DRAFT REPORT

DK1-DE COUNTERTRADE MODELS IMPACT ASSESSMENT

Date:
1. november 2017

Contents

1. Introduction

This impact assessment prepared by Energinet and TenneT shall be used as a starting point for the stakeholder workshop held on 8th November 2017 in Copenhagen. The input for this impact assessment was based on the current work between the two TSOs and feedback from market participants at Energinet's workshop on the 7th of September 2017 as well as bilateral feedback received from stakeholders.

This impact assessment is a draft report to be discussed on the stakeholderworkshop on the 8th of November 2017. The final report will be prepared and submitted to NRAs before 1st of December 2017.

The impact assessment starts with a short introduction of the background in chapter 2, 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 3 possible markets and models for providing countertrade are described. Chapter 4 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 5, 6, 7, and 8 each describe individual countertrade models and evaluate them according to the criteria listed in chapter 4. Finally, the weighted scoring model, for comparing the models, is introduced in chapter 9.

2. Background

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 and Bundesnetzagentur have signed 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.

[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/

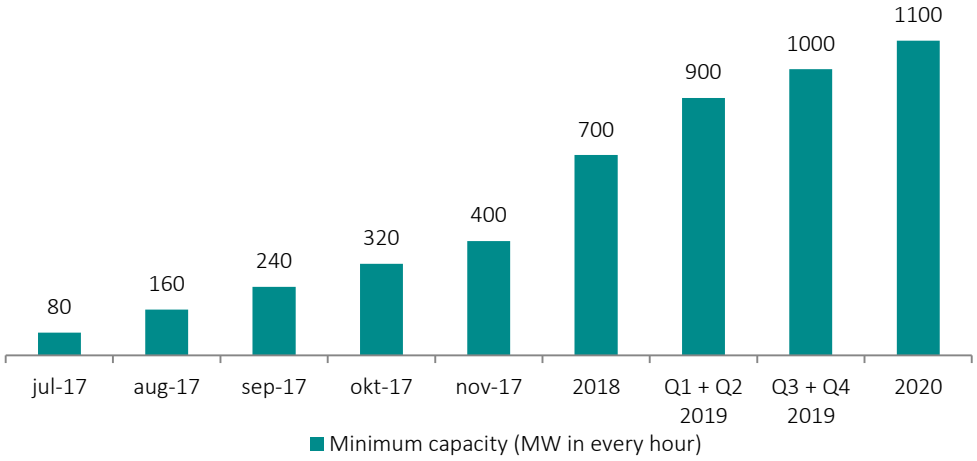

Figure 1: Required minimum of import- and export capacities on DK1-DE

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.

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

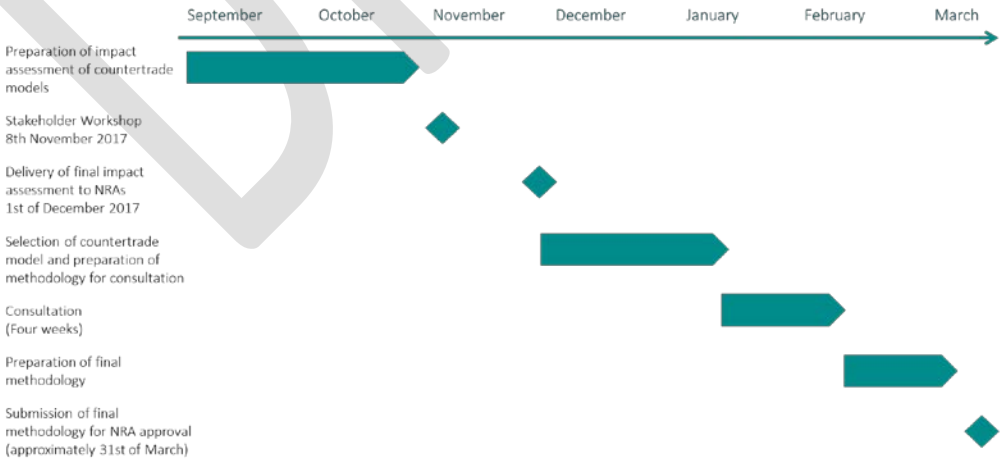

Figure 2: Process description for countertrade model selection

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.

2.1 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 - German 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.

2.1.1 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[2]); (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 with intact internal grids. 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.

2.1.2 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

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

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.

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:

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

2.2 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 DK1 to DE, 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 area to compensate for the limited flow from DK1.

