Norwegian market area NO2. The whole problem addressed in this project is due to the decision that GB quantities and prices cannot be determined in the auctions that settle local equilibria in Norwegian and Continental market areas. Hence, for NO2, there will be the current auctions for day-ahead (SDAC) and intraday (SIDC) plus a separate NSL arrangement.

The GB day-ahead market is now organised by two power exchanges but the current European market coupling results in only one GB price. The future organisation of the British day-ahead market if UK is not allowed to be a part of the European market coupling is currently unclear. For the analysis in this chapter it suffices to note that there will indeed be British market prices; we do not need to elaborate on whether the two power exchanges will be coupled in a British market coupling or if the two power exchanges will report two different GB day-ahead prices.

Furthermore, it is important to note that with an implicit auction for NSL, market participants in NO2 and GB are offered a market for trading local energy within NO2 or GB respectively. Although the purpose of that market would be to have the market to determine whether there should be export to or import from GB to NO2, this is not likely to be fair description of how market participants likely will use it. NO2-sellers in an NSL auction would not necessarily think they are selling for export to GB – rather, they would tend to interpret the implicit NSL auction as an alternative to selling NO2 quantities in the SDAC auction. The same of course holds for NO2 buyers as well as GB sellers and GB buyers. Hence, the traded volume in an implicit NSL auction is thus not restricted to the capacity of the NSL connection.

To ensure consistency and in an attempt to avoid confusion, the relevant market areas will be denoted as NO2(SDAC) and GB(PX) or NO2(NSL) and GB(NSL) respectively. In order not to complicate the sketches, we ignore ramping and loss calculations in these diagrams.

4.1.1 Implicit auctions under full certainty

The diagram in Figure 4-1 depicts to the left the current equilibrium in NO2(SDAC) (before NSL is considered). The red downward sloping line represents demand, that is not very elastic, while the dark blue stepwise line represents the supply in NO2 that is quite elastic within the capacity constraint. The way the diagram is made, the NO2(SDAC) price is determined by the height of the horizontal part of the supply curve. The height is, in turn, determined by the water value, which depends on expectations for future precipitation and electricity prices. The green dot points to the NO2 consumption and corresponding price.

The sketch to the right in Figure 4-1 depicts an implicit auction for NSL. The thin vertical black lines represent the capacity of NSL in both directions. In the diagram it is implicitly assumed that there exists prices or price expectations in both market areas NO2 and GB, here denoted as $P_{NO2(NSL)}$ and $P_{GB(NSL)}$ respectively. To these prices, it is assumed one can buy or sell as much as desired (at least up to 1400

MW). In reality, we would expect the GB price to be less elastic than the NO2 price, decreasing with larger exports from Norway, i.e. the green line would be downward sloping from left to right. The location of the equilibrium points (the green dots, representing equilibrium prices in NO2 and GB)) depends on which is the higher price; GB or NO2. As the GB price is assumed to be above the NO2 price, the NSL equilibriums are in the 'export half' (i.e. to the right). If GB prices were below the NO2 prices, the equilibriums would be in the 'import half'; to the left.

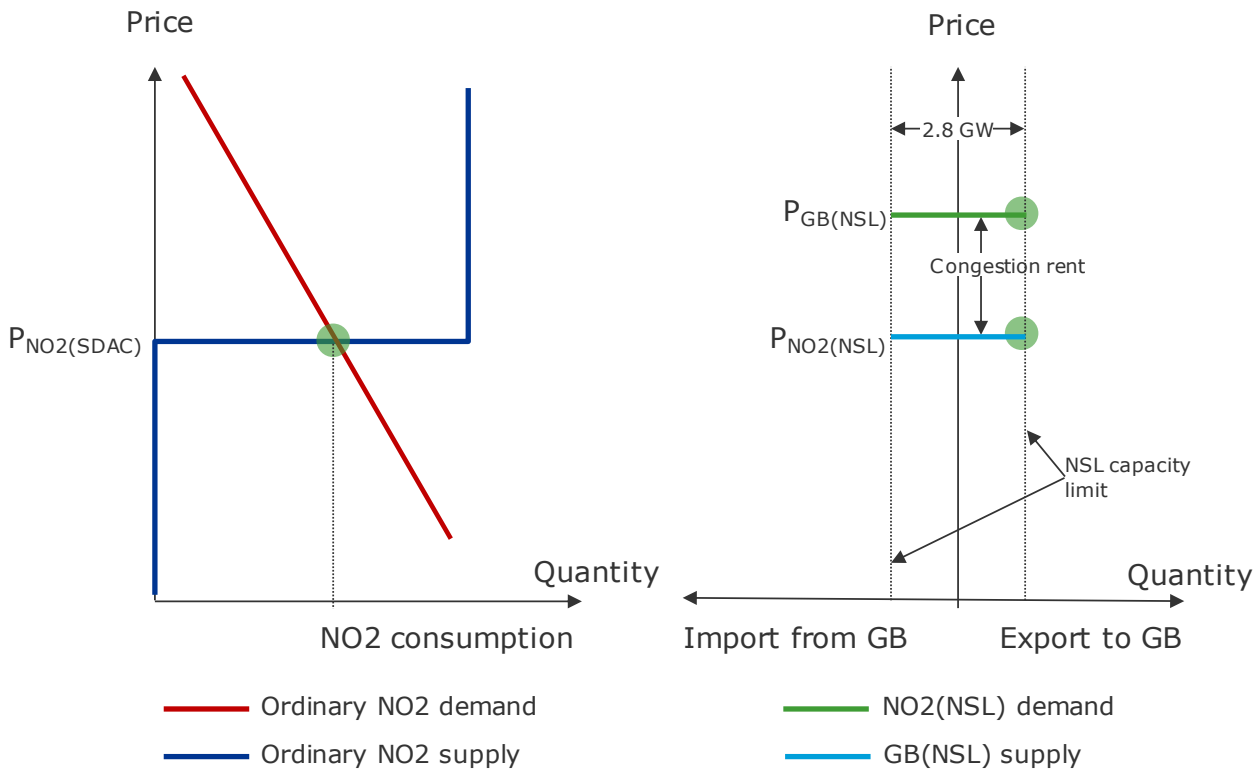

Figure 4-1 Implicit auctions without uncertainty; NO2(SDAC), NSL and NO2

The situation illustrated in Figure 4-1 is characterised with no uncertainty, perfect foresight and full harmony and consistency between the different markets. Before introducing uncertainty, we shall see what happens if two markets for the same area (SDAC and NSL) are inconsistent with respect to prices. More specifically, let us assume that the bids for the NO2 prices are as depicted in Figure 4-2; that is, for some reason, market participants bid the NSL price for NO2 ($P_{NO2(NSL)}$) to be lower than the SDAC price for the same area ($P_{NO2(SDAC)}$).

