FINAL REPORT

DK1-DE COUNTERTRADE MODELS IMPACT ASSESSMENT

Date:
29th of November 2017

Contents

1. Executive summary

The Joint Declaration agreed on between the Danish and German Ministries aims to gradually make the full capacity of interconnectors between Western Denmark and Germany available for electricity trade as soon as the relevant infrastructure development has been completed. In the interim period, the cross-border electricity trade capacity available for the market shall be increased in a stepwise approach. In case the agreed minimum capacity cannot be physically transported due to grid constraints, countertrading will be used to avoid congestions in the grid while ensuring the agreed minimum level of trade in every hour. The relevant transmission system operators of both countries, TenneT and Energinet are jointly responsible for the implementation of the Joint Declaration.

Currently both TSOs are using existing measures to secure the necessary amounts of countertrade. With increasing minimum capacities and the related risks of having to perform larger amounts of countertrade, existing measures might, however, not be suitable in the longer term. The TSOs have been asked by the regulators to provide an impact assessment of the different possible models for countertrade to the regulators no later than by the end of the pilot phase, i.e. 1st December 2017.

Six different countertrade models were analyzed as part of this impact assessment as summarized in Table 1 below. Relevant for both TenneT and Energinet are the CoCA model and the intraday auction models (opening and closing auctions). Relevant for Energinet only are the "trading on the intraday market" and the "special regulation" models. TenneT is already now trading on the intraday market and the special regulation regime is something that is not applicable on the German side of the border.

Model	Market	Relevant for
Counter Capacity Allocation (CoCA)	Intraday market by introducing explicit auction of capacity between day-ahead market and start of intraday market	TenneT, Energinet
Intraday Opening auctions	Intraday market by introducing regional or pan-European opening auctions before start of continuous intraday market	TenneT, Energinet
Intraday Closing auctions	Intraday market Intraday market by introducing regional or pan-European closing auctions before gate closure for each hour	TenneT, Energinet
Energinet and TenneT active on the intraday market	Intraday market – continuous trading	Energinet, already currently used by TenneT
Special Regulation without capacity auctions	Regulating Power market	Energinet
Special Regulation with capacity auctions	Regulating Power market	Energinet

Table 1: Overview of countertrade models analysed in impact assessment

Stakeholder involvement in the analysis of the models has been ensured through two workshops, individual discussions and the inclusion of written comments received by the TSOs.

By providing for the stepwise increase in capacities given to the day-ahead market, the Joint Declaration intends to facilitate trade through a more efficient use of the interconnector between Germany and Western Denmark. Giving capacity to the day-ahead market usually has two effects: (1) prices are increased in the exporting area(s), while prices are decreased in the importing area(s) and (2) the TSOs receive an income from the congestion rent on the impacted borders.

The analyses of the different countertrade models included in this impact assessment show that the effect of higher prices in the day-ahead market in the exporting area(s) will be diminished by arbitrage between day-ahead and subsequent markets (intraday and/or balancing market) when capacities are only “virtual” and the need for countertrade can be predicted by the market. Market participants will position themselves in the day-ahead market, i.e. open up positions that they can close in the subsequent markets by providing upward and downward regulation.

This arbitrage effect will happen in all models, however, the exact size cannot be predicted as it will depend on how easy it is to predict the amount of countertrade needed and the likelihood of being able to benefit from the countertrade, either by being chosen/activated to provide the necessary countertrade or by being able to profit from a favorable imbalance price.

2. Introduction

The Danish Ministry of Energy, Utilities and Climate and the Federal Ministry of Economic Affairs and Energy of the Federal Republic of Germany together with the Danish Energy Regulatory Authority (DERA) and Bundesnetzagentur have agreed on a Joint Declaration[1].

The Joint Declaration aims to gradually increase the capacity between Denmark West (DK1) and Germany (DE) available to the day-ahead market by securing a minimum of available hourly import and export capacity (referred to as minimum capacities) in each hour on the interconnector.

The Joint Declaration was launched on the 3rd of July 2017 with a pilot project lasting until the end of November 2017, and will until 2020 increase the minimum capacities in a stepwise approach, as Figure 1 shows.

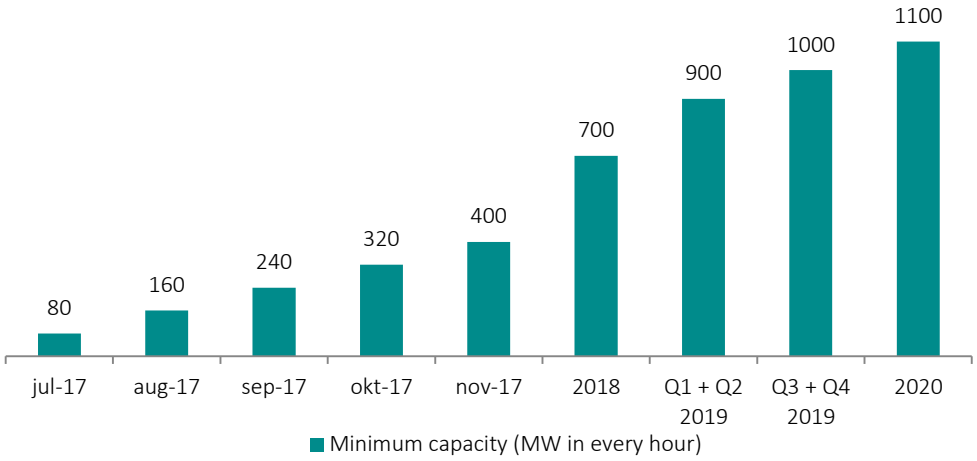

Figure 1: Required minimum of import- and export capacities on DK1-DE

Energinet and TenneT, as the relevant TSOs, are jointly responsible for the implementation of the Joint Declaration. The Joint Declaration specifies that the TSOs shall, in case of physical congestion, conduct countertrade to secure the minimum capacities. Countertrading is a market-based mechanism which is more transparent than redispatching[2]. Due to the special topological situation on the border DK1-DE countertrading is possible and best practise. Currently, this countertrade is achieved by using existing methods on both sides of the border. In Denmark West, Energinet uses the special regulation regime as part of the Nordic Regulating Power market and in Germany, TenneT acquires the necessary resources in the German intraday market.

With substantial increase of minimum capacities in the medium to long-term, existing methods might not be sustainable from a system security and cost-efficiency perspective. Therefore, the TSOs have decided to prepare an impact assessment of potential countertrade models, which will form the basis for deciding on which model to use until 2020. The time plan for this pro-

[1] http://efkm.dk/aktuelt/nyheder/nyheder-2017/juni-2017/dansk-tysk-aftale/
https://www.energinet.dk/Om-nyheder/Nyheder/2017/06/14/Faelleserklaering-sikrer-kapacitet-paa-dansk-tysk-graense-paa-1100-MW
https://www.tennet.eu/de/news/news/guaranteeing-minimum-available-hourly-capacities-for-de-dk-west/

[2] Countertrading is considered to cover measures with the objective to relieve physical congestions between two bidding zones, where the precise generation or load pattern alteration is not pre-defined. Redispatching is considered to cover measures with the objective to relieve physical congestions by changing particular generation and/or load schedules. Specifically, this refers to one or several TSO(s) requesting, when congestion appears, some generators (or certain consumers) to start or increase production and some other generators to stop or reduce production, in order to maintain the network security.

cess is shown in Figure 2. The deadline for submission of a final methodology for relevant NRA approval is in March 2018.

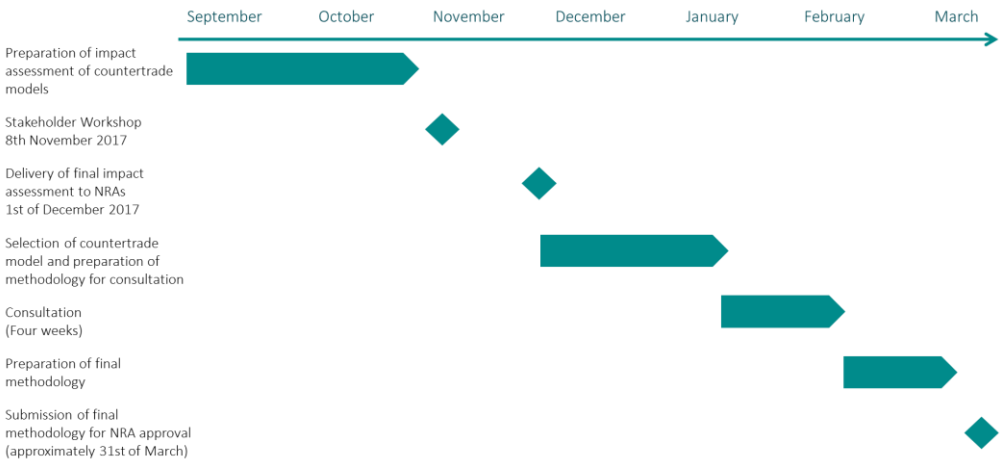

Figure 2: Process description for countertrade model selection

It is envisaged to revise the Joint Declaration 12 months prior to the end of 2020. Thus, at the point of deciding on a countertrade model in 2018, the TSOs still would have to assume that the need for countertrading would no longer exist after 2020.

The TSOs have chosen to conduct the impact assessment qualitatively based on stakeholder inputs and experts' evaluation, as there is little experience with minimum capacities and a lack of sufficient data or simulation models to evaluate the quantitative effect of the countertrade models. Energinet and TenneT have contracted the consultancy firm Consentec to perform an overall quality assurance of the assessment with a special emphasis on the description of arbitrage possibilities between markets.

The input for this impact assessment is based on the current work between the two TSOs and feedback from market participants at Energinet's workshop on the 7th of September 2017, the stakeholder workshop held on 8th November 2017 in Copenhagen as well as bilateral feedback received from stakeholders.

The impact assessment starts with a short introduction of the background in chapter 3, which contains an explanation of the current capacity allocation method used at the DK1-DE border with the new minimum capacity requirement in place as well as the scope of countertrading. In chapter 4 possible markets and models for providing countertrade are described. Chapter 5 introduces the overall framework of the impact assessment and introduces the evaluation criteria, which shall be used to assess the different models. The following chapters 6, 7, 8, 9, 10 and 11 each describe individual countertrade models and evaluate them according to the criteria listed in chapter 5. The models are summarized in chapter 12. In addition, chapter 13 describes potential combinations of countertrade models. Finally, the weighted scoring model, for comparing the models, is introduced in chapter 14.

3. Capacity calculation and allocation on DK1-DE with minimum capacities

For each hour TenneT and Energinet separately calculate the available Net Transfer Capacity (NTC) in both directions for the DK1-DE border. In case of reductions, the minimum of the two values is released to the market. The capacity offered to the market is determined by whichever TSO calculates the lowest transmission capacity on its side. The TSOs have to respect a limitation set on capacity by each other, as the method is used to restrict the flow on the interconnector to a volume that does not endanger the other TSO's system security.

3.1 Day-ahead capacity and allocation

With the implementation of the minimum capacity requirements, the TSOs have to secure a day-ahead NTC at the same or at a higher level than the minimum capacity in each hour for both import and export capacities as specified in the Joint Declaration. The capacity to the day-ahead market is defined as the highest value of either the day-ahead NTC or the minimum capacity:

Day-ahead capacity = MAX ((day-ahead NTC – nominated PTRs[3]); (minimum capacity - nominated PTRs))

Following this methodology, if one of the TSOs calculates an import and/or export NTC on the border for a given hour, which is lower than the level of minimum capacity specified in the Joint Declaration, the TSOs are obliged to disregard the calculated NTC value for the day-ahead market, and instead increase the capacity to the level specified in the Joint Declaration.
On the other hand, if the calculated NTC is higher than the level of minimum capacities, the Joint Declaration is disregarded, and the calculated higher NTC is released to the market.

The Joint Declaration covers both directions at the border, which implies that TenneT and Energinet will have to secure the minimum capacities in both the import and export direction.

The minimum capacity requirement applies only to the day-ahead market. The Joint Declaration's intention is to secure day-ahead prices that reflect a capacity situation at the DK1-DE border without limitations imposed by internal grid elements. Given the fact that minimum capacities are applied in situations where the internal grid cannot sustain the actual physical flow resulting from the day-ahead market, the minimum capacity flow cannot result in actual physical flow, but needs to be countertraded by the TSOs. The minimum capacities apply, when the reductions are caused by internal congestions, however, in hours with direct outages of the exact interconnectors between DK1-DE, the TSOs can disregard the minimum capacities.