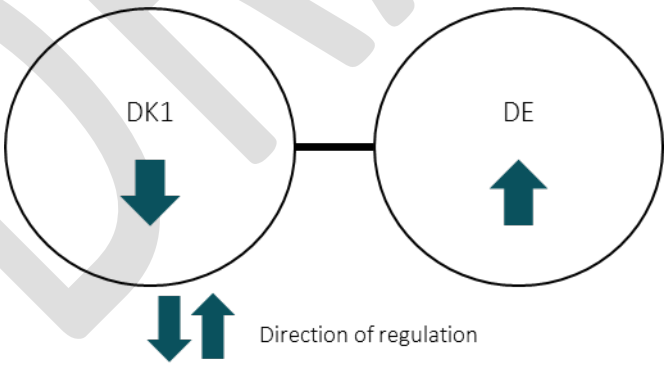

Figure 3: Countertrade between bidding zones

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 relive 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 of flow from DK1 to DE, where TenneT is responsible for providing up-ward regulation in their control area, and Energinet is obliged to secure down-ward 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 Energinets 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 and September 2017 as shown in Table 1:.

	July 2017	August 2017	September 2017
Hours with countertrade	57	80	70
MWh to be countertraded[3]	4.537	11.541	14.622

Table 1: Overview of countertrade from Joint Declaration, July – September 2017.

[3] MWh before Energinet performs mFRR imbalance netting.

3. 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 for 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.

3.1 German and Nordic intraday markets

The current intraday markets are covered by the Nordic power exchange NordPool in the Nordics and by EPEX, a French-German power exchange and NordPool 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, current applied methods are described when relevant.

For 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 is 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 European REMIT legislation, all trades from TSOs have to be done from a special workplace. 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 mar-

ket 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 starts trading the respective volumes on the German intraday market via a special workplace at approximately D-1 15:30.

The volumes traded in the German and Nordic intraday markets are significantly different. EPEX SPOT Intraday DE/AT markets reached all-time high 2016[4] with a total of 41 TWh traded, whereas the Nordic Elbas market covering Denmark, Norway, Sweden, Finland, Lithuania, Latvia, Estonia and Germany total traded amounts reached 5 TWh in 2016[5].

Liquidity in EPEX SPOT is considered enough to provide the necessary up- and downward regulation on the German side[6].

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 energy plants and physics, it is possible to perform a countertrade and have full physical effectiveness. 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.

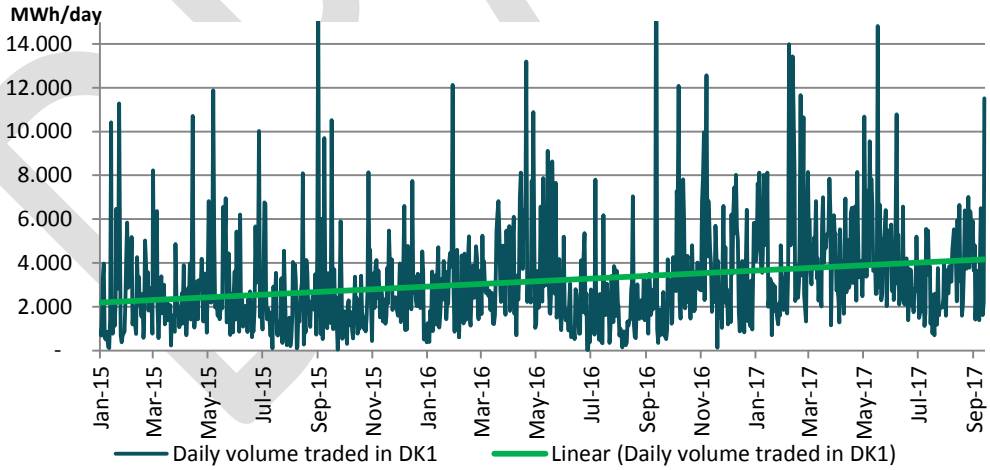

Figure 5: Buy and/or sell trades in the intraday market with market participants from DK1, 2015- September 2016.

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

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

[6] 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.

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

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

3.1.1 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 Article 59 of the CACM GL, which was submitted to the NRAs on the 28th of August 2018. 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 6 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.

3.2 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.[7]

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 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[8] 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[9] 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, 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[10]. 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 automatically provides more downward regulation. 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

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

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

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

[10] 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.

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 do not reflect the full year[11].