To understand what happens, recall that in a 'world' as described in Figure 4-1, market participants should be indifferent as to where they place their bids and asks for quantities to be traded in NO2. Whether a seller sells in NO2(SADC) or NO2(NSL) does not matter, and of course the same would hold for buyers. An implicit NSL auction simply offer an alternative trading venue to the SDAC. In such a world, there might be at least two different motivations determining which venue to use:

- Seeking profits from exploiting price differences between the venues (inconsistent prices, although inconsistent prices really would be surprising if there were no uncertainty and thus a contradiction in terms).

- Reducing risks caused by 'wrong' prices at one of the venues by splitting the volume to be traded between the two venues.

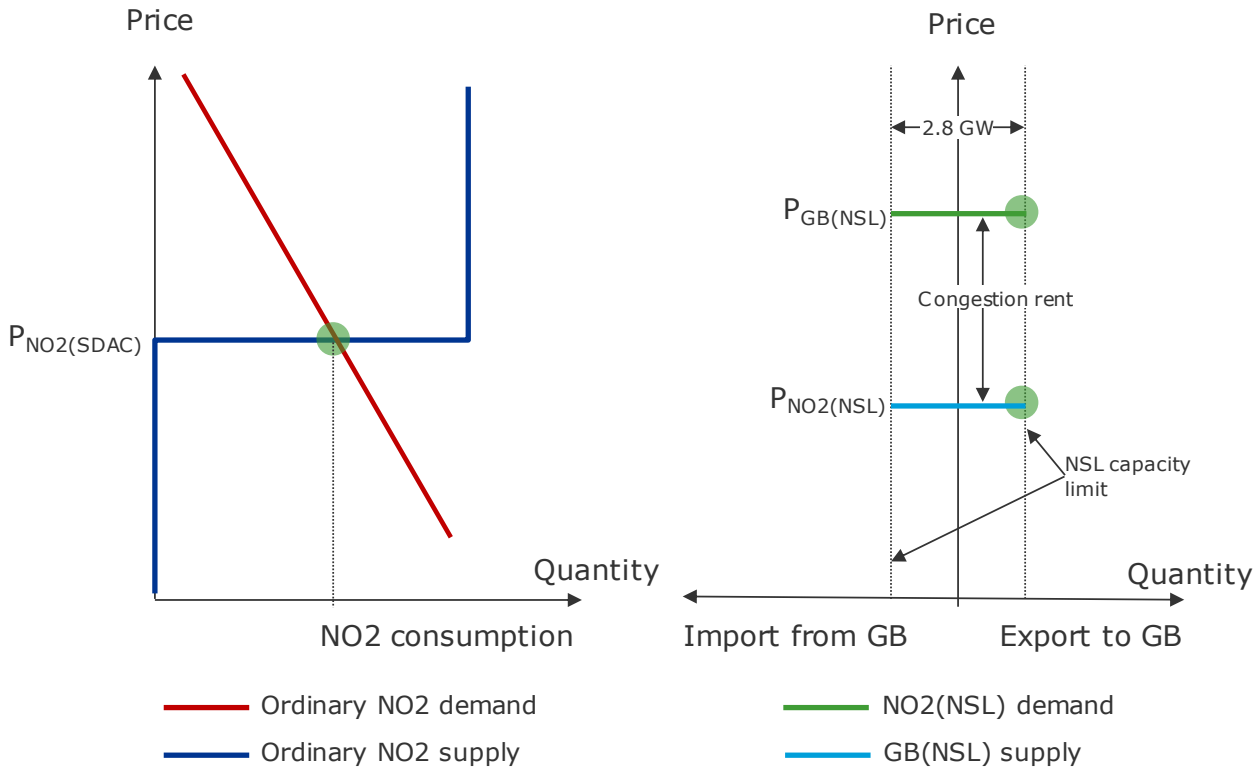

Figure 4-2 Biased expectations for the NSL auction

Thus, if the situation is as illustrated in Figure 4-2, NO2(SDAC) buyers [or sellers] would tend to move some of their purchase from SDAC to NSL [sale from NSL to SDAC]. This will continue until the prices equals (or the NO2(NSL) price comes above the NO2(SDAC) price).

If the opposite was the case, that the NSL price was expected above the SDAC price, NO2(SDAC) sellers [buyers] would tend to move some of their sales from SDAC to NSL [purchases from NSL to SDAC]. This would continue until the prices equals (or the NO2(NSL) price comes below the NO2(SDAC) price).

With reasonably rational and efficient market participants, such corrections would likely be quite fast.

The key point here is that hourly differences between $P_{NO2(NSL)}$ and $P_{NO2(SDAC)}$ can be interpreted as a forecast error of the market. The expected net forecast error would be zero, given clever market players. Any unexpected deviations between the NO2(NSL) and NO2(SDAC) prices would 'immediately' cause traders to seek taking advantage of the difference, such that a systematic difference will disappear.

This was experienced in the Kontek bidding zone, which Nord Pool implemented in 2005. Market participants active in Germany could place bids in the so called Kontek bidding zone which was included in the Nord Pool market. The cross-border capacity between DK2 and the Kontek zone was given by the owners of the Kontek interconnection between DK2 and DE. The Kontek bids reflected Nordic and Continental participants' expectations of the EEX price.

4.1.2 Implicit auctions and uncertainty

As a means to illustrate uncertainty graphically, the horizontal parts of all supply and demand curves are replaced by broader rectangles (Figure 4-3). The interpretation is that the actual (true) demand or supply are expected to be within the bands indicated by the rectangles, but the precise location and slope of the curve is less certain.