3.2 Intraday capacity and allocation

The capacity for the intraday market depends on the results from the day-ahead market.
In normal situations, the left-over capacity from the day-ahead market is given to the intraday market. However, in hours of minimum capacities, the TSOs apply the calculated NTC from the day-ahead market by default and disregard the minimum capacities in order to secure that no more capacity is allocated in the intraday market, than what can be physically applied. Therefore, the allocation of capacity on the border will in all cases reflect the NTC.

3 "Nominated PTR" are physical transmission rights, sold in the long-term market and nominated by the owner.

The available transmission capacity (ATC) in the intraday market will be readjusted according to already allocated capacity (AAC) and continuously updated with the intraday trade (intraday allocation) to the following equations:

Available northbound intraday capacity:

$$ATC_{DE\rightarrow DK1} = NTC_{DE\rightarrow DK1} - AAC_{DE\rightarrow DK1} + AAC_{DK1\rightarrow DE} - Intraday\ allocation_{DE\rightarrow DK1} + Intraday\ allocation_{DK1\rightarrow DE}$$

Available southbound intraday capacity:

$$ATC_{DK1\rightarrow DE} = NTC_{DK1\rightarrow DE} - AAC_{DK1\rightarrow DE} + AAC_{DE\rightarrow DK1} - Intraday\ allocation_{DK1\rightarrow DE} + Intraday\ allocation_{DE\rightarrow DK1}$$

3.3 Scope of countertrade

The need for countertrade is based on the results from the day-ahead market and whether the scheduled flow creates physical congestions in either TenneT's or Energinet's internal grid. In hours with physical congestion, the TSOs respectively activate upward regulation on one side of the congestion and activate downward regulating power on the other side. The use of up- and downward regulation depends on the direction and volume of the scheduled flow.

For example, if the day-ahead market results in a flow from Denmark West to Germany, but TenneT experiences internal congestions, TenneT can initiate a countertrade with Energinet. Energinet will provide the downward regulation in DK1, and TenneT will purchase sufficient upward regulation within their control area to compensate for the limited flow from DK1.

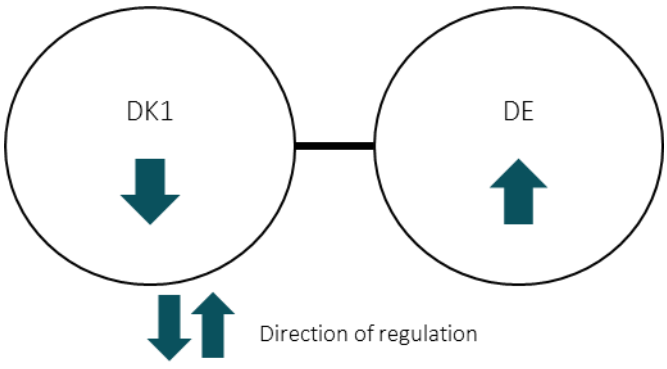

Figure 3: Countertrade between bidding zones

In the hours with physical congestions, the amount of MWh to be countertraded is, as written below, based on the difference between the calculated NTC, the minimum requirements and the scheduled flow resulting from the day-ahead market:

Countertrade capacity = MAX ((Nominated PTR + Flow day-ahead) – day-ahead NTC; 0)

The above formula is valid for all countertrade models.

The scope of countertrade is only related to the activation of sufficient amounts of up- and downward regulation to relieve the congestion at the border without further consideration of internal congestions. The countertrade and redispatch to relieve internal congestions are conducted by TSOs in their daily balancing.

As mentioned, the Joint Declaration states that Energinet and TenneT shall secure the minimum capacities in both directions, i.e. import and export. Currently, the dominant case is a countertrade against flow from DK1 to DE, where TenneT is responsible for providing upward regulation in their control area, and Energinet is obliged to secure downward regulation within their control area. However, it is also likely that a flow from DE to DK1 will have to be countertraded, i.e. Energinet shall provide upward regulation and TenneT shall provide downward regulation. This would be the case, if either TenneT is not able to export electricity to Denmark, or if Energinet is not able to import the electricity from Germany due to internal congestions. Providing upward regulation is especially of great concern in Energinet's control area, as upward regulation capacity is already bought each day to restore an unplanned outage of the largest element, i.e. interconnector, in the grid.
The amounts of countertrade needed since the start of implementation of minimum capacities have been increasing steadily in line with the increase in minimum capacities for the months July, August, September and October 2017 as shown in Table 2:

	July 2017	August 2017	September 2017	October 2017
Hours with countertrade	57	80	70	355
MWh to be countertraded[4]	4.537	11.541	14.622	105.962

Table 2: Overview of countertrade from Joint Declaration, July – October 2017.

[4] MWh before Energinet performs mFRR imbalance netting.

4. Possible markets and models to provide countertrade

The minimum capacities have to be secured in the day-ahead market, which will, all other things being equal, have an effect on day-ahead prices in DE and DK1, as it secures that additional electricity can be sold from low-price areas to high-price areas. This effect is the main purpose of the Joint Declaration, and the countertrade should, as much as possible, not diminish or eliminate the effect on day-ahead prices.

The countertrade for guaranteeing minimum capacities to the day-ahead market can be handled in the intraday or the regulating power market.

Figure 4: Markets by which the countertrade can be conducted

Before describing the different models within these two markets, the following chapter provides an overall description of the considerations and impacts by providing the countertrade in either the intraday market or regulating power market, and the possible interaction between these markets and the day-ahead market. Lastly, this section provides a description of the different arbitrage opportunities between the markets, and their effect on the day-ahead market.

4.1 German and Nordic intraday markets

4.1.1 The present intraday markets

The current intraday markets are covered by the Nordic power exchange Nord Pool in the Nordics and by EPEX, a French-German power exchange, and Nord Pool in Germany. With the planned go-live of the Single European Cross-border Intraday Market Coupling (XBID) in Q1 2018 both power exchanges will provide their trading services in most European countries, thus enabling direct competition between trading platforms in the intraday market. As it is expected that the final countertrade model will be implemented from 2019, the following sections are in general written to reflect a situation with XBID, however, currently applied methods are described when relevant.

In Germany, the intraday market plays a different role than in Denmark. The intraday market is the only short-term market in Germany, where several products with different time resolutions are traded continuously. Since there are no voluntary bids in the regulating power market or a similar 'special regulations' market in Germany, there is a high liquidity in the intraday market.

According to §13(1) Energiewirtschaftsgesetz (EnWG), the German TSOs are allowed to act on the short-term markets for exercising countertrade. In order to fulfill the obligations from the EU Regulation 1227/2011 on wholesale energy market integrity and transparency "REMIT", all trades from TSOs have to be done from a special workplace. At TenneT, all trading processes are managed 24/7 by TenneT trading experts with special trading licenses. While exercising countertrade, TenneT is acting as a non-speculative and demand-driven market participant. In

contrast to other profit-driven market participants, TenneT's trading activities are not based on complex trading strategies and algorithms.

For the countertrade between Energinet and TenneT following the minimum capacities, TenneT currently starts trading the respective volumes on the German intraday market via a special workplace after the countertrade volumes are known (at approximately D-1 15:30). There are no special provisions on the way of trading regarding the timing and amount. It is up to the special workplace to decide on the trades depending on the respective intraday market situation.

The volumes traded in the German and Nordic intraday markets are significantly different. EPEX SPOT Intraday DE/AT markets reached all-time high 2016[5] with a total of 41 TWh traded, whereas in the Nordic Elbas market covering Denmark, Norway, Sweden, Finland, Lithuania, Latvia, Estonia and Germany total traded amounts reached 5 TWh in 2016[6].

Liquidity in EPEX SPOT is considered enough to provide the necessary up- and downward regulation on the German side[7].

By buying the necessary countertrade volumes in the intraday market, TenneT cannot determine the location and thus the impact on the overall grid of the activated production and consumption. From TenneT's point of view, this is not necessary as the Danish-German AC connection is a very special case in terms of topology. Since the border has a one-to-one correspondence between power plants and physics, it is possible to perform a countertrade and have full physical effectiveness. The critical network elements in TenneT's control area for the border DK1-DE are located in the area around Hamburg. Since there is strongly limited production capacity north of Hamburg available, there is only a low risk of activating this capacity with intraday countertrading what is also proved by the experience from recent years. This implies that the additional upward and downward regulation required in Germany can be purchased at the intraday market.

For the Nordic areas, the intraday market experiences several low periods with little trade and few MWh in turnover, as the following figure shows. While this does not indicate an especially liquid market, at least compared to the German market, Figure 5 also shows that there seems to be a trend towards both more trades and higher volumes over the last year.

[5] EPEX SPOT Press Release 11/1/2017: https://www.epexspot.com/document/36851/2017-01-11_EPEX%20SPOT_2016_Annual%20Press%20Release.pdf

[6] Nord Pool Spot 2016 Annual Report: http://www.nordpoolspot.com/globalassets/download-center/annual-report/annual-report_2016.pdf

[7] This includes the consideration of the split of the currently joint bidding zone Germany-Luxembourg-Austria, beginning 01 October 2018. The split will take place at the Austrian-German border.

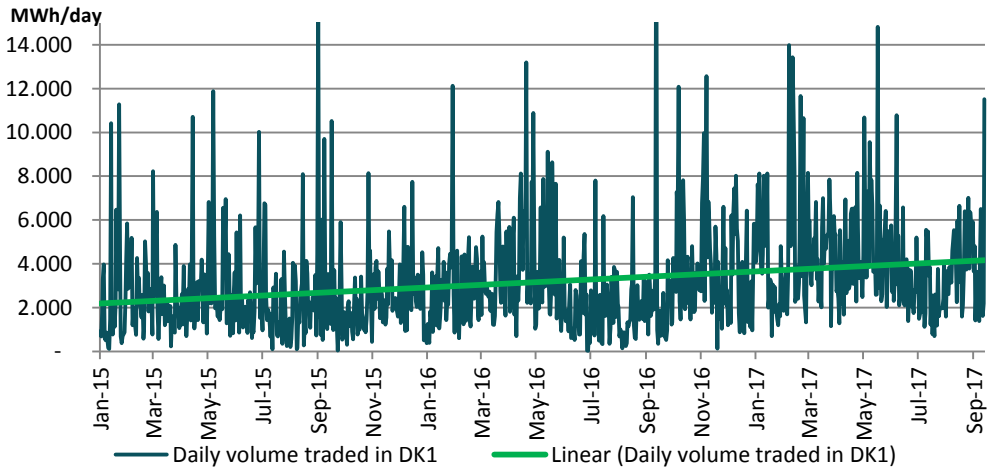

Figure 5: Buy and/or sell trades in the intraday market with market participants from DK1, 2015- September 2016.

It can be expected that if both Danish and German countertrade is traded in the intraday market, Energinet and TenneT will indirectly work as market facilitators, and increase the liquidity in the intraday market, and thereby the interest for Nordic participants to participate in the market.

In some situations, it will not be possible to select other bids than those provided in Denmark West or Denmark East. This will be the hours where there is a full export from all interconnectors from Denmark towards the Nordic, and it will therefore not be possible to export additional power to the rest of the Nordics (this is equivalent to providing downward regulation). These situations are likely to happen during periods with high wind, but on the other hand, if there is a lot of wind in Denmark West, then it would be possible to provide sufficient downward regulation.

The intraday market has no direct impact on the TSO operation and system security, and does not provide any new procedures or exchanges between the TSOs and Nominated Electricity Market Operators (NEMOs).

4.1.2 The future European Intraday Market

The future European Intraday market will consist of continuous trading and auctions, where especially the intraday auction is a new model in the Nordics.

On the 28th of August 2017, all TSOs submitted a proposal for a single methodology for pricing intraday cross-zonal capacity in accordance with Article 55 of the CACM GL (EU 2015/1222 establishing a guideline on capacity allocation and congestion management), which includes a cross-zonal intraday implicit auction at pan-European level and opens up for the use of a regional cross-zonal intraday implicit auction before an auction on the pan-European level. Capacity Calculation Region (CCR) Nordic suggests implementing a regional auction, however CCR Hansa (which includes DK1-DE border) has so far not proposed a regional auction besides the pan-European. The proposal has been submitted to all NRAs, and they can return with an approval or request for amendment no later than February 2018.