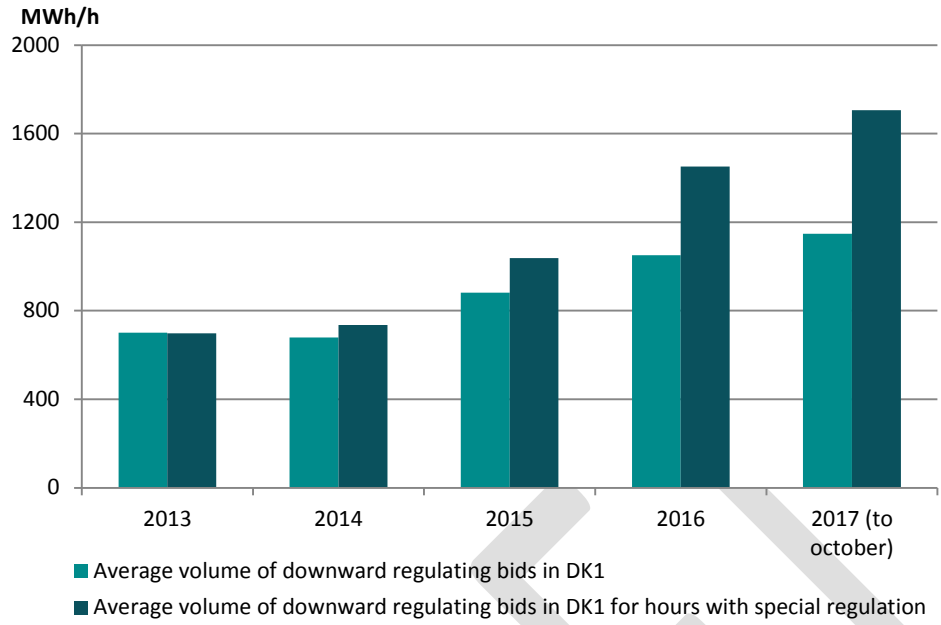

Figure 6: Average volumes of bids for downward regulating in all hours and in hours where special regulation was used.

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.

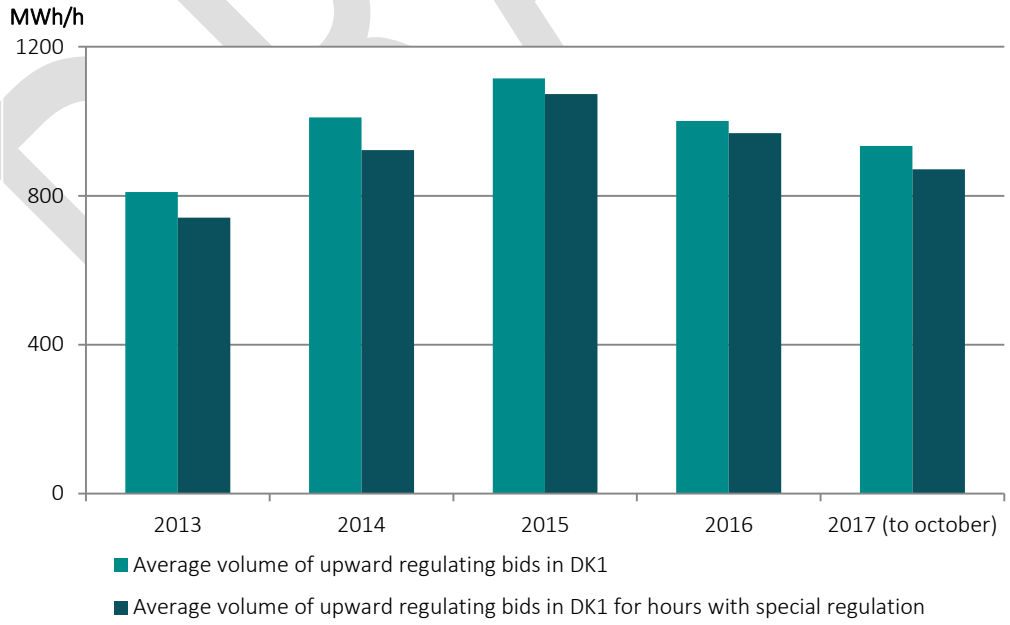

Figure 7: Average volumes of bids for upward regulating in all hours (approx. 8760) and in hours where special regulation was used.

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[12], which is due to the fact that Energinet only in rare situations has provided up-ward 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.