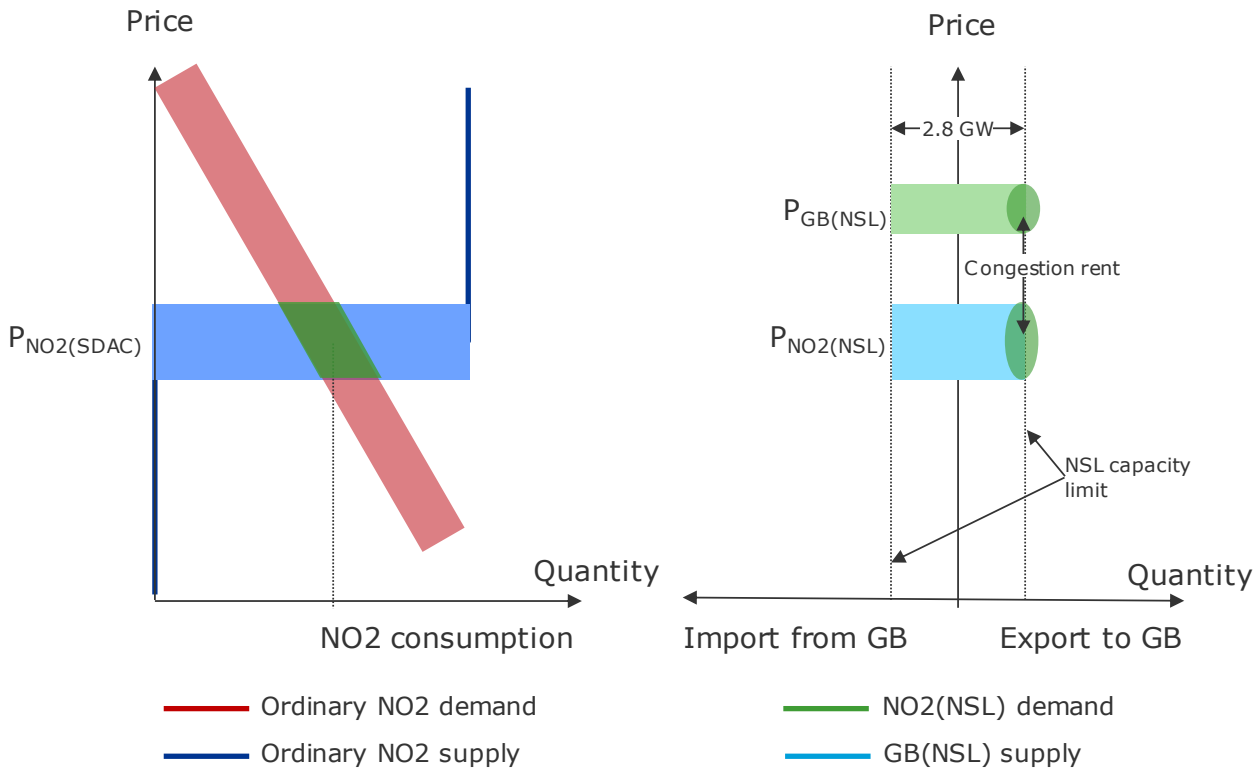

Figure 4-3 Implicit auctions with uncertainty; NO2(SDAC), NSL and NO2

In the NO2(SDAC) market to the left, the equilibrium price should be within the green parallelogram, and the expected equilibrium might be precisely the same as the certain price in Figure 4-1. The precise impact of uncertainty on equilibrium prices in a hydro-dominated power market is a complex issue and

well beyond the scope of this report. For our purpose, it suffices to note that there will indeed exist an expected equilibrium price for NO2(SDAC), and this will depend on, among other things, whether there can be expected import from or export to GB through NSL.

The important part of Figure 4-3 is the NSL illustration to the right. Uncertainty will result in an interval of possible prices for GB and NO2. However, no systematic difference is expected compared to an implicit auction with full certainty. The expected congestion rent under uncertainty will be about the same as the congestion rent without uncertainty.

4.1.3 Explicit auctions without uncertainty

A key difference between implicit and explicit auctions is of course that the product being traded is different. While implicit auctions trade electricity at different locations, an explicit auction trade cross-border capacity. The explicit auction allocates rights or obligations to transfer electricity between locations. An implicit auction has price formation for different locations/bidding zones while an explicit auction has price formation for cross-border transfer, i.e. the price difference between two bidding zones. Beyond the economic implications, this also means that the graphical illustration will be different. The right-section of Figure 4-4 thus differs from the corresponding section of Figure 4-1 above:

- The vertical axis measures the price difference between locations and not the price at each location.
- The horizontal lines cross the vertical axis where we measured the Norwegian and British price levels in the implicit auction diagrams.
- The expected Norwegian and British price levels can no longer be interpreted as supply and demand curves. However, they help us identify the demand for transmission capacity in one direction, as illustrated by the yellow dotted line.
- The diagrams for explicit auctions, both Figure 4-4 and Figure 4-5, show only a situation where it is full export towards England. The uncertainty (in Figure 4-5) only concerns the value and the optimal quantity. The green dots show the willingness to pay for export capacity towards England. The willingness to pay equals the expected price difference when there is no uncertainty.

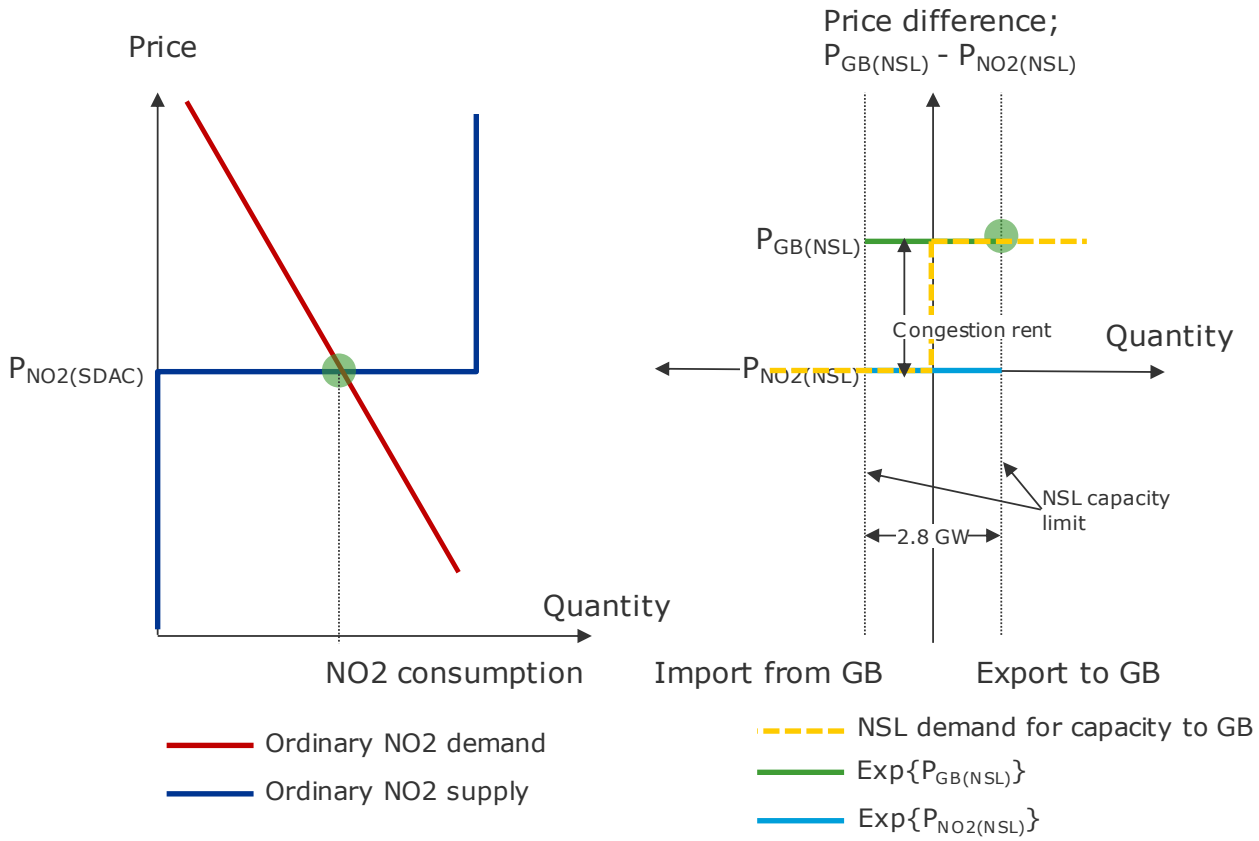

Figure 4-4 Explicit auctions without uncertainty; NO2(SDAC), NSL and NO2

The diagram also somewhat falsely suggests that absent uncertainty, the congestion rent would be the same as in an implicit auction without uncertainty. As the diagram essentially ignores trading costs, associated costs of balancing and the necessity to be active in both locations, this is no surprise.