The timing of the pan-European auction following this proposal is closely related to the all-TSO proposal for intraday cross-zonal gate opening and gate closure times in accordance with Arti-

cle 59 of the CACM GL, which was submitted to the NRAs on the 28th of August 2018, but NRAs have forwarded the decision to ACER, whom will make the decision by March 2018[8]. The pan-European implicit intraday auction is to be arranged at the time of the cross-zonal gate opening time, i.e. before cross-border continuous trading. The proposal for intraday cross-zonal gate opening time suggests an opening time at:

- 15:00 in CCR Nordic
- 18:00 in CCR Hansa and CCR Baltics
- 22:00 in the remaining CCRs (Core, Italy North, Greece-Italy, South-West Europe, Ireland and United Kingdom, Channel and South-east Europe).

The above suggests that auctions in the intraday market are introduced in Europe, and the design suggested in section 7 is highly related to the European development. Furthermore, the TSO trade in the intraday market is also part of the current legislation, and there are not any proposed changes to this.

4.2 The Nordic Regulating Power Market

4.2.1 Introduction to the Nordic Regulating Power Market

Energinet is part of the liquid and well-functioning Nordic Regulating Power market, which operates on the same fundamental principles as the day-ahead market. On this market, a market price – regulating power price – is formed hour by hour, which will be identical in all Nordic bidding zones if there are no bottlenecks in the system. Balance Responsible Parties (BRPs) in the Nordics submit their up- and downward regulation to the Nordic TSOs on a voluntary basis, and TSOs combine the bids in a single merit order curve, from which they can activate the regulation in order to secure the physical balance of the power system and to relieve network congestions. The total amount of bids is displayed in real time updates on Nord Pool's homepage.[9]

This asset-based market closes 45 minutes before the operational hour leaving market participants 15 minutes to shift unused bids to the regulating power market after the closure of the cross-border intraday market.

The TSOs determine the activation of the regulating power based on the perceived imbalance, i.e. difference between total demand and supply, for the respective hours, and the regulating power price is set at the marginal costs of the last activated product/unit on the merit order curve.

Special regulation[10] is applied, when Energinet selects specific regulating power bids for upward and/or downward regulation disregarding the merit order list. This may occur either as a consequence of bottlenecks/restrictions in Energinet's or neighboring areas' grid. The instructions for the common Nordic Regulating Power Market[11] specify that bids used for network reasons such as congestions should not affect the Nordic imbalance prices. The instruction further states that the bids should be used for balancing purposes first and foremost, however,

[8] Decision from NRAs https://www.ceer.eu/eer_activities/all_regulatory_authority_decisions

[9] Nord Pool website: http://www.nordpoolspot.com/Market-data1/Regulating-Power1/Volume-of-Regulating-Power-Bids/ALL/Hourly/?view=table

[10] Described in Market Regulation C2: Balancing Market at Energinet https://en.energinet.dk/Electricity/Rules-and-Regulations/Market-Regulations

[11] Nordic Balancing Philosophy: https://www.entsoe.eu/Documents/Publications/SOC/Nordic/Nordic_Balancing_Philosophy_160616_Final_external.pdf

unused bids can be used for special regulation, i.e. mitigation of congestion, and these bids are settled according to pay-as-bid.

Towards the DK1-DE border Energinet uses manual Frequency Restoration Reserves (mFRRs) in DK1[12]. Statnett, Svenska kraftnät and Fingrid do not participate in the special regulation scheme towards TenneT. Therefore, Energinet has to consider the liquidity in DK1 to provide the up- and downward regulation.

The available capacity for downward regulation in DK1 currently is lowest during the summer and highest during the winter, as production of electricity from thermal power plants is bound to heat production, and the wind production is also higher during the winter period. Energinet has provided downward regulation towards TenneT the last few years, and the following figure shows the hourly average volume of downward regulation in DK1 from 2013 to September 2017, split between all hours and in hours with special regulation.

On a general average there has been over 1100 MWh available each hour in DK1 to provide downward regulation. The table also shows that in hours, where Energinet has activated special regulation towards TenneT, the average volume of bids is higher. This is due to the fact that special regulation historically has been activated during hours with excess winds, both in Denmark and German, which increases production in DK1 and thereby naturally provides more downward regulation bids. This could also indicate that the market for special regulation can predict hours with special regulation, and thereby adds more bids into the market. However, it has to be noted that the average volume of downward regulation bids in DK1 for hours with special regulation is based only a limited number of hours, and does not reflect the full year[13].

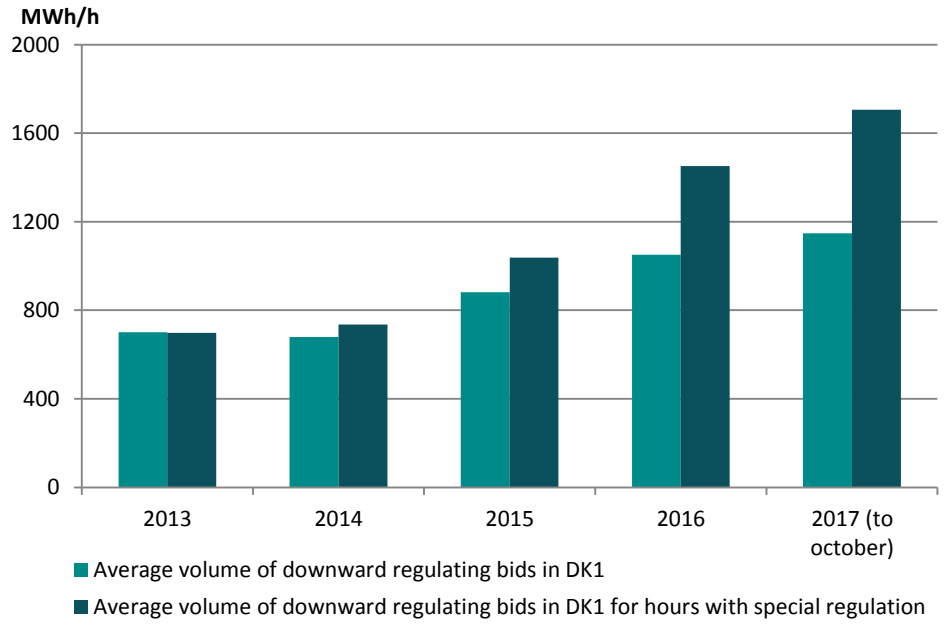

Figure 6: Average volumes of bids for downward regulating in all hours and in hours where special regulation was used.

[12] In principle also bids from DK2 can be used, however, the flow on the Great Belt connector is usually fully used in the direction DK1-DK2, which would be needed for providing downward regulation in DK2. Energinet is currently not allowed to reserve capacity for the regulating power market. In the rest of the document bids in DK2 will not be mentioned explicitly.

Figure 6 shows the hourly average volume of downward regulation in DK1 from 2013 to September 2017, split between all hours and in hours with special regulation.

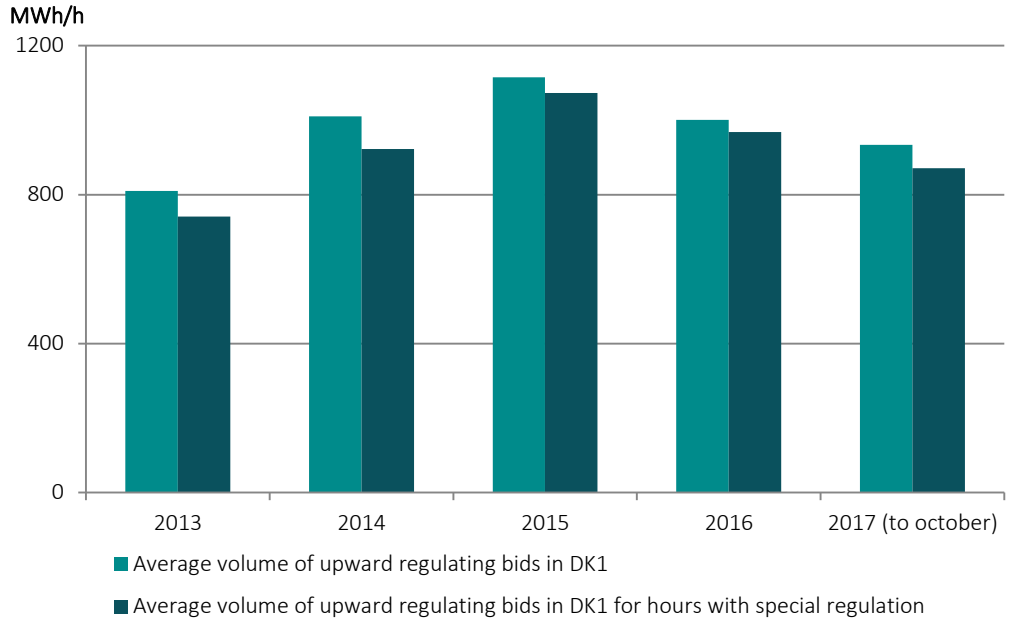

Figure 7: Average volumes of bids for upward regulating in all hours (approx. 8760) and in hours where special regulation was used.

On a general average there has been less than 1100 MWh upward regulation per hour in DK1. There is only a small difference between the hours with special regulation[14], which is due to the fact that Energinet only in rare situations has provided upward regulation towards Germany (see Figure 7).

The above figures are thus not sufficient to estimate the liquidity of the market to provide up- and downward regulation following the Joint Declaration. As stated, the volumes depend on the heat and wind production. Looking at the duration curve from January 2016 to October 2017, it shows that there was less of a total of 1000 MWh offered as downward regulation in 68 % of the hours, and as upward regulation in 54 % of the hours.

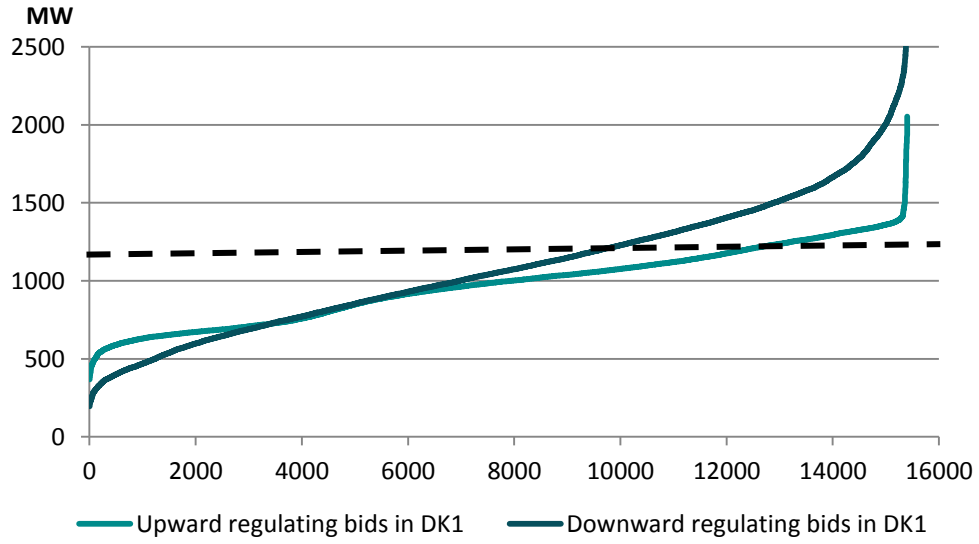

Figure 8: Duration curve of the regulating power bids in the DK1 market, January 2016 to October 2017

Based on these figures, there is a risk that the regulating power market using only DK1 bids will not be sufficiently liquid to provide the necessary downward regulation in all hours and at high minimum capacities. However, the implementation of the Joint Declaration could add more value to the market, and thereby facilitate investments to provide this regulating power, which might increase the volume of bids. However the investment in capacity for regulating power might be limited, as the Joint Declaration only runs until 2020.

As will be further elaborated in section 10.1 under special regulation, Energinet has the possibility to purchase the downward regulation capacity each morning and afternoon, which could provide a security for the delivery of the up- and downward regulation, however, at a given cost.

4.2.2 Use of Nordic bids for special regulation – Svenska kraftnät and Statnett response

The possibility of extending the market area for this specific type of special regulation to include also other Nordic bids would need to be agreed by the three other Nordic TSOs. After the workshop on the 8th of December, Energinet have received the following input from Svenska Kraftnät and Statnett on the use of special regulation for countertrading following the Joint Declaration.

The Nordic system operators activate regulating power manually via telephone to producers and large consumers. Regulating large volumes of imbalances in a very limited time period is already a challenging task for the operators in today's system. This is specifically related to internal constraints in the Norwegian grid that significantly constrain the operators' ability to utilize the available resources, as well as the complexity of finding the relevant resources. It should be noted that Statnett even today sometimes has 100-150 simultaneously activated bids. The manual process of activating a significant number of bids to handle large imbalances can often result in poor frequency quality and a system operated outside agreed security limits. Significant imbalances from Germany in addition to already existing challenges in the Nordic synchronous system would be detrimental to the frequency quality and system security.