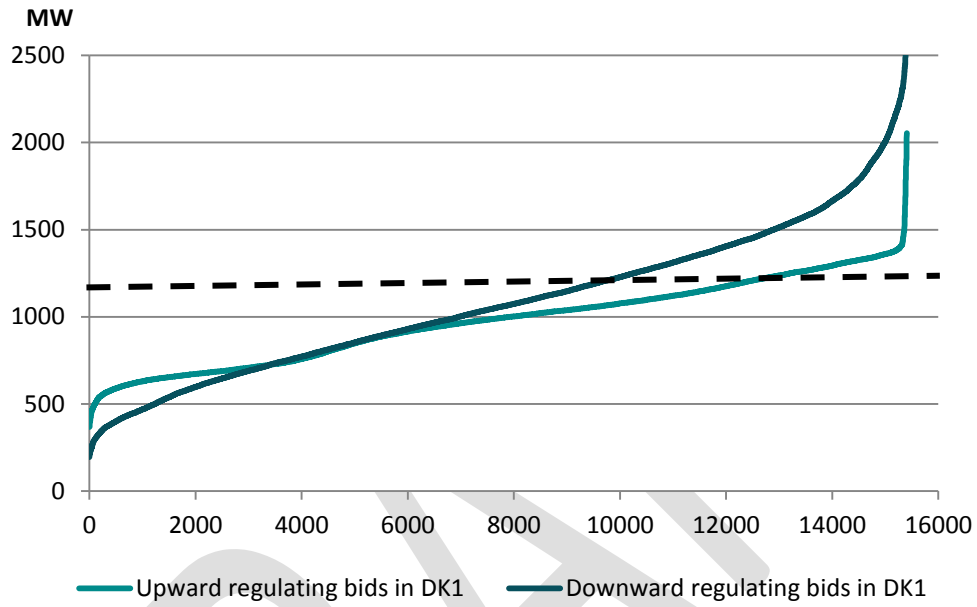

Figure 8: Duration curve of the regulating power bids in the DK1 market, January 2016 to October 2017

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.

As will be further elaborated in section 8.1 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.

3.2.1 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. However, it can be expected that the use of the intraday market could affect the prices in the Nordic Regulating Power market, whereas the use of special regulation will not.

As the bids in the intraday market and the Nordic regulating power market are in principle the same, implying 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. A bid offered and activated in the intraday market will not be available for the regulating power market, which should 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.

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 more higher imbalances to be handled by Energinet. One of the recommendations from the "Market 2.0"[13] 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 it 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 2. 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 by upward og 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 2: Average cost for either buying or selling power in the intraday market compared to buying upward or downward regulation in the regulating power market.[14]

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

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

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.

3.3 Effects of arbitrage between markets

The main purpose of the Joint Declaration is to have an effect on day-ahead prices, and the countertrade should, as much as possible, not diminish or eliminate the effect on day-ahead prices.

Arbitrage means utilizing price differences of a product that occur because the product is traded at different places or different points in time. In this context, 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 out 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 that, which would not have been 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 – German 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 worst case eliminate the price effect in the day-ahead market.

In the concrete case on the DK1 - German 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 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 receiving the day-ahead market price and either buying their "production" in the intraday or regulating power 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 thereby provide the consumption as downward regulation in the intraday market. These arbitrage opportunities exist for upward regulation as well.

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 following paragraph.

3.3.1 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[15]. 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 which consequently remedy the total imbalance of the system are 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 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[16], 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

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

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

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. 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[17].

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 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, 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 bigger 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.

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 is, as there is less time for correcting imbalances. The market size has a detrimental effect on the willingness to speculate. Likewise, a model that eliminates the possibility of imbalance netting has a detrimental effect on the arbitrage possibilities.

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

4. 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.

Given the limited time available for presenting this impact assessment to the regulators, a qualitative approach for evaluation has been chosen. On the TSO side, there is only 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 be done by either 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 qualitative 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 what is already happening on the German side in the DK1 market area. 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.

4.1 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. However, 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, 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 3.3.

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.

5. 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.