The diagram also ignores the impact of the particular type of explicit auction; Use-It-or-Sell-It (UIoSI), Use-It-or-Lose-It (UIoLI) or Use-It (UI) as explained in section 3.2. With UI, the transmission right is in effect a transmission obligation. Even absent uncertainty about day-ahead prices, the fact that many things can happen after an explicit auction but before delivery suggests there is a risk of committing to flow in one direction 'too early'. The cost of this risk obviously reduces the willingness to pay for the transmission right. Similar considerations also apply for UIoLI, but to a lesser extent.

In a hypothetical reality without uncertainty, we would indeed expect different outcomes for the congestion rent under implicit and explicit auctions, precisely because of these other costs or features associated with explicit auctions. Profit-seeking also explains why the willingness to pay for a day-ahead transmission right (or obligation) would be lower than the expected price difference also without uncertainty; there is no reason to pay 100 for an expected return of 100 – although it does not imply a loss, it does not provide a profit either.

4.1.4 Explicit auctions with uncertainty

In Figure 4-5, uncertainty is illustrated for an explicit NSL auction. The uncertainty is reducing the willingness to pay for the right or obligation to transfer and thus reducing the congestion rent captured in the explicit auction. Uncertainty will thus reduce the congestion rent more in an explicit auction than in an implicit auction. The explanation is that there is no fundamental need for a participant to acquire transmission capacity in an explicit auction. A participant producing in one bidding zone and selling in another can manage the transfer by placing bids in the two bidding zones. Bids for transmission capacity are driven by a trading interest and will only be submitted if the participant expects a reasonable profit. Uncertainty means risk costs for a trader and its required return will increase.

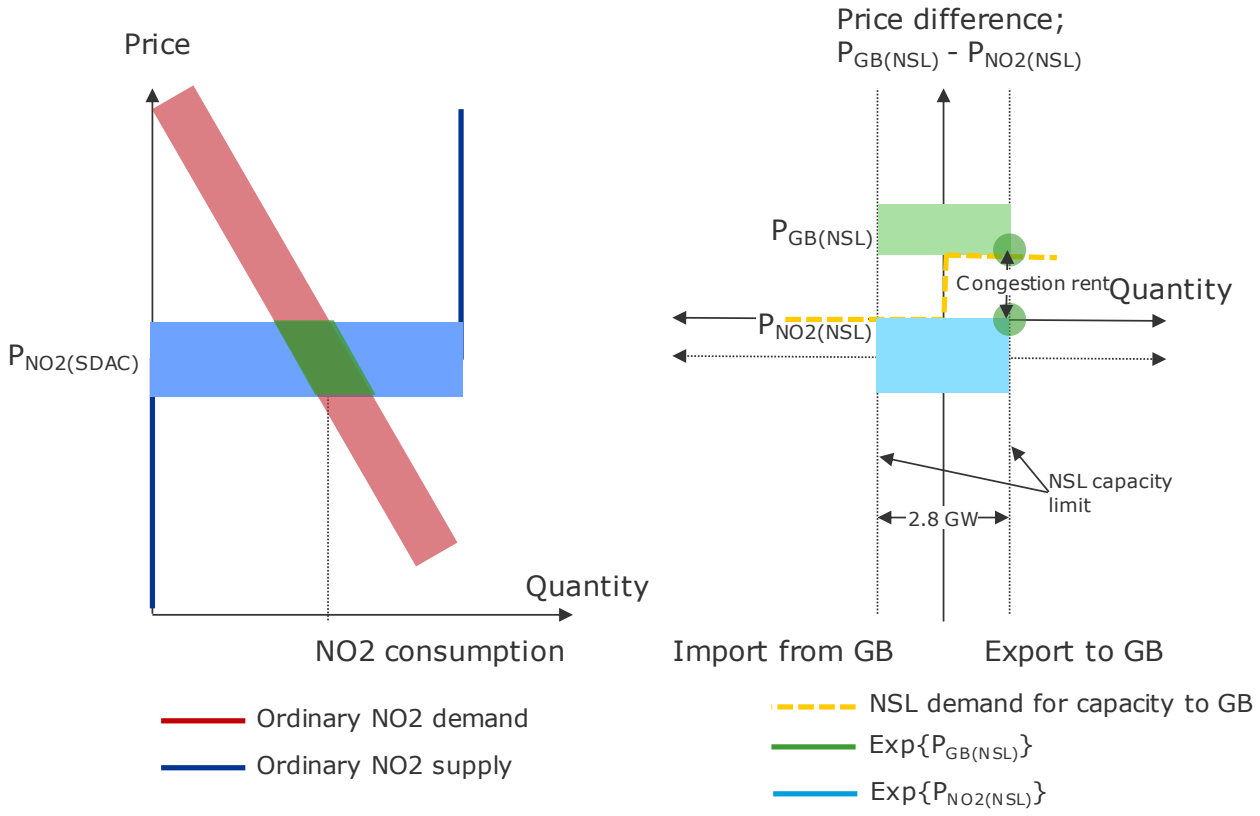

Figure 4-5 Explicit auctions with uncertainty; NO2(SDAC), NSL and NO2

A key observation from this diagram is that when the expected price difference is small (the green and the blue bands are close or even overlapping), market participants are uncertain about what the profitable direction is. Under explicit auctions, such situations will reduce willingness to bid and imply low or no congestion rent. Under implicit auctions, however, the same scenario would imply congestion rent in all situations when the price difference is bigger than the loss factor.

If there is a large expected price difference between NO2 and GB, there's hardly any uncertainty about the optimal direction or quantity, but rather about the 'right' size of the congestion rent. This uncertainty will in an explicit auction not reduce the power flow, but it will reduce the congestion rent.