Svenska kraftnät does not see a Nordic special regulation model as physically possible due to the fact that the guarantee of virtual capacity from DK1 to DE to a large extent will coincide

with high import of wind from Germany and Denmark to SE3 and SE4. When there is high import of wind to SE3 and SE4 Svenska kraftnät already today has an operational challenge with handling congestions that occur due to the west coast cut. Down regulation in Sweden in these situations will not be possible since it aggravates congestions and put system security at risk.

Further, Statnett and Svenska kraftnät cannot guarantee that special regulation resources will always be available for countertrading towards Germany. Balancing of the Nordic synchronous area will always have first priority. As it is impossible to obtain perfect regulation, the use of special regulation for counter trading would also utilize FCR and/or aFRR resources procured for balancing the Nordic synchronous area, with a further negative impact on system security. Finally, it is not possible to activate bids in price order in the Nordic region to cover German imbalances or planned countertrade. It is important that such bid activations do not affect the imbalance price and the bids should therefore be taken as special regulations. If bids are activated in price order, regulations done for Germany will be distributed in all price areas. This makes it challenging to separate the bids activated for Nordic imbalances from the bids activated for German imbalances. Before the imbalance price calculation can start, the volume and price of all the countertrades between all the price areas in the Nordic region must be set. There are no support systems for such trades today, and it is not practically manageable. We do not see activation of the most expensive bids from Nordic regulating power market as a viable alternative: activating the most expensive bids will give perverse incentives for bidding and potentially increase the price level for all bids and increase the imbalance prices in the Nordic market.

4.2.3 Effect on the Nordic Regulating Power Market

It is out of scope of this document to estimate an expected price effect on the Nordic Regulating Power market from the different countertrade models, it depends on whether the minimum capacities in the day-ahead market results in more or less MWh that can be regulated afterwards, i.e. the number of bids is static or not.

As the bids in the intraday market and the Nordic regulating power market are in principle the same, it can be assumed that market participants can offer their up- and downward regulating bids in the intraday market first, and if it not used, the market participant can offer the same bid in the Nordic regulating power market. Where and when bids will be offered will depend on the market participants' expectations about demand, liquidity and prices. If it is assumed that the minimum capacities will not result in more capacity for up- or downward regulation, and this the total number of bids will not change, a bid offered and activated in the intraday market will not be available for the regulating power market. This could have an effect on the prices in the Nordic regulating power market. It is assumed that the cheapest bids will be activated in the intraday market to provide the up- and downward regulation for countertrade, which will leave higher price bids available for the Nordic regulating power market and thereby increase prices in this market. On the other hand, higher prices in a market will provide signals to the market participants to invest and participate in the markets, which could also lower the prices in the Nordic market area. The minimum capacities do increase production in the Nordic, which all other things being equal, could be used for upward and downward regulated at a later stage.

Energinet does not require the BRP for production or consumption to be in balance after the day-ahead market. This could impose an indirect effect on system security, as BRPs can choose not to provide a balanced operational schedule, which could lead to higher imbalances to be

handled by Energinet. One of the recommendations from the "Market 2.0"[15] project was to remove the balance requirements from Energinet's market regulations, as it goes against the principles of allowing trade closer to the hour of operation. Therefore, the higher imbalances are seen as a calculated risk in Energinet. The imbalances will be handled as in a normal situation, and as this is handled in the entire Nordic system, and all Nordic bids can be used.

Prices in the regulating power market should, all things equal, be higher than in the intraday market. An analysis has been conducted based on historical market data, and the results are summarized in Table 3. To achieve comparable results, only hours with trade in DK1 in the intraday market were included in the calculation of the average regulating power price. This way the results reflect the average situation that the TSO would have faced if given the option to buy upward or downward regulation in the intraday or regulating power market.

Buying power in DK1 (average in EUR/MWh)			
	2015	**2016**	**2017**
Intraday market	26.8	29.4	30.8
Upward regulation in the Regulating Power Market	32.6	31.9	33.6
Difference	5.8	2.5	2.9
Selling power in DK1 (average in EUR/MWh)			
	2015	**2016**	**2017**
Intraday market	24.9	27.2	29.3
Downward regulation in the Regulating Power Market	22.2	24.7	26.7
Difference	2.7	2.5	2.6

Table 3: Average cost for either buying or selling power in the intraday market compared to buying upward or downward regulation in the regulating power market.[16]

Ideally, the use of special regulation for countertrade should not impact the prices for the Nordic balancing market. In general, special regulation uses the bids that have not been activated as part of the Nordic Balancing market. On the other hand, an extended use of special regulation, which is remunerated as pay as bid might have a detrimental effect on the prices for bids activated in the Nordic balancing market, where payments are based on marginal pricing. Using special regulation as the future model for countertrade in DK1 can introduce a distortion in the current balancing market, as market participants would then to a larger degree anticipate a settlement according to pay-as-bid, and thereby increase prices.

4.3 Effects of arbitrage between markets

4.3.1 Introduction to arbitrage

The main purpose of the Joint Declaration is to secure a minimum of capacities to the day-ahead market between German and West Denmark. The assumption behind the minimum

[15] Description of the project and report: https://en.energinet.dk/About-our-reports/Reports/Market-Model-2-0

[16] The data are weighted to the volumes traded in the intraday market and only hours with intraday trading in DK1 were included

capacities is to allow a flow from low price areas to high price areas, which will result in increased day-ahead prices in the exporting area(s), while prices are decreased in the importing area(s). It is this day-ahead price effect that the countertrade should, as much as possible, not diminish or eliminate.

Arbitrage means utilizing price differences of a product that occur because the product is traded at different places or different points in time. In the context of this impact assessment, the product is the capacity for scheduled power exchange between DK1 and DE, and the arbitrage potential arises due to price differences between the day-ahead market and the market used for countertrading. As an effect of arbitrage, the price difference between these markets is reduced, limiting the effect of the minimum capacities.

The fundamental market value of the capacity DK1-DE is determined by the physical capacity amount, i.e. the NTC. In situations when the minimum capacity exceeds the NTC, the value of the minimum capacity constitutes a “virtual” market value, and market prices approximate the market value.

A large potential for arbitrage exists, if the difference between the virtual price and the fundamental (NTC based) price is large. This potential is, however, only a theoretical figure, which cannot be observed in practice. In practice, market participants, anticipating this price difference, adjust their bids in the day-ahead market to benefit from the situation. In an ideal market and leaving aside further price influences (such as changes in RES forecast), this behavior of the market participants (arbitrage) will eliminate the price differences.

In general, the possibility to use arbitrage and thus eliminate price differences between markets as much as possible is considered to be a positive side effect of choosing market based measures. The problem with the minimum capacity agreement is, however, that the capacities provided in the day-ahead market under the agreement are not physical-based capacities, but rather virtual ones, which would not have been (and will not be) implemented in operations.

Market participants have developed an advanced understanding of the correlation between high-wind or other situations that require capacity limitations on the DK1-DE border given the existing limitations in the German grid. Thereby, the times where TSOs need to countertrade can be predicted with a rather high certainty. This knowledge about the virtual capacities and corresponding countertrade requirements opens up for arbitrage possibilities between the day-ahead, intraday and regulating power markets that can in the extreme case eliminate the price effect in the day-ahead market.

In the concrete case on the DK1-DE border, the opportunities for arbitrage arise if the combined profit from day-ahead market and countertrading can be maximized by altering the bidding behavior on the day-ahead market compared to the situation without minimum capacity.

Opportunities for arbitrage can for example be to place buy and sell bids in the day-ahead market in order to create a better position to provide countertrade in the intraday market or regulating power market. This could be facilitated by either consumption or production, as both can provide up- and downward regulation in the intraday market. In a case, where the market participants expect a need for downward regulation in a specific area, the BRP for production in the day-ahead market can plan to submit more production, or to offer the same production for a lower price, in order to be selected in the day-ahead market. These BRPs will provide the excess capacity in the intraday market as downward regulation, thereby both re-

ceiving the day-ahead market price and either buying their "production" in the intraday or regulating power market.

	Potential behavior of the BRP in the day-ahead market	
	BRP for consumption	BRP for production
Need of upward regulation in the intraday/regulating power market	Provide more consumption	Withhold production
Need of downward regulation in the intraday/regulating power market	Withhold consumption	Provide more production

Table 4 Overview of the different BRP incentives in the day-ahead market

From a consumption side, the BRPs for consumption can, if they expect a need for downward regulation, bid less consumption in the day-ahead market, and then either provide the consumption as downward regulation in the intraday market or remain imbalanced and speculate on a lower imbalance price than the day-ahead market price. These arbitrage opportunities exist for upward regulation as well.

While some degree of arbitrage is considered to be within market based, but conditions, REMIT clearly addresses manipulation [17] on wholesale energy markets to also include artificial prices at a level not justified by market forces of supply and demand, involving withholding availability of production, storage or transport capacity and demand, as well as placing and withdrawal of false orders. The monitoring of market behavior is the responsibility of NRAs, and they thus have all means to investigate if there is ground for suspicion.

The above applies equally to all market participants; on the other hand, this behavior is considered to be further enhanced due some specific Danish circumstances, described in the following paragraph.

4.3.2 Danish one- and two price system and mFRR netting

There are two elements of the Danish regulating power market that currently enhance these incentives for arbitrage even more for the BRPs for consumption.

The first element is caused by the different models for settlement of production and consumption imbalance; the one- and two-price system[18]. A BRP for consumption's imbalance is settled at the regulating power price, irrespectively of the system's total imbalance (one-price system). A BRP for production's imbalances is on the other hand dependent on the system's total imbalance. BRPs imbalances in the same direction as the system's total imbalance, which consequently contribute to the total imbalance of the system, are settled at the area's regulating power price. If the BRP imbalance is in the opposite direction of the system's total imbalance and consequently remedies the total imbalance of the system, it is settled at the area's electricity spot price (two-price system). A BRP for consumption will therefore, overall, have less risk in an arbitrage situation than a BRP for production. However, this imbalance settlement is harmonized across the Nordics, and any change to it would have to be coordinated between all

[17] REMIT whereas no 13 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011R1227&from=DA

[18] Described in Market Regulation C2: Balancing Market at Energinet https://en.energinet.dk/Electricity/Rules-and-Regulations/Market-Regulations

Nordic TSOs. Therefore, it is out of scope of this countertrade model selection to alter the pricing system for imbalance.

The imbalance settlement system was also discussed in the "Marketmodel 2.0" process[19], and the recommendation was to align the imbalance settlement to a one-price system, which has been further supported by the common Nordic TSO report "Full Cost of balancing". The change of the imbalance settlements is expected to be completed as part of the implementation of the European Commission Electricity Balancing guideline. Expected timeline is around the end of 2020. There is, on the other hand, nothing in the regulations or the market regulations by Energinet, which prevent the BRPs for productions, to shift their production imbalances to consumption imbalances, if the market participant also is a BRP for consumption. Further this is mainly a benefit for larger market participants, as they generally are both BRP for consumption and production.

The second element is the effect of imbalance netting. Imbalance netting is the process agreed between TSOs that allow for the avoidance of simultaneous activation of balancing power, i.e. mFRR, in opposite directions by taking the respective and adjacent area control imbalances into account, in order to maximize social economic welfare. This implies that if one bidding zone has a need for upward regulation, whereas the adjacent bidding zone has a need for downward regulation, the TSOs can agree to net the different regulation needs and this way secure that only the needed amount of either upward or downward regulation is activated.

Energinet is practicing manual imbalance netting of mFRR towards the Nordics and automatic imbalance netting of aFRR towards TenneT, as part of the IGCC project[20].

Energinet is currently, with special regulation, using mFRR bids to conduct the countertrade towards Germany, and thereby also using the imbalance netting with TenneT control area. If TenneT requests downward regulation in DK1, Energinet will use the excess production from Germany to balance the Nordic areas, if upward regulation is required there and if interconnector capacity towards the Nordic area is available. This reduces the need for mFRR activation both in Denmark and in the other Nordic bidding-zones without affecting operational security.

The use of imbalance netting, while cost-efficient from a system point of view, increases the incentive for consumption BRPs to remain imbalanced after the day-ahead market, i.e. bid less consumption than actually planned, as the risk of meeting a high imbalance price because of the need for upward regulation in the Nordics is substantially decreased by the imbalance netting. Imbalance netting is also described in the Electricity Balancing guideline, in Article 15, where TSOs shall operate the imbalance netting process. The use of imbalance netting for both mFRR and aFRR with the development of pan-European Market will, all things considered, lead to a larger use of netting, also in DK1.