4.2 Consequences for Norwegian market players

Considering the differences between explicit and implicit auctions explained above, some relatively straight forward conclusions with respect to Norwegian market participants seem to emerge:

- With an implicit NSL auction, Norwegian market participants are offered trading opportunities and potential impact on price formation of NSL that are as familiar as possible when comparing with e.g. NorNed or the Skagerrak connections.
- With an implicit arrangement, the most important difference from the existing market design is that market participants will need to (or should consider to) split both buy and sell orders between two auctions in order to manage possible price differences (this will minimise the 'forecast error' explained at the end of section 4.1.1).
    - To the extent the forecast error really is minimised, there will be no significant impact on total NO2 liquidity as compared to a standard SDAC arrangement. The same applies for the behaviour of the NO2 price or for the calculation of the Nordic system price.
- With explicit alternatives, the differences are larger:
    - Most Norwegian market participants would find an explicit NSL auction as a quite unusual approach. They have no fundamental need to place bids and most of them will probably not participate. However, an explicit auction can be interesting for a participant who is engaged in proprietary trading.
    - Those who decide to engage in the NSL market would need to arrange for balance responsibility in two different markets, and to take positions in not only the NO2 market but also the British market.
- Due to Statnett's needs to have some certainty and/or early information about the flow, in order to minimise the costs of ramping constraints as well as to ensure better capacity calculations for SDAC, we recommend the UI format if explicit auctions are to be chosen. Both UIoSI or UIoLI come with properties that are not fulfilling Statnett's needs.

5 CONSEQUENCES OF DIFFERENT TIMINGS OF SEPARATE NSL AUCTIONS

With two auctions partly covering the same area, the timing of each auction has an impact on auction results. Three alternatives are feasible; the NSL auction could be before, after or at the same time as the European market coupling SDAC. Below, we explain the different consequences for each alternative for two types of participants, or more precisely two types of bids.

- Fundamental bids are motivated by a task to buy or sell a (physical) quantity. A buyer wants to get hold of a quantity, and a seller wants to get rid of a quantity. There are also fundamental bids related to power transfer between bidding zones. A producer can produce in one bidding zone and sell the power to a consumer in another zone. A consumer can consume in one bidding zone and buy the power in another zone.
- Trading bids are motivated only with an aim to make a profit; buy cheap and sell expensive. With two alternative auctions for the same product, an obvious strategy would be to buy in one auction and sell in another. If no profit opportunities are identified, there might be no (serious) trading bids. The traders' perceptions of the risks have a major impact on their bidding behaviour.

Understanding the two different types of motivation is a key to understand expected (and observed) behaviour in different types of auctions.

Note that in all sections below, the language used seems to hint towards implicit auctions, but the arguments apply also to explicit auctions. To any expected NO2(NSL) price in an implicit auction, there exists an expected NSL price for the transmission capacity in an explicit auction: Assume for simplicity the market value of electricity in GB is known. The value of NSL capacity is then the difference between the GB price and the expected NO2(NSL) price.

The share of fundamental bids can be expected to be much lower in explicit auctions than in implicit auctions. Participation in explicit auctions requires extra administrative routines. There is no fundamental need to buy transmission capacity. A power transfer between two bidding zones can be arranged by placing bids in the two bidding zones. This means that for explicit auctions, the consequences for trading bids are essential while for implicit auctions, we must understand the consequences for both trading bids and fundamental bids.

5.1 NSL auctions before European market coupling

If NSL implicit auctions comes first, the participants know their NO2(NSL) positions before bids are given to SDAC. Due to the expected liquidity of the SDAC in general, and the NO2(SDAC) in particular, it seems reasonable to assume that it is easier to predict the NO2(SDAC) prices than the NO2(NSL) prices. Hence, this setup minimises the uncertainty for traders regarding how to offset any NO2(NSL) position.

This implies that trading bids to NO2(NSL) will come close to the expected NO2(SDAC) price and include larger quantities, as compared to other timing alternatives where there can be a larger interval around the expected NO2(SDAC) price without trading bids. This sequence thus seems to maximise trader participation and liquidity.

For fundamental bids, NO2(NSL) can be seen as an alternative trading venue and provide options and diversification of risks. Bids to NO2(SDAC) can be given afterwards for desired quantities not yet bought or sold.

An NSL auction D-2 means that the reference scenarios for flow-based SDAC can be based on auction results regarding NSL power flows. However, this creates more uncertainty for trading bids and fundamental bids and probably lower liquidity compared to an implicit auction in the morning D-1. It seems reasonable to believe that the magnitude of the consequences increases with the time span between an early NSL and the SDAC. For explicit auctions D-2, the liquidity will probably not be affected as long as there is no uncertainty regarding the direction of the power flow. Increased uncertainty of NO2 and GB prices will in such situations only affect the willingness to pay.

5.2 NSL auctions in parallel with European market coupling

If both auctions are at noon, participants obviously cannot know their position in the other auction when bidding into each of them.

Traders thus have to guess their coming NO2(NSL) positions when bids are given to SDAC, and vice versa. This creates higher uncertainty regarding how to offset a NO2(NSL) position. Hence, we might expect that trading bids to NO2(NSL) will have a larger interval around expected NO2(SDAC) price (larger dead band) and include smaller quantities near the expected NO2(SDAC) price, as compared to an early NSL auction.

In this scenario, fundamental bids to NO2(NSL) are no longer options in relation to SDAC but can still provide diversification of risks for fundamental bids. It seems likely that most of the fundamental bids will be given to SDAC since NO2(SDAC) has more interconnections than NO2(NSL) and will probably be the most liquid auction. The larger fundamental players can be expected to split their bids between NO2(SDAC) and NO2(NSL) – perhaps in the interval 60/40 – 90/10.

5.3 NSL auctions after European market coupling

Arranging the NSL auction after the European market coupling does not seem to change very much as compared to running two parallel auctions, except that SIDC now emerges as the 'correction opportunity' for NSL positions.

For explicit auctions, traders will still have to guess their coming NO2 positions when bids are given to SDAC. This creates uncertainty about how to offset any NO2 position, and a risk that trading bids to the explicit auction will have a larger interval around expected NO2(SDAC) price without bids (larger dead band). Parallel or late explicit auctions are thus probably the alternatives with lowest liquidity overall but still high participation from traders to the extent the expected price differences are sufficiently high.

A late implicit auction offers to a larger degree an alternative for fundamental bids, as is the case for an early NSL. Fundamental players do not need to fulfil all their needs in SDAC. They have now the option to reduce their buy bids in SDAC at prices higher than expected and reduce their sell bids at prices lower than expected and use NSL as a corrective auction. However, there will in such a case be asymmetric fundamental bids to a late implicit auction – either mostly buy bids or mostly sell bids. Cleared volumes will in such a case be lower and we see a risk for lower liquidity in implicit NSL auctions after SDAC.

6 CONSEQUENCES OF DIFFERENT GEOGRAPHICAL EXTENSIONS

6.1 Competition in NO2

The consumption in NO2 during 2018 was 36.5 TWh (27 % of Norwegian consumption). The peak demand in NO2 during 2018 was 6 712 MW (28 % of Norwegian peak load).

Possible consequences for NO2 of a separate trading solution for NSL are dependent on the competition in NO2. There is a risk for price impacts because of use of market power if it is poor competition in NO2. This risk is much lower if there is good competition.

There is a lot of hydro power in NO2. The hydro power production is 47 TWh in a normal hydro year (35 % of total Norwegian hydro production). The hydro storage capacity in NO2 is 32.7 TWh (38 % of total hydro storage capacity in Norway). NO2 thus has the biggest production of the five Norwegian bidding zones and is the biggest flexibility provider.

The flexibility in the NO2 hydro reservoirs results in a very price-elastic supply bidding curve. The supply bids from market participants reflect the water value in their reservoirs. The water value is normally nearly the same in night and day but changes over time due to changes in precipitation and changes in expectations of future export/import prices.

The hydro production capacity in NO2 is 11 300 MW. There are more than 200 owners of hydro production in NO2. Ownership to the NO2 hydro capacity is split between the following companies (if partnerships are divided among the owners and consolidated companies are attributed to the parent company):

Table 6-1 Market shares of production capacity, NO2

Company or group	Share of normal production
Statkraft	45.7 %
Agder Energi	15.8 %
Hydro	13.9 %
Lyse	13.8 %
Sunnhordland Kraftlag	4.1 %
More than 200 other owners	6.7 %

If NO2 was an isolated power market, NO2 would be considered as a market with poor competition. The market shares above mean that the calculated Herfindahl Index is 2740 for an isolated NO2 market. The index is calculated as the sum of the squares of the market shares of all companies in the market. The higher the index, the more is the market concentrated. The maximum Herfindahl index is 10 000 and corresponds to a monopolistic market with only one company having a market share of 100 %. The US Federal Trade Commission/Department of Justice guidelines stipulate that an index over 1800 corresponds to high market concentration and an index under 1000 corresponds to low market concentration. An index between 1000 and 1800 corresponds to moderate market concentration.

However, NO2 is not an isolated power market. The following figure from Nord Pool shows all existing interconnections to Nordic and Baltic bidding zones.

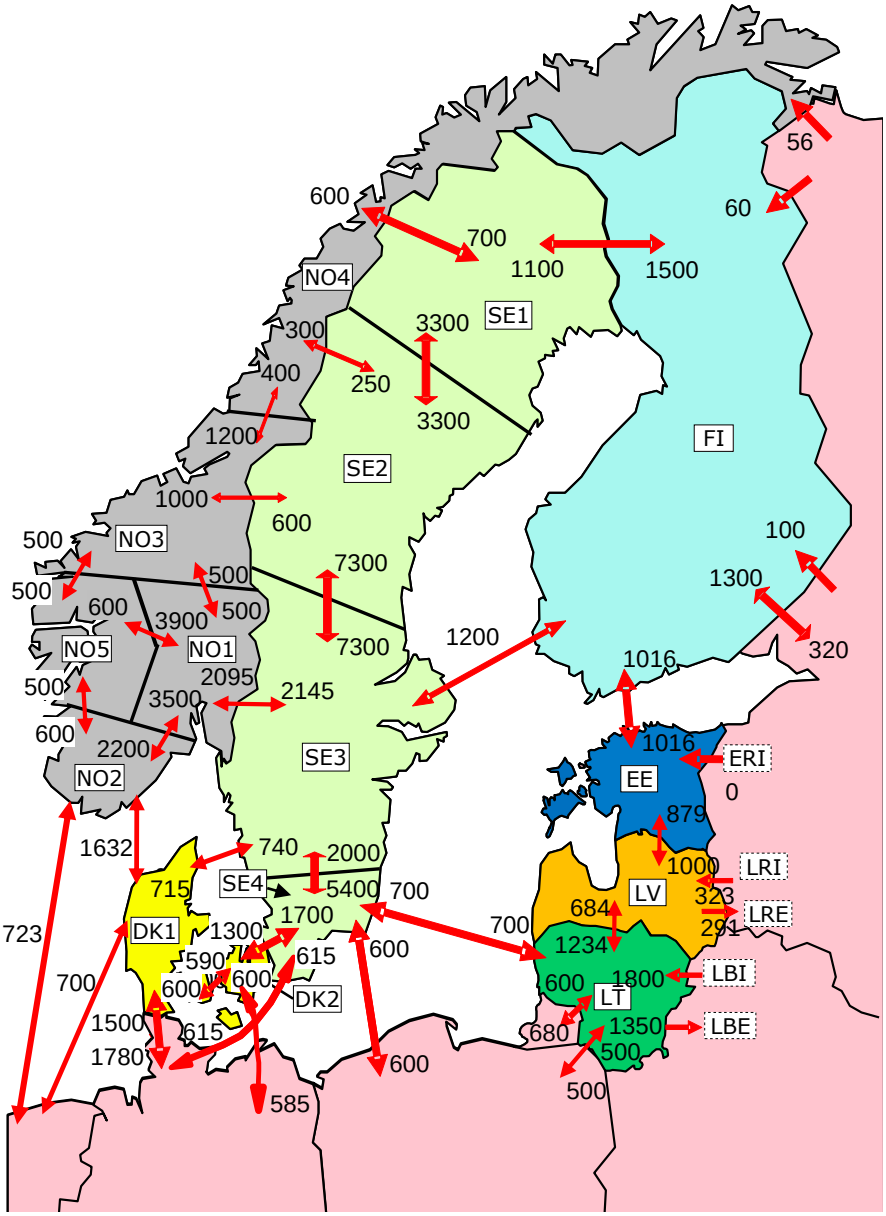

Figure 6-1 Cross-border capacities in the Nordic and Baltic area

The competition in NO2 is enhanced by the following interconnections:

- 3500 MW to NO1 and 2200 MW from NO1
- 1632 MW to/from DK1 (Western Denmark)
- 723 MW to/from NL (Netherlands)
- 500 MW to NO5 and 600 MW from NO5

In addition, there are two interconnectors under construction, both with a capacity of 1400 MW to/fom NO2. NordLink to Germany is expected to be operational in the end of 2020 and NSL to Great Britain is expected to be operational in 2021.

The Residual Supply Index (RSI) is used as an indicator in monitoring market power. RSI gives information about the potential for an analysed supplier to use market power in order to impact prices. The index is calculated as the capacity of all other suppliers (including import capacities) in relation to the demand in the area. If the index is under 1, the analysed supplier is classified as a pivotal supplier. Such a supplier is necessary in order to achieve market clearing and has the potential to use market power in order to impact prices. If the index is slightly over 1, the analysed supplier is not necessary for market clearing but has still a potential to use market power in order to impact prices, although the potential is less than for a pivotal supplier.