The arbitrage possibilities between the markets are thus of great concern when choosing the future countertrade model, as they might decrease the effect on the day-ahead market from the minimum capacities. However, as will be discussed further below, neither of the suggested models will completely eliminate this risk.

19 Description of the project and report: https://en.energinet.dk/About-our-reports/Reports/Market-Model-2-0

20 Details of the ENTOS-E project: https://www.entsoe.eu/major-projects/network-code-implementation/electricity-balancing/igcc/Pages/default.aspx

The fact that market participants can predict the need for countertrade with some certainty together with a one-price imbalance settlement for consumption BRPs and the use of imbalance netting, provides a baseline incentive for arbitrage between markets, which is independent of the countertrade model chosen. The closer the timing of countertrade is to the operational hour, the lower the willingness to speculate might be, as there is less time for correcting imbalances. The market size has a detrimental effect on the willingness to speculate. Likewise, a model that does not result in additional amounts of imbalance netting because of the minimum capacities, such as the intraday models, has a detrimental effect on the arbitrage possibilities. Imbalance netting is used in the balancing market, thus by using intraday market countertrade models, the full countertrade will be purchased here.

4.4 Back-up solutions

If the selected model for countertrade will fail, i.e. in case of technical failures, shortage in bids, TenneT and Energinet have specified the following methods, to ensure system security.

As a back-up solution for any other selected model, TenneT will use the current countertrade process. This results in TenneT being active in the intraday market. If the liquidity of the German intraday market is not high enough or if there is a failure in the intraday trading, TenneT will conduct redispatch to ensure the needed up- or downward regulation. As a last resort measure TenneT is able to cut off German wind power plants in order to ensure system security before real time. After real time, imbalance netting and activation for control reserve will be applied.

Currently, Energinet would suggest to use special regulation as back-up if an intraday model is used, but it has to be further investigated if these methodologies can concatenate. This will be addressed with the specification of a new countertrade model.

5. Impact assessment of different countertrade options

As the minimum capacities increase over time, it is necessary to consider alternatives to the current process for guaranteeing minimum capacities. According to the Joint Declaration, the TSOs have been asked to submit a description of the potential technical implementation of the different countertrade models, they consider by the end of the pilot phase on the 1st of December 2017. At a workshop held on 7th September 2017, four different countertrade models were discussed with stakeholders in order to achieve a detailed overview of the pros and cons of each model. In addition, potential evaluation criteria for selecting the final model were discussed.

Preparing a quantitative impact assessment is too challenging, as the TSOs only have limited experience and data available for the intraday market. Both in the intraday and regulating power market, current levels of liquidity can be poor indicators for the future development of the markets as an increase in demand for up- and downward regulation most likely will increase the liquidity over time. This can, for instance, be done by shifting bids from one market to another or by developing new flexibility on the production side, e.g. increased use of heat pumps and electrical boilers in district heating systems or additional wind and PV production that can be down-regulated. It is also rather difficult to anticipate the extent and form of arbitrage between markets in order to include effects here in the form of quantitative estimates in an analysis.

The models described in later sections of this analysis are not all equally relevant for both TSOs. In general, the Counter Capacity Allocation (CoCA) model and the implicit intraday auction require the participation of both TSOs in order to include the border directly in the countertrade. The option of Energinet using the continuous intraday market only mirrors in the DK1 market area what is already happening on the German side. Furthermore, the option of Energinet using the regulating power market is only applicable on the Danish side, because of the substantially different setup of the regulating power market in Germany. The use of redispatch resources in Germany is therefore not considered in this report.

The description of the regulating power market will therefore mainly be a description of the situation in Energinet's control area.

The following descriptions should thus be seen more as an expert evaluation based on input received from the stakeholders involved in the process and TSO internal expertise.

5.1 Evaluation criteria

The evaluation of and decision for a specific countertrade model will be based on the following criteria:

A. System security
B. Cost-effectiveness
C. Market access
D. Effect of arbitrage
E. Transparency

The sequence of the criteria listed above as well as the sequence in the evaluation of each model does not reflect a prioritized list from a TSO point of view.

A. System Security

The TSOs have the responsibility of maintaining and operating a grid. Each countertrade model will be considered and evaluated on its effect on system security. In relation to countertrade

system security can be impacted both by the potential non-availability of resources for up- or downward regulation and the lead time from the purchase of sufficient up- and downward regulation until real time.

B. Cost-effectiveness

The Joint Declaration specifies a cost cap for TenneT covering all costs related to the activation of up- and downward regulation. Independently of this cost cap, minimum capacities will need to be ensured by the TSOs.

The cost effectiveness will be a criterion for the selection of a countertrade model. Cost effectiveness both includes the cost for the purchase of each MWh of up- and downward regulation and a consideration of the implementation time and cost for a model.

C. Market access

Germany and Denmark are closely linked with neighboring countries, and the impact of the minimum capacities will affect the day-ahead prices, and thereby production, in these adjacent bidding zones. Additional export from DK1 to DE as a result of the minimum capacities will not only benefit production facilities in Denmark, but also the other Nordic Countries. The larger the market area applicable to countertrading, hence the higher the liquidity of the market for purchasing the necessary up- and downward regulation.
Market access, i.e. which market participants can participate to secure an open and non-discriminating model, is therefore one of the criteria for model selection.

D. Effect of arbitrage

One general concern for applying countertrade models is the risk that the day-ahead market price will not reflect the increased capacity at the border. The minimum capacities provide the possibility of arbitrage, as TSOs will include the capacity in the day-ahead market in order to buy up-and downward regulation at a later stage, to mitigate the congestion at the border. This could give an incentive for market participants to bid more production/less consumption in the day-ahead timeframe in order to offer this production and/or consumption for upward and/or downward regulation later. This examples and conditions were further described in section 4.3.

E. Transparency

Energinet and TenneT will always have to adhere to the requirements and guidelines from EU Regulation 714/2009 and the Danish law on energy supply (Elforsyningsloven). These regulations set the requirements for transparency, non-discrimination and non-distortion of competition. Therefore, the implementation of each model also needs to adhere to these transparency rules and regulations.

6. CoCA Model – Intraday market

One of the suggested models is the Counter Capacity Allocation (CoCA) Model, which is an additional daily auction with explicit capacity between DK1 and DE after the closure of the day-ahead market and before the intraday gate opening at the border.

6.1 Overall description

This countertrade model was developed by Energinet and TenneT. The principle behind the CoCA model is to allow market participants to execute countertrade on behalf of the TSOs.

Capacity for countertrade is auctioned as a physical transmission obligation (PTO), which is an explicit product for the respective direction. The bids from market participants are aggregated in a single bid curve, and all accepted bids are settled at the marginal price in the auction.

The PTO commits its holder to transport power in the respective direction. The PTO is not covered by Use-It-Or-Sell-It (UIOSI) and cannot be used to transfer system capabilities, i.e. balance products. The transmission obligation will be nominated automatically before the intraday market opens, and only Danish (DK1) and German market participants can buy PTOs. Furthermore, it is expected that the price of a PTO will be negative, i.e. the TSOs pay the market participants.

The preliminary suggested process for CoCA is shown in Figure 9:

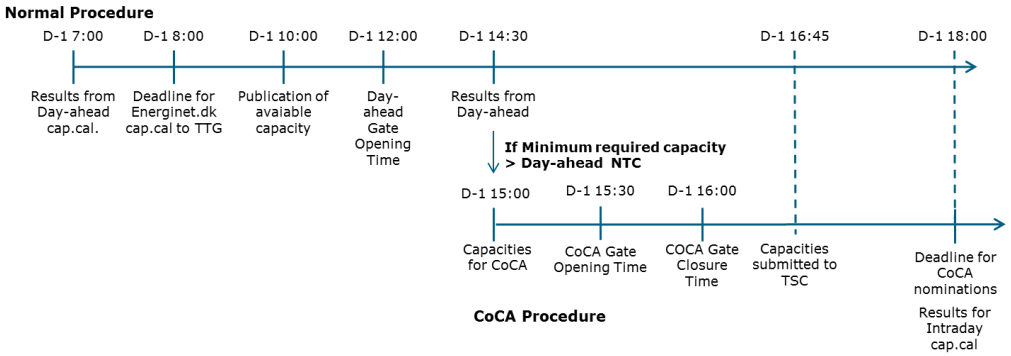

Figure 9: Suggested process for the CoCA model

The market participant holding a PTO is responsible for buying the up- and downward regulation on either side of the border and can use both bilateral trades and the intraday market.

Although the auctioning of (long-term) transmission rights is not new for the market, the additional step added through the CoCA model is not part of any future planned development of the European markets. It would therefore add a new feature into an already highly complex market setup of intraday auctions and continuous intraday trading that will have to happen in parallel.

The CoCA model can be compared to the auctioning of Physical Transmission Rights (PTRs), however the PTO from the CoCA auction cannot be seen as forward capacity, as it is sold after the day-ahead market. The CoCA is therefore not covered by the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation (FCA GL"). The auctions is also held between the day-ahead market and the intraday market, however there is no current set up or similar methodology coming from the CACM GL. It is therefore considered that a regulatory approval of the CoCA is to be made outside the scope of

European guidelines. A methodology is to be approved by relevant NRAs, following the current legislation.

6.2 Evaluation based on criteria

A. System security

As all the countertrade will be handled in the intraday market, there is no direct effect on system security and system operation. The additional physical flow resulting from the day-ahead market is reversed in the intraday market. As with all intraday market models, there is a risk of trades not reflecting actual production and consumption and thus leaving imbalances to the Danish regulating power market. In case this model is chosen, this behavior needs to be monitored closely. On the other hand, Energinet has access to the whole Nordic balancing market in the case of imbalances resulting from the intraday market, which reduces the potential risk for system security substantially.

Since the TSOs do not need to be active on the short-term markets for conducting countertrade, the CoCA model means a relief of the TSOs' operational centers compared to the current situation, because less activity on the short term markets will be required.

Currently, liquidity is not very high in the Nordic intraday market, which could mean insufficient bids will be submitted in the auction. If insufficient bids are received in the CoCA auction, the TSOs will have to solve the countertrade through other means, probably using current measures. However, the liquidity might change with the go-live of XBID. Implementing a CoCA auction will most likely also act as a "market maker" in the Nordic areas, thus increasing liquidity, as the respective up- and downward regulation behind the bids provided, can be secured from the intraday market.

B. Cost-effectiveness

The CoCA model requires a lengthy development and implementation period of at least 9 months following the approval by regulators. The model builds on principles as the auctioning of PTRs currently in place at the border which is handled by JAO. However the CoCA auction itself will be a new scheme and will require new processes and new investments at JAO and at the TSO side. Implementing this model would also require new processes on the market participants' side with related extra costs for maybe only a limited time period of 2 years, until the current end date of the Joint Declaration.

Regarding the price to be paid for up- and downward regulation (and thus the price of the CoCA bid) this model can benefit from using bids from the intraday market, including the whole Nordic area and all of Europe with the implementation of XBID.

On the other hand, the price for the countertrade will be established before actual intraday trading starts. This might make it difficult for market participants to calculate their bid prices, which therefore will include a risk premium. According to the timeline shown in Figure 9, the CoCA auction would take place after the current intraday auction at 15.00 in Germany and after continuous intraday trading starts in the Nordics (currently at 14.00). Some indications of prices for up- and downward regulating bids should therefore be available.

C. Market access

Only BRPs in DK1 and DE can participate in the CoCA auction, however the BRPs have the opportunity to use bilateral trade or the intraday market to purchase the required up- and

downward regulation. This fact is detrimental to liquidity compared to countertrade models directly using the intraday market, where all market participants can take part.

Furthermore, the model requires the BRPs to be members of JAO. However it is considered that the vast majority of BRPs in DK1 and DE are already members of JAO as this is the platform for auctioning of Physical Transmission Rights on the border and Shadow Auctions as well. Some market participants indicated that JAO and JAO procedures can be complicated and that rules/registration processes here might keep participants away from participating in this auction.

The model adds another step to the current market setup at a time, i.e. shortly after the day-ahead market closure, when updated information for renewable production is not yet available, which might diminish the total amount of production that can actually participate in this auction.

D. Effect of arbitrage

Since gate closure of the CoCA is foreseen shortly after gate closure of the day-ahead market, arbitrageurs face a low risk of not being able to close any positions that they might have left open in the day-ahead market. This per se facilitates arbitrage.

In combination with the asymmetrical situation of TSOs being obligatory buyers or sellers (depending on the countertrade direction)[21], this can result in overpriced bids. However, it should be borne in mind that such opportunities would attract liquidity, thereby damping the price distortion.

Nevertheless, one could expect that price convergence between D-1 and the separate, relatively small CoCA segment would be weaker compared to some models involving the intraday markets (cf. following sections).

E. Transparency

The auctioning of the PTOs will be announced prior to the auction, which will create transparency regarding the MWh for countertrade. The full amounts will be fully auctioned, and not netted.

21 This is different when the intraday market (either auction or continuous trading) is used for the countertrade, because the positions of the TSOs would be mixed with those of the other participants and thus be less evident.

7. Intraday Opening auction – Intraday market

7.1 Overall description

The countertrade model suggests to relieve the congested direction from DK1 to DE by an implicit intraday auction with a negative capacity corresponding to the needed countertrade at this border. This methodology is currently in use between the bidding zones NO1-NO3.

The system to be used for the intraday auction is the day-ahead algorithm Euphemia. After the day-ahead market results are known, the TSOs specify the needed amount for countertrade for each hour, and – in case the DK1-DE border is included - add these as negative capacities in the Euphemia algorithm.[22] The negative capacities are implicitly indicating that the flow from the intraday auction is forced to only go in the other direction, and decrease the flow by the needed amount of countertrade. For example if the flow from DK1 to DE for a particular hour has to be decreased by 160 MW, the capacity for export will be set to -160 MW.

In the intraday auction, all market participants in the bidding zones participating in this regional auction can provide up- and downward regulation. The intraday auction will match the bids on either side of the border and relieve the congestion, i.e. the negative capacities. Following the previous example, if 160 MW from DK1 to DE has to be countertraded, the intraday auction can be used to find the available upward regulation in DE and the necessary downward regulation in either DK1 or the adjacent bidding zones.

As the solution is bound to move production from a low price zone to a high price zone, it will result in a negative transmission income for the involved TSOs. As this negative transmission income is the result of the need for countertrade, it will be covered by the respective TSO requesting the countertrade.

The market participants will be remunerated by pay-as-cleared, i.e. marginal pricing will be applied as in the day-ahead market.

Two different options for the timing of the auction are possible. One option is an opening auction after day-ahead results are received and before the continuous intraday trading starts in the Nordic region. Alternatively, the auction could be held as closing auctions. This is described in the following chapter.

Continuous ID trading will be handled in the XBID system after XBID go-live in Q1 2018. Opening auctions could be held either before the gate opening time of CCR Nordic at 15:00 D-1 or CCR Hansa at 18:00 D-1, as described in section 4.1.2.

Intraday auction are not as such included in CACM as a future part of European intraday market coupling. In fact, chapter 6 “Single intraday coupling” of CACM only refers to continuous trading, with the exception of Article 63 under which proposals for complementary regional auctions could have been submitted until February 14th 2017.

As described in chapter 4.1.2 intraday auctions have, however, been suggested as part of the methodology for pricing of intraday capacity in fulfillment of Article 55 of CACM. This proposal only contains opening auctions, no closing auctions. If an intraday auction is chosen as the

[22] The working of the Euphemia algorithm and the effect of negative capacities are explained the PCR publication “Euphemia Public Description” available at all NEMOs websites, for example on Nord Pool’s homepage here.

preferred option for countertrade, and the implementation of this methodology should follow the process related to CACM Article 55, only a very short implementation time would be available in order to have the new countertrade model implemented at the beginning of 2019. Approval of the methodology is expected earliest February 2018. If TSOs are asked to amend the proposal, this would prolong the approval period until June 2018.

The CACM day-ahead and intraday capacity calculation methodology in CCR Nordic has been, at the time of writing this document, submitted to the Nordic NRAs for approval. Currently in this process, there is an ongoing discussion among NRAs, whether the methodology should allow negative capacity calculation and allocation. The outcome of this discussion could also affect the use of this countertrade model.

The timing of implementing a pan-European auction is very uncertain at the moment and is not expected for the next two years. Implementing a regional auction in the CCR Nordic region might go faster, but would not cover the DK1-DE border directly as this border is included in the CCR Hansa region, which has not announced any regional auctions yet. In case the DK1-DE border is not included Energinet would need regulatory approval for the methodology of trading on the intraday market and placing the necessary down- or upward regulation bids in the regional Nordic auction. With such a Nordic regional ID auction, the auction mechanism would thus be only applied on the Nordic side of the border. TenneT would continue to use the current trading on the continuous intraday market on the German side.

A regional intraday auction including the DK1-DE border would need to be proposed and implemented outside of the CACM regulation. The regulatory basis would be similar to the one for the CoCA model, just with an implicit auctioning of negative capacities instead of an explicit auction. Depending on which other adjacent bidding zones would like to participate in this regional auction, a proposal would need to be prepared by all participating TSOs and approved by all relevant regulators.

7.2 Evaluation based on criteria

A. System security

As all the countertrade will be handled in the intraday market, there is no effect on system security and system operation. The additional physical flow resulting from the day-ahead market is reversed in the intraday market.

Having an opening auction shortly after the day-ahead results are known will provide some certainty to the control center well in advance of the operating hour.

TSOs anyhow need to determine the capacity for the intraday market. For the Danish borders and from Energinet's perspective, this is generally done by simply subtracting the already allocated capacity in the day-ahead market from the previously calculated NTC. The capacity for the intraday market does not include minimum capacities as determined in the Joint Declaration, see section 3.2. Normally intraday capacity would be provided to the XBID system for implicit continuous trading. With a regional opening auction the intraday capacity would need to be provided to the Euphemia platform first. After the auction, any remaining capacity would then be provided to the XBID system or could remain in the Euphemia platform for a pan-European opening auction and thereafter be submitted to XBID.

Regional auctions, either as opening or closing ones, would thus require an additional procedure on the TSO side, but not necessarily changes to TSOs' IT systems as these would already be in place for the day-ahead market. For the Nordic region, the Nordic RSC would be responsible for capacity calculation and submission.

Given that competition between NEMOs becomes a reality in the Danish and German bidding zones, the auction also needs to enable the submission of bids from all relevant NEMOs in the participating bidding zones. Today, the day-ahead market coupling algorithm Euphemia already gathers bids from all participating NEMOs. In addition, a process is on-going to adapt the algorithm to be able to accommodate multiple NEMO hubs within one bidding zone. These changes are anticipated to be implemented by Q2 2018.

Additionally, these auctions cause difficulties in the operational planning processes of TenneT. It starts with the establishment of the best forecast for the next day at 15:30 in Germany and besides others leads to the coordination of the redispatch portfolio. As the implicit intraday auction will be performed in parallel, the latest information is not taken into account and the planning process does not rely on the latest market data. This is a concern to be included when discussing timing of the auction.

B. Cost-effectiveness

The principle of an auction is a good, efficient and well proven methodology that currently is regularly applied in the day-ahead market and in the 15 min product auction in the German intraday market operated by EPEX. For the opening auction it also follows the All TSO Intraday Capacity pricing methodology, which is based on auctions, and there would thus be some synergies in the implementation of this countertrade model.

The disadvantage is, as with the CoCA model, the lengthy development and implementation period. However, as a similar methodology is to be implemented on European and maybe Nordic level, a fast track implementation to enable countertrade already from 2019 and onwards would only move later costs to an earlier stage.

C. Market access

An intraday auction is generally open for all market participants in the bidding zones that will participate in this auction. This auction could in addition to DK1 and DE bidding zones, potentially include all or selected Nordic Bidding zones[23]. Thus everyone can offer down- and upward regulation given that capacities on interconnectors are available.

D. Effect of arbitrage

The timing of the opening auctions would be similar to the CoCA, hence shortly after day-ahead gate closure. This facilitates arbitrage. Therefore, using intraday opening auctions for countertrading is likely to provide the highest incentives for arbitrage, as positions opened in the day-ahead market can be closed shortly afterwards.

Depending on the ability of market participants to predict the need for countertrade, an opening auction that is conducted shortly after the day-ahead market would provide a strong incentive to open up positions in day-ahead market that would then be closed in the ID auction shortly after. In addition, fluctuating power production like wind and PV would not yet participate in the ID auction as their positions are still rather uncertain so long before operating hour and will not have changed substantially compared to the day-ahead market. In general, it

[23] This is to be decided by Nordic TSOs

might be expected that an auction, which is implemented very shortly after the day-ahead auction, using the same algorithm, the same market participants, but reflecting the real capacities at the DK1-DE border, most likely will eliminate the day-ahead market price effect of the minimum capacities.

E. Transparency

Intraday implicit auctions are very transparent, both opening and closing auctions. The TSOs would openly announce the amount of needed countertrade and the (negative) capacities would have to be published on the ENTSO-E transparency platform one hour before gate opening of the auction.

8. Intraday Closing auction – Intraday market

8.1 Overall description

Similar to the opening auction described before, closing auctions could be used to relieve the congested direction from DK1 to DE by an implicit intraday auction with a negative capacity corresponding to the needed countertrade at this border. Also here the system to be used for these auctions would be the day-ahead algorithm Euphemia[24]. A closing auction requires hourly auctions, i.e. 24 auctions per day, one at the end of intraday trading for each specific operating hour.

As with the opening auction, all market participants in the bidding zones participating in this auction can provide up- and downward regulation. The intraday auction will match the bids on either side of the border and relieve the congestion, i.e. the negative capacities, resulting in negative transmission income for the involved TSOs at the DK1-DE border. As this negative transmission income is the result of the need for countertrade, it will be covered by the respective TSO requesting the countertrade.

The market participants will be remunerated by pay-as-cleared, i.e. marginal pricing will be applied as in the day-ahead market.

The European proposal for intraday capacity pricing does not contain closing auctions, neither pan-European nor regional. Implementing this type of implicit auction for the countertrade purpose will therefore need to be handled outside of CACM regulation, similar to the CoCA methodology. Besides the two main TSOs Energinet and TenneT, also all other TSOs responsible for adjacent bidding zones that would like to participate in this auction would need to agree on a common proposal to be submitted to all relevant regulators.

As written for the Intraday Gate Opening model, there is an ongoing discussion among Nordic NRAs, whether the day-ahead and intraday capacity calculation methodology should allow negative capacity calculation and allocation. The outcome of this discussion could also affect the use of this countertrade model.

8.2 Evaluation based on criteria

A. System security

As all the countertrade will be handled in the intraday market, there is no direct effect on system security and system operation. The additional physical flow resulting from the day-ahead market is reversed in the intraday market.

Having closing auctions postpones the countertrade too shortly before the operating hour. However, the risk is more related to the price and thereby costs associated with the countertrade.

For a closing auction, the impact on the TSO side would be larger as in an opening auction as a closing auction requires an auction every hour instead of only one the day before. Gate closure for the continuous intraday trading in XBID is set to H-60 min. This leaves only very limited time to implement a closing intraday auction before TSOs balancing markets start, which currently

[24] The working of the Euphemia algorithm and the effect of negative capacities are explained the PCR publication "Euphemia Public Description" available at all NEMOs websites, for example on Nord Pools homepage here.

have a gate closure of H-45 min. From market participants' side it was stated that it might be difficult for them to handle an additional auction between the continuous intraday market and the Nordic balancing markets. There might not be enough time to move remaining bids from one market to the other thus bids not matched in the intraday auction would maybe not be available for the balancing market afterwards.

Closing auctions would on the other hand fit the operational planning processes of TenneT and allow the inclusion of the latest forecast in the capacity calculation.

B. Cost-effectiveness

The disadvantage, as with the CoCA model, is the lengthy development and implementation period. As closing auctions are currently not included in the proposal for intraday capacity pricing submitted under Article 55 CACM, a separate – non CACM – process for approving this methodology would need to be applied. If this auction should be able to take advantage of a large market area, preferably the whole Nordic area, to secure the necessary countertrade on the Danish side, the proposal would need to be agreed by a large number of TSOs, and approved by an equally large number of regulators. This can be expected to take a substantial amount of time.

C. Market access

An intraday auction is generally open for all market participants in the bidding zones that will participate in this auction. This auction could in addition to DK1 and DE bidding zones, potentially include all or selected Nordic Bidding zones[25]. Thus everyone can offer down- and upward regulation given that capacities on interconnectors are available. However, as pointed out before, it might be difficult to engage other bidding zones than DK1 and DE in this closing auction as it is a new process, currently not included in any CACM proposals.