A precise calculation of RSI requires information of actual available production from other producers. In the absence of bid information to the day-ahead market, we have calculated a rough RSI for Statkraft in the following way. We use for each hour during 2018 the actual NO2 consumption and the actual NO2 import capacities given to the day-ahead market. We assume 90 % availability during all hours for the other producers in NO2. We also assume that a maximum of 750 MW production in NO2 is needed as reserve for system services.

Thereafter we calculate for each hour the sum of import capacities and available production capacity from other producers and divides this sum with the sum of consumption and maximum NO2 reserves. The result is an RSI for Statkraft for each hour during 2018.

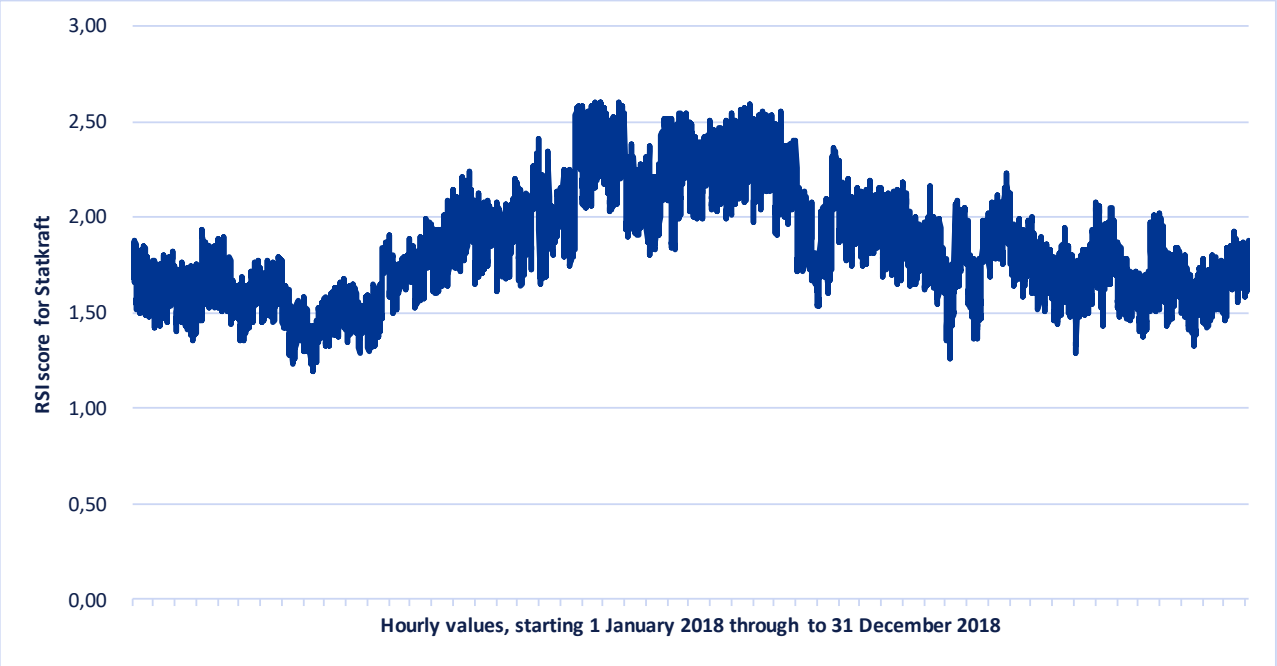

Figure 6-2 RSI for Statkraft in NO2, 2018

The graph in Figure 6-2 above shows the calculated RSI for Statkraft in NO2 for all 8760 hours during 2018. The average RSI is 1.82. The lowest RSI is 1.19 and occurs hour 9 and 10 in the morning 1 March when the 2018 peak load occurs. Low RSI (1.26) occurs also hour 9 in the morning 25 September when

the import capacities are only 1 402 MW because of grid maintenance and disturbances coinciding with rather high consumption. Possible low RSI in hours with low availability of production from other companies in NO2 is missing in the figure because of absence of bid information to the day-ahead market. The bandwidth in the figure shows the daily RSI variations between peak hours and off-peak hours.

Our conclusion from these RSI calculations is that Statkraft normally has a low potential to use market power in NO2 although its market share is 45 % in NO2 production. The reason is that the competition in NO2 is enhanced by the extensive interconnections between NO2 and other bidding zones. However, the potential to use market power is higher in peak load hours or in hours with very low import capacities. The potential is also increased in hours with low availability in the plants of other producers in NO2. This motivates a more thorough monitoring of the power market in these hours.

The RSI for Statkraft in NO2 will be substantially higher when NordLink and NSL are taken into operation. Consumption growth in NO2 will partly countervail this increase.

It can be noted that annual average prices in NO2 have very high correlation with the Nordic system price and are normally slightly lower. The annual unweighted average difference between the NO2 price and the system price has been nearly constant during the latest ten years (between -0.58 €/MWh and -2.38 €/MWh).

We have not observed any competition issues in NO2 during the latest 10 years. Our RSI analysis show that the biggest producer Statkraft normally has a low potential to use market power in NO2 although its market share is 45 % in NO2 production. The reason is that the competition in NO2 is enhanced by the extensive interconnections between NO2 and other bidding zones. The competition will be even better when NordLink and NSL are taken into operation. Therefore, we see no competition concerns regarding NSL auctions including only NO2 on the Norwegian side of NSL.

6.2 Price formation if NSL auctions include more bidding zones than only NO2

A related question is the impact of different geographical extensions (only NO2 or more bidding zones) of NSL auctions. One issue is the possibility to design NSL auctions with such geographical extensions. Another issue is if a geographical extension will give a better (or different) price formation.

Separate NSL auctions can either be explicit or implicit auctions.

An explicit NSL auction means that there is an auction for the cross-border capacity itself. The contract in an explicit NSL auction relates to the right and obligation to transfer a certain volume on NSL in a certain direction in a certain hour.

An important consequence of explicit NSL auctions is that the power transfer to or from NSL cannot be arranged simultaneously with the NSL capacity acquisition. The power transfer to or from NSL has to be arranged by the market player in both NO2 and GB either before or after the explicit auction. It can be arranged internally, bilaterally or on power exchanges. The explicit NSL auction will be open only for market players who can arrange balance responsibility both in NO2 and GB.

A market participant in a Norwegian bidding zone outside NO2 will in addition have to arrange a power transfer between its bidding zone and NO2. This can be done by using the European day-ahead market coupling or intraday market coupling in the same way as power transfers between Norwegian bidding

zones are made today. Market participants outside Norway can also arrange their power transfer by using the European market coupling as long as their bidding zones are included in it.