Introducing a closing auction only with the participation of the Danish and German market areas and the DK1-DE border, would – like with the current special regulation – would confine the available bids to DK1.

D. Effect of arbitrage

If countertrading is performed via intraday closing auctions, arbitrageurs can utilize the whole intraday trading period for passing on the price risk that they may have taken in the day-ahead market coupling. For example, the behaviour of holding back capacity in day-ahead could be continued during the intraday period. Compared to using opening auction for countertrading, the longer period between day-ahead and countertrading increases the complexity for the market participants. This makes it harder to predict the resulting effect on prices, but it does not necessarily reduce the effect of arbitrage.

E. Transparency

Intraday implicit auctions are very transparent, both opening and closing auctions. The TSOs would openly announce the amount of needed countertrade and the (negative) capacities would have to be published on the ENTSO-E transparency platform one hour before gate opening of the auction.

[25] This is to be decided by Nordic TSOs

9. Energinet and TenneT active on the intraday market

9.1 Overall description

This countertrade model is currently applied by TenneT on the German side in order to secure upward regulation in case of countertrade. Currently, Energinet is not trading in the intraday market. This countertrade model would therefore require regulatory approval of a new methodology on the Danish side, both if Energinet were to conduct the intraday trade on equal terms as other market participants, or if Energinet would contract a service provider, probably through a tender process, to conduct the trade on behalf of Energinet.

Energinet can either on its own or through a service provider buy the necessary down- or upward regulation on the intraday market. Although some experience can be gained from TenneT trading in the intra-day market, the situations are very different for the two TSOs. On TenneT's side, the TSO is also responsible for balancing a substantial amount of renewable production. Thus the total volume of intraday trading justifies the implementation of a separate TSO trading desk. On the Danish side, the countertrade based on minimum capacities would constitute the only intraday trading necessary on the TSO side, thus hiring a service provider for a limited amount of time (i.e. until end of 2020), would be the most cost-efficient option.

If the countertrade is initiated, for example to limit the flow from DK1 to DE, Energinet or the service provider could sell the electricity in DK1 - either to DK1 market participants or to any other market area as long as cross-border capacity is available. The TSO or the service provider can have access to the Nordic intraday market ELBAS, and to the entire European market, when XBID goes live in 2018.

In general, if choosing this countertrade model Energinet and TenneT should discuss with their regulators about publication and transparency regarding the amount to be countertraded and the trading strategy.

9.2 Evaluation based on criteria

A. System security

As all the countertrade will be handled in the intraday market, there is no direct effect on system security and system operation. The additional physical flow resulting from the day-ahead market is reversed in the intraday market. Provided that all the trading in the intraday market is based on actual consumption and production, no imbalances should occur in the regulating power market. But even in the case of imbalances that are carried over to the Nordic balancing market, Energinet would have access to the whole Nordic merit order curve and not only the bids from DK1.

B. Cost-effectiveness

This countertrade model would rely on the already existing continuous intraday market. No new mechanisms would need to be established. Therefore, this model provides a flexible solution for solving the countertrade needs, with the current uncertainty of the time after 2020.

From the implementation side, there would be a requirement for (a) the regulatory approval of the methodology for Energinet to trade in the intraday market and (b) the respective tool to implement this trade, i.e. either establishing a trading desk in Energinet or hiring a service provider to conduct the trade.

Establishing a trading desk within Energinet would require substantial investments in clear "Chinese walls" between the TSO business and the trading activities. As the Joint Declaration currently only lasts until end of 2020, it is hard to justify these investments. Hiring a service provider would require a tender process, which could most likely be managed within a 3-6 month period. Obtaining regulatory approval would probably need [6-9] months and could be initiated in parallel with the tender process.

C. Market access

The intraday market is in principle open for all market participants in the XBID area. Thus everyone can offer down- and upward regulation given that capacities on interconnectors are available. Although the current liquidity in the Nordic intraday market is not very high, this might change in the future, both with the go-live of XBID and by Energinet in-directly increasing liquidity by buying the necessary countertrade volumes in the intraday market.

In addition, the need for countertrade would most likely initiate the need for capacity allocation against day-ahead market direction, thus capacity limitations should in general not limit the liquidity for these types of trades.

D. Effect of arbitrage

The arbitrage effect of this model lies somewhere between the models of using the implicit intraday opening auctions and closing auctions, since the continuous intraday market also takes place between both timeframes.

Trading should be done the most cost-efficient way, thus the timing of buying the necessary up- or downward regulation would be up to the judgment of the trading desk or service provider.

By using the intraday market, the full amount of countertrade would be purchased by the TSOs, and will thus not affect the total amount of imbalance netting done in the Nordic balancing market. This will reduce the incentives for the consumption BRPs to speculate in low imbalance prices by withholding demand from the day-ahead market.

E. Transparency

TSOs acting as market participants in the intraday market will require a high level of transparency and have to follow European legislation such as REMIT. Transparency has to be discussed further with the regulators if this countertrade model is chosen.

10. Special regulation - without capacity auctions

10.1 Overall description

In this model, the minimum capacities will be released in the day-ahead market and the trade in the Nordic intraday market will continue unaffected, as Energinet will conduct the countertrade by using the regulating power market.

Energinet selects DK1 bids from the Nordic regulation power market's merit order list according to pay-as-bid. The bids selected for countertrade from the merit order list are all bids not used in the balancing in the Nordics.

Energinet has the opportunity to purchase downward regulation capacity each morning and afternoon, and the market participants who win the capacity in the auction are obliged to submit downward regulation bids in specific hours, this model is described in section 11. In this further description, a model without purchased capacity is described.

With the currently agreed methodology, it is only possible to provide one price per bid independently of in which market – Nordic balancing market or special regulation regime – the bid is activated. Market participants will therefore adjust their bidding strategy according to expectations of a need for countertrade or not, see section 4.3. If special regulation is chosen as a countertrade model, it could be worthwhile to consider modifications to the auction design. An alternative settlement, such as separating the marginal price bids with the pay-as-bid, see section 4.2. There are several ways to solve this, for example allowing two prices (one marginal-price if the bid is used for balancing, one pay-as-bid if the bid is used for special regulation) for the same bid. Another way would be to "split" the merit order curve, and to handle bids used for balancing according to marginal price, and the same for the part of the bids used for special regulation. However, it would not be possible to completely avoid the arbitrage effect, as they arise due to the fundamental fact that regulating power bids in DK1 would get an additional value through the frequent use of special regulation. Moreover, as Energinet is part of the common Nordic market, a change in the system would have to be harmonized and agreed with the Nordic TSOs.

The current measure of special regulation follows the description in the Nordic manual for the regulating power market and in the System Operation Agreement with TenneT.

A similar procedure is currently not described in any published European legislation or guidelines, so the use of special regulation with the participation of the other Nordic areas is to be approved, if relevant, by DERA and other regulators following "Elforsyningsloven".

As explained in section 4.2, the currently agreed process for special regulation only allows the use of bids from DK1. The possibility of extending the market area for this specific type of special regulation to include also other Nordic bids, would need to be agreed by the three other Nordic TSOs. Svenska kraftnät and Statnett have so far declined to participate, see section 4.2.2.

10.2 Evaluation based on criteria

A. System security

This countertrade option is physical and asset backed, thus delivery of activated bids is guaranteed. Energinet is already using special regulation today, however, on a voluntary basis, i.e. Energinet can in case that there are not enough bids available decline to help TenneT. For the

countertrade amount related to the Joint Declaration Energinet has to guarantee the up- or downward regulation. The main disadvantage of this countertrade model from a system security point of view is thus that it is only possible to use bids from DK1, which might not provide sufficient MWh of downward and upward regulation to meet the minimum capacities.

The regulating power market closes 45 minutes before the operational hour and most trade by Energinet is done in this short lead time. This leaves little room to handle any situations with too few bids for up- and downward regulation, and it increases the risk of a failure in the system.

Ideally, this countertrade model is considered to have a minor effect on the Nordic regulating power price, as the bids selected are outside the ranges used for balancing purposes, which is also an advantage. However, as special regulation bids are remunerated as pay-as-bid, and as it is currently only possible to submit one price per bid, the expectations about being activated in the special regulation regime instead of the Nordic balancing market, might result in a general higher price level for bids on the merit order curve.

B. Cost-effectiveness

The use of bids in DK1 will, all other things being equal, be less cost efficient compared to the intraday models, as the market is smaller and market power of individual market participants could lead to higher prices. The scarcity of the MWh will also increase costs, compared to more liquid markets.

The timing of the countertrade very close to the operational hour will on the other hand ensure a higher liquidity as wind uncertainty at this point in time is low. In times of substantial transit flows, it might be necessary to buy down-regulation from renewables, which will increase costs.

An advantage of this countertrade model is that it is currently in use, and can be used going forward without major implementation costs and approval by regulators.

A continued use of special regulation would require further IT development in Energinet, and perhaps additional resources have to be assigned in the control centre.

The imbalance netting used during the regulating power market timeframe can have the positive benefit that the need for up- and downward regulation of mFRR is reduced. However it depends on the imbalances and interconnector capacity towards neighboring Nordic price-areas and the net positions there and should therefore not be considered as a given. It does not decrease the operational risk, as Energinet still need to secure the given amount of downward and upward regulation both to meet the requirements from the Joint Declaration and also to solve balancing issues.

C. Market access

Only market participants in DK1 can participate directly in this market. This limits the market access substantially with all the associated effects on system security, costs and arbitrage possibilities explained elsewhere. Although an increased demand within DK1 might result in additional resources being made available, either through new types of productions or more flexible production from renewables, it is difficult to anticipate the general increase of capacity within a very limited geographical area.

D. Effect of arbitrage

The arbitrage effect of this model is similar to that of the intraday closing auction, but subject to less liquidity, because only bids from DK1 could be used, as opposed to entire Nordic for intraday based models.

In case market participants can anticipate the need for downward regulation, the baseline incentive for both consumption and production BRPs are the same as in the previous models. Consumption BRPs can choose to bid less consumption than needed into the day-ahead market and speculate on an imbalance price in the Nordic balancing market, and whether it is lower than the day-ahead market price. As explained in section 4.3.2 Energinet uses imbalance netting as part of the special regulation regime in case the extra energy from the German area can help the other Nordic areas. The imbalance netting increases the incentive for consumption BRPs to bid less consumption in the day-ahead market as the likelihood of an imbalance price lower than the day-ahead market price is further enhanced. Thus, based on the consumption BRP incentives, the risk of reducing the price effect in the day-ahead market is even larger in the special regulation regime.

Also production BRPs have in principle the same incentive to bid larger amounts of production in the day-ahead market while speculating on being able to buy back the sold production at attractive prices in the special regulation regime, when being activated for downward regulation. Although the special regulation regime in principle is asset based, Energinet does not have any legal leverage to enforce that power plants that sell production in the day-ahead market actually have started up and any legal leverage follows REMIT see section 4.3. The schedules sent by production BRPs to Energinet's control centre before the operating hour are not binding in any legal way.

As the special regulation regime is based on a very limited market size and all market participants within this market in principle have an incentive to keep up a higher day-ahead price, there might, however, be an implicit understanding to keep the day-ahead prices higher level and to limit the arbitrage effect.

E. Transparency

In general, the total amount of bids available in the DK1 area is transparent and shown on Nord Pool's homepage. However, bids for the Nordic regulating power market and special regulation are not separated. As bids for the Nordic balancing market are paid based on marginal costs of the last activated bid, and bids for special regulation are paid pay-as-bid, the market participants need to speculate in advance in which market they will be activated and adjust their pricing strategy accordingly. Also, the amount of imbalance netting to be used is difficult to estimate for market participants.

11. Special Regulation - with capacity auctions

11.1 Overall description

This model builds on the same principles as described in the model with special regulation, however the main difference here is the purchase of capacity in the morning or in the afternoon.

Energinet has the opportunity to purchase downward regulation capacity each morning and additional in the afternoon, and the market participants who win the capacity in the auction are obliged to submit upward or downward regulation bids in specific hours. Today, the option of purchasing capacity is usually not applied as enough bids are expected to be available in the merit order list on a voluntary basis.

The capacity purchase is of course used to secure the level of bids, but the option is also considered to provide an additional signal to the market participants to submit more voluntary bids.

In the operational hour, Energinet will select the necessary upward or downward regulation bids according to the merit order curve, and is not obliged to select the bids which have won the capacity auction, but the cheapest bids.