Regarding explicit NSL auctions, we see two theoretical possibilities to achieve the inclusion of more Norwegian bidding zones than NO2. One possibility is that the balance responsibility for power transfer to/from NSL can be performed outside NO2. The balance responsibility can in such an alternative also be performed in one or more other Norwegian bidding zones. Another possibility is that the balance responsibility has to be performed in NO2 but that a successful bidder has the right to trade this volume for free between its bidding zone and NO2. In economic terms, both alternatives are equal to automatically donate an EPAD combination to successful NSL bidders. Such arrangements have no practical consequences as long as there is no congestion between the other bidding zone and NO2 and the prices in the other bidding zone and NO2 are equal. However, the function of the market will be disturbed when there is congestion and the prices are not equal.

The arrangements described above are beneficial to market participants with NSL explicit auction contracts, but they will not create a level playing field with other market participants. The only way to combine such arrangements with a level playing field is that also other market participants can choose the same arrangements. This will in practice be the same as a full merger of NO2 with one or more other Norwegian bidding zones.

The issue of enhanced geographical extension in explicit NSL auctions is thus the same as if NO2 shall be merged with one or more Norwegian bidding zones. Article 14 in the new regulation (EU 2019/943) on the internal market for electricity demands that a bidding zone review shall be carried out and includes rules for the bidding zone review. Criteria for reviewing bidding zone configurations are given in Article 33 in the CACM regulation (EU 2015/1222). The Nordic TSOs presented 26 August 2019 alternative configurations to be considered in the bidding zone review process. A merger of NO2 with other bidding zones was not among the alternatives to be considered.

Our conclusion is that there are no relevant possibilities to include more Norwegian bidding zones than NO2 in explicit NSL auctions. An explicit auction is an auction for capacity between two areas.

The issue of enhanced geographical extension in implicit NSL auctions is different. The market coupling in an implicit auction means a common matching of the bids from the concerned bidding zones and simultaneous calculation of zonal prices and cross-zonal power flows.

The more participants in an implicit NSL auction, the more can the efficiency of the auction be expected to increase. A trading solution for NSL which includes more interconnectors than NSL or more bidding zones than NO2 is therefore attractive. It has been outside the scope for our study to analyse the possibilities for and effects of implicit NSL auctions that include also interconnectors between Great Britain and the Netherlands, Belgium or France. However, such alternatives are probably not possible to realize so soon that they can be implemented already when NSL is taken into operation.

However, more bidding zones than NO2 in an implicit NSL auction gives rise to problematic challenges. Continued Norwegian participation in the European market coupling must not be at risk. The CACM regulation and the new EU regulation on the internal market for electricity do not forbid other day-ahead or intraday markets in addition to the European day-ahead market coupling (SDAC) and intraday market coupling (SIDC). The principles and rules that are given in the regulations are so strict and detailed that the possibilities to design cross-border supplementary trading solutions are very limited.

The most important challenge concerns capacity allocation between bidding zones included in SDAC. A methodology for Nordic flow-based capacity calculation is now under development. The aim of flow-based calculation is to provide maximum available capacity to the day-ahead market within the

operational security limits. Power flows from internal trade within a bidding zone and trade with bidding zones not included in SDAC are considered as a fixed input to the capacity calculation. Best forecasts are incorporated in a reference scenario and remaining available margins on critical network elements are calculated. Flow-based market coupling means that all power trade between bidding zones compete for the use of scarce capacities. The allocation is done in such a way that social welfare is maximized.

This means that power flows related to explicit NSL auctions or implicit NSL auctions including only NO2 can be treated in the reference scenario in the same way as power flows related to internal trade within NO2.

However, implicit NSL auctions including more Norwegian bidding zones than NO2 means that capacities are allocated outside the flow-based market coupling to some trade between Norwegian bidding zones. This should not be problematic as long as it not affects SDAC trade between these bidding zones. This is the case as long as there are no congestions between the bidding zones, i.e. the bidding zones can be merged. In hours when there are congestions and SDAC trade can be affected, the situation is totally different. It is not clear that such a situation is in accordance with the CACM regulation.

There are also national and European competition issues. On what ground can participants in one or a few Norwegian bidding zones near NO2 get a special allocation of scarce capacities between bidding zones that are not available on the same terms for other participants? It is also a European competition issue. Are participants in other countries discriminated in such an alternative?

The most efficient price formation will of course be obtained if NSL can be a part of the European market coupling. The use of all interconnections and day-ahead prices in all zones will then be established in the same implicit auction. However, a separate trading solution has to be established for NSL if the UK is not allowed to take part in the European market coupling.

There will be no systematic difference in NO2 prices dependent on whether NSL is within the SDAC auction or whether it is a separate NSL auction as long as the NSL auction results in the same power flows on NSL. The issue of efficient reservoir management in NO2 is the same. The key parameters determining NO2 prices are precipitation and demand in NO2 together with interconnection capacities and prices in adjacent bidding zones, including the British market. The number of auctions covering NO2 and the liquidity in such auctions have no systematic impact on NO2 prices unless one arrangement results in significant barriers to participate in any market arrangement for some market participants.

As concluded above, we see no relevant possibilities to include more Norwegian bidding zones than NO2 in explicit NSL auctions. An explicit auction is an auction for capacity between two areas.

It is conceivable to design implicit NSL auctions including more Norwegian bidding zones than NO2. However, the possible solutions mean that capacities are allocated outside the flow-based market coupling to some trade between Norwegian bidding zones. Such splitting of capacities will create inefficiencies in the price formation, and it is unclear if it is in accordance with the CACM regulation. We see no reasons that implicit NSL auctions including more Norwegian bidding zones than NO2 will give a more efficient price formation than an NSL implicit auction including only NO2 on the Norwegian side of NSL.

Our analysis regarding competition in NO2 showed no competition concerns regarding NSL auctions including only NO2 on the Norwegian side of NSL. The reason is that the competition in NO2 is enhanced by the extensive interconnections between NO2 and other bidding zones. The NO2 competition will be even better when NordLink and NSL are taken into operation.

Market participants in other bidding zones can take part in implicit NSL auctions including only NO2 on the Norwegian side of NSL via two different routes. The easiest one will be to buy or sell the relevant quantity in NO2 (NSL) and do the opposite in NO2 (SDAC). This alternative is open to all registered participants on a NEMO serving NO2. Alternatively, if the participants consider selling production or purchase for consumption in a different bidding zone than NO2, all participants in SDAC can arrange a "power transfer"[1] to or from NO2. This can be done in SDAC by placing opposite bids in NO2 and their own bidding zone. The "power transfer" can be arranged without other risks than price risks for the "transfer" between their own bidding zone and NO2 if the results of the NSL auction are known before SDAC. From this perspective, an NSL auction before SDAC is preferable for market participants in other bidding zones than NO2.

[1] This «transfer» is not to be understood as an explicit physical transfer between bidding zones by individual market participants. In SDAC which is an implicit auction, the cross-border capacities are taken into account when flows between bidding zones and prices in each bidding zone are determined. The market participants trade in their local bidding zone and their price risk is the price difference between their local bidding zone and the NO2 price. This strategy does not require that there is cross border capacity between their local bidding zone and NO2.

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