The process for special regulation follows the general Nordic model for submitting mFRR bids:

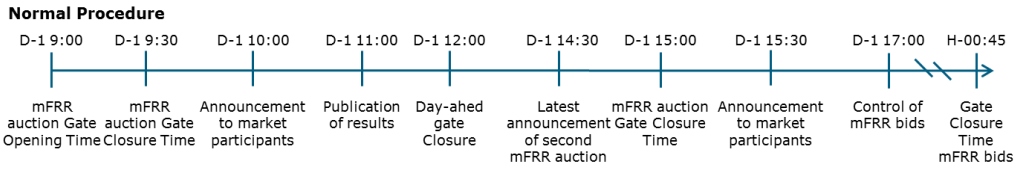

Figure 10: Process for mFRR bids in the Nordic regulating power market

The remuneration of the capacity auction in the morning or afternoon is based on marginal price, however the specific MWh bids selected for countertrade using special regulation before operational hour are settled according to pay-as-bid. Description of this is provided in section 10.1.

The current measure of special regulation follows the description in the Nordic manual for the regulating power market and in the System Operation Agreement with TenneT. The option of having capacity auctions is available to Energinet, but is currently not used as enough bids are available.

11.2 Evaluation based on criteria

System security

This countertrade option is physical and asset backed, thus delivery of activated bids is guaranteed, and the purchase of the capacity in the morning or in the afternoon gives some certainty to the amounts of up- or downward regulation. One prerequisite for this is, of course, that sufficient MWh are available in the capacity auction as well.

The main disadvantage is, as for the other special regulation model, which it is only possible to use bids from DK1, and the liquidity is therefore questionable. Another disadvantage is also the

short lead time to the operational hour, which leaves little room to manoeuvre and it increases the risk of a failure in the system.
By having the auctions well in advance of the operational hour, on the other hand, producers might be enabled to increase the total amount of bids for the special regulation market. Power producers would have time to adjust the productions plans by optimizing their portfolio towards providing up- or downward regulation bids.

B. Cost-effectiveness

The use of bids in DK1 will, all things being equal, be less cost efficient compared to the intraday models, as the market is smaller and market power of individual market participants could lead to higher prices. The scarcity of the MWh will increase costs, compared to more liquid markets. The purchase of the capacity each morning will only make the MWh for up- and downward regulation more expensive.

The price of the morning auction will include more uncertainty for the market participants regarding their position and the general prices in the market, as the day-ahead market have not cleared. The market participants will therefore, all other things being equal, include a higher risk premium, i.e. higher price for the capacity auction. In the afternoon auction the market participants know the day-ahead clearing, and can predict if the TSOs will initiate the auction, which could provide incentive to give higher bids in the afternoon auction.

C. Market access

Only market participants in DK1 can participate directly in this market, both for capacity auction in the morning and in the afternoon, and for delivering the upward and downward regulation. As the rules for these auctions require the winning parties to place their asset based bids in the Nordic balancing market bid curve, it will be difficult for wind production to participate. In practice thus, only flexible thermal production from DK1 area can participate in these auctions.

As not all market participants can offer capacities in the two capacity auctions, this further limits the number of bids that can be selected.

D. Effect of arbitrage

The arbitrage effect of this model is, in principle, similar to that of the intraday opening auction, and the previous described special regulation model. Like in the previous special regulation model without capacity auctions the consumptions BRPs have an incentive to bid less consumption in the day-ahead market when they expect the need for downward regulation. Also in this model with capacity auction this incentive is further enhanced by the potential use of imbalance netting.

For the production BRPs this model provides an additional incentive for the market participants to position themselves in the day-ahead market, especially, with the morning capacity auction. If the market participant wins the capacity auction in the morning, they will have to consider this in their position in the day-ahead market, and this will decrease the day-ahead price.

An afternoon auction will provide the same incentive for speculation, as market participants already today have a good forecast on how and when the TSOs will initiate the countertrade, as the day-ahead capacities are announced at the latest at 10, and if the capacity given is equal to the minimum capacity, it provide an indication that countertrade is necessary. This is further supported by their wind forecast.

Energinet can buy the capacity for sufficient upward and downward regulation, thus this could provide a higher incentive to the market participants to have a better position in the day-ahead market, i.e. for providing downward regulation by adding excess production in the day-ahead market.

E. Transparency

In general, the total amount of bids available in the DK1 area is transparent and shown on Nord Pool's homepage. However, bids for the Nordic regulating power market and special regulation are not separated. As bids for the Nordic balancing market are paid based on marginal costs of the last activated bid, and bids for special regulation are paid pay-as-bid, the market participants need to speculate in advance in which market they will be activated and adjust their pricing strategy accordingly. Also, the amount of imbalance netting to be used is difficult to estimate for market participants.

12. Summary of the models

The following provides an overview of the models and the points discussed in the above sections.

Model	System security	Cost-effectiveness	Market access	Effect of arbitrage	Transparency
CoCA Model	No direct effect. Risk of lack of liquidity as new mechanism.	High implementation costs. Lower costs of purchasing countertrade because of access to ID market.	Requirement to be member of JAO and BRP in DK1 and Germany for bidding in the auction, however, indirect access to whole ID market.	Incentive for consumption BRPs to withhold consumption. No additional imbalance netting. High incentive for production BRPs to open positions in day-ahead market as CoCA auction takes place shortly after day-ahead, where positions can be closed.	High (capacities are announced prior to auction, no imbalance netting)
Intraday opening auction	Cause difficulties in the German operational planning process. Current illiquidity of Nordic ID market.	High implementation costs. Lower costs of purchasing countertrade because of access to ID market.	Whole ID market. European or regional Wind and PV might not participate because long lead time to operational hour.	Incentive for consumption BRPs to withhold consumption. No additional imbalance netting. High incentive for arbitrage as auction takes place shortly after day-ahead and same algorithm is used as in day-ahead.	High (capacities are announced prior to auction, no imbalance netting).
Intraday closing auction	No direct effect. One auction to be handled for each operating hour and close to real time. Current illiquidity of Nordic ID market.	High implementation costs. Lower costs of purchasing countertrade because of access to ID market.	Whole ID market, European or regional.	Incentive for consumption BRPs to withhold consumption. No additional imbalance netting Incentive for arbitrage is slightly lower as in CoCA and ID opening auction as trade is done close to operational hour.	High (capacities are announced prior to auction, no imbalance netting).
Intraday market	No direct effect. Current illiquidity of Nordic ID market.	Some implementation costs as Energinet needs to contract a service provider.	Whole ID market.	Incentive for consumption BRPs to speculate in lower imbalance prices. No additional imbalance netting. Incentive for arbitrage is slightly lower as in CoCA and ID auctions as trading can be done close to operational hour	High (TSOs have to follow REMIT, no imbalance netting).

Special Regulation without capacity auction	Risk of insufficient bids as only DK1.	Some implementation costs as additional investments in IT systems are needed. Additional operational costs in Energinet control center and settlement department.	Only DK1.	Additional incentive for consumption BRPs to speculate in lower imbalance prices as additional imbalance netting might be applied. Incentive for production BRPs, but smaller market size might limit arbitrage.	Reduced transparency (marginal vs. pay as bid activation and imbalance netting).
Special Regulation with capacity auction	Still some risk of insufficient bids as only DK1.	Some implementation costs as additional investments in IT systems are needed. Additional operational costs in Energinet control center and settlement department.	Only DK1. Wind cannot participate in capacity auction.	Additional incentive for consumption BRPs to speculate in lower imbalance prices as additional imbalance netting might be applied. High incentive for production BRPs, when they are selected in the capacity auction.	Reduced transparency (marginal vs. pay as bid activation and imbalance netting).

Table 5: Summary of the models evaluated according to the criteria

13. Combination of models

One general concern for all models is whether the market can provide the necessary up- and downward regulation bids in Denmark. Therefore, one suggested solution is to combine the different models.

Generally, two combinations of models are considered:

1. Intraday auction + special regulation
2. Intraday trading + special regulation

It was suggested that the combination of two models could solve the question of liquidity of the markets, i.e. too few bids, which has an impact on the two criteria: System security and cost-effectiveness. Especially in the Nordics, the intraday market has periods with little trade, see Figure 5, while the regulating power market in the same period might has more liquidity. Over time, it is assumed that the intraday trade made by the TSOs will provide an incentive for the Nordic market participants to join the intraday market, which will increase liquidity. There might, however, be a transition period until this extra liquidity is achieved.

If an intraday model is selected, it could be possible to have the special regulation methodology as a "fallback" solution in the transition phase, if the intraday models seem to be low in liquidity for a time period. The shift from the intraday model to special regulation could be triggered by the price of the MWh in the intraday market as being above a maximum prices specified by the TSOs. This would require that the TSOs specify a price cap for the provided MWh in the intraday market. The price cap should be based on historic data, and it should be considered if this price limit should be made public or should be undisclosed in order to not manipulate the market.

With a price cap, it is certain that the price in the intraday models will not be higher than a specified level, which might be beneficial if the countertrade model suffers from low liquidity and low competition. On the other hand, if the prices reflect the general prices in the market, then it will not be possible for the TSOs to purchase the downward and upward regulation in any other market or through other models at a lower price. This follows equally for the level of system security, in the sense that a combination of models might secure that enough upward and downward regulation bids are available, however if there is not sufficient amounts of bids in the intraday market, it is not certain that more liquidity is available in other markets.

14. Comparison of models – Weighted Scoring Model

For the comparison of the different countertrade models at the DK1-DE border and the final selection of the preferred model, a Weighted Scoring Model will be used. To also consider the opinions of interested market parties, the Weighted Scoring Model was presented on the workshop on the 8th November 2017 in Copenhagen and tested by conducting a scoring exercise during the workshop. The results of this scoring exercise are published on Energinet's webpage[26] and show no clear preference for one of the models. Depending on where market participants see the highest chance of profiting from the countertrade, they will either support the intraday market models or the special regulation regime. It should be noted that the TSOs did abstain from participating in the scoring exercise at the workshop. In addition the workshop evaluation was only based on four models. The split up of the intraday auction model in opening and closing auctions and the division of the special regulation model into one without capacity auction and another model with capacity auction was one of the outcomes of the discussion with market participants.

The Weighted Scoring Model is a qualitative, non-monetary method for analysis within decision theory to rationally support findings in complex situations and to define the effectiveness of different alternatives. It facilitates decisions based on multiple qualitative and/or quantitative criteria, conditions or target solutions in a transparent way.

In this impact assessment, the different models described should be compared on their outcomes within the different evaluation criteria; system security, cost-effectiveness, market access, possibility of arbitrage and transparency. These criteria should be weighted by their importance, with the inputs from the stakeholder workshop on 8 November 2017. Hence it is ensured to receive a maximum of different views on the weighting of the criteria and the fulfilment by each alternative is taken into account.

The **criteria** weighting is based on a total of 100 %, while each criterion is represented by a share of this 100 % based on its importance to the stakeholder.
The fulfilment of each **alternative** by each criterion is scored by values between 1 and 9 and should differentiate to following proxies in more detail:

- 1-2 for poor fulfilment
- 3-5 for medium fulfilment
- 6-8 for good fulfilment
- 9 for very good fulfilment

If the criteria are weighted and the alternatives are scored, the final score per alternative is calculated as followed:

$$Total\ value(A_i) = \sum_{j=1}^{n} weight\ of\ criteria_j * score_{ij}$$

With:
A_i = Alternative i
j = number of criteria
n = total number of criteria

The alternative with the highest score should be chosen as the most effective solution.

[26] https://en.energinet.dk/About-us/Events/Workshop-on-the-DK1-DE-border-081117

The following table provides an example of how the Weighted Scoring Model could be specified.

Criterion:	System security	Cost-effectiveness	Market access	Possibility of arbitrage	Trans-parency	Total
Weighted:	X%	X%	X%	X%	X%	100%
CoCa Model						
Intraday opening auction						
Intraday closing auction						
Intraday market						
Special Regulation without capacity auction						
Special Regulation with capacity auction						

Table 6 Overview of the weighted scoring model

One of the main feedbacks from the market participants at the workshop on the 8th of November was that there were still many outstanding issues for each countertrade model, and a scoring at the current stage thus was difficult due to these shortcomings. The TSOs acknowledge that many of the details are still being examined, i.e. implementation costs and time. Therefore it is not possible at the current stage to fill out the weighted scoring model and point in the direction of a preferred countertrade model.

For the next period until a final countertrade model is selected, see Figure 2, TenneT and Energinet will further explore the possibilities and elaborate on the missing information of the models. The final outcome of the weighted scoring model will be published at the time of the public consultation of the suggested countertrade model.