5.1 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:

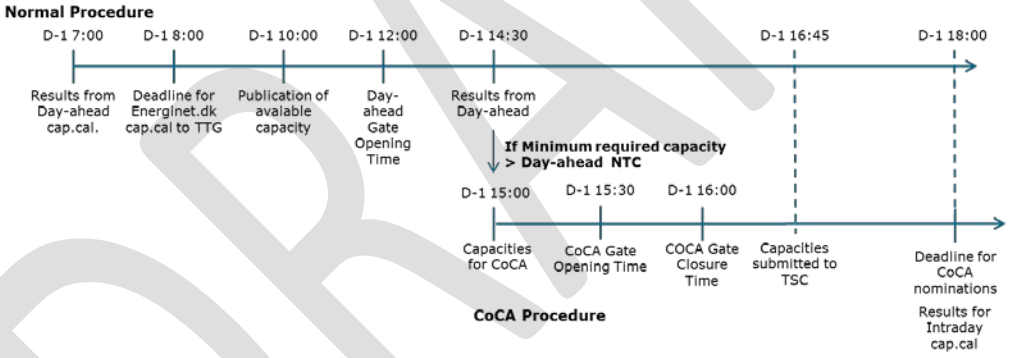

Figure 9: Suggested process for the CoCA model

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.

5.2 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 moni-

tored 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 activities on the short term markets will be required.

Currently, liquidity is not very high in the Nordic intraday market, which could mean no bids will be submitted in the auction. If no 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. The model builds on principles as the auctioning of PTR 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 generally is 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, where updated information for renewable production is not yet availa-

ble 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)[18], 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.

18 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.

6. Intraday auction – Intraday market

6.1 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. 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. One example is if the flow from DK1 to DE for a particular hour has to be decreased by 160MW, the capacity for export will be set to -160 MW, and a positive number for capacity import.

In the intraday auction, all market participants in the bidding zones participating in the additional 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. Gate opening for continuous trading is suggested to be at 15.00 as described in section 3.1. Alternatively, the auction could be held as closing auctions. This would, however, require hourly auctions, i.e. 24 auctions per day. Both options have advantages and disadvantages that are further described when going through the different evaluation criteria.

Additional implementation costs could be avoided, if the currently planned pan-European intraday auction is used to secure the countertrade/reverse the flow at the DK1-DE border. This auction is awaiting NRA approval, which might take until summer 2018 to obtain, see section 6.6. Currently, no final implementation date for this intraday auction is determined, but it is not likely to be in place before 2019-2020. A regional intraday auction in the Nordic is planned with the introduction of 15 min products in the balancing market. For the Danish market areas this is not planned before 2020-2021.

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 might therefore be difficult.

There are different variants of the models, e.g. using regional Nordic auction on the Danish side. In this case, TenneT could continue to use continuous intraday trading. This is not further elaborated in this report, as the evaluation based on the criteria will be the same in any variant for the intraday auction.

6.2 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. Having closing auctions, on the other hand, postpones the countertrade to shortly before the operating hour. However, in both cases, the risk is more related to the price and thereby costs associated with the countertrade.

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 2.1.2. 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 for first thereafter to be submitted to XBID. This would mean, however, that the liquidity for the continuous trading within XBID will decrease with having an implicit regional starting auction before.

For a closing auction, the impact on the TSO side would be larger as a closing auction requires an auction every hour instead of 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.

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. 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[19]. Thus everyone can offer down- and upward regulation given that capacities on interconnectors are available.

D. Effect of arbitrage

The extent and effect of arbitrage strongly depends on whether opening or closing auctions are used for countertrading.

The timing of the opening auctions (assuming it would be 15:00 for Nordic and the existing auction in DE at 15:30) would be similar to the CoCA, hence shortly after day-ahead gate closure. This facilitates arbitrage. Moreover, liquidity would be higher than in the CoCA model, because it would not be split between two market segments. Therefore, using intraday opening auctions for countertrading is likely to yield the highest degree of price convergence between day-ahead and the countertrade (among the models discussed in this document).

If countertrading is performed via intraday closing auctions, arbitrageurs can utilize the whole intraday trading period for passing on the price risk. 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.

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 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 capaci-

[19] This is to be decided by Nordic TSOs

ties 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.

7. Energinet and TenneT active on the Intraday market

7.1 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 allowed to trade directly in the intraday market. This countertrade model would therefore require permission for Energinet to trade, 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.

If Energinet were to go through a service provider to conduct the countertrade, Energinet would specify rules for transparency, so this service provider does not receive any information prior to the market. One solution could be to announce the MWh needed for countertrade via UMM messages.

7.2 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.

Bids activated in the intraday market are no longer available for the Nordic regulating power market. Thus choosing this model might reduce liquidity and increase prices in the Nordic regulating power market.

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, the only thing required is (a) the regulatory approval for Energinet to be allowed 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 Agreement 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. 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 increase 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. A public trading strategy could maybe be devised that would diminish the possibility for speculation and arbitrage as much as possible.

Buying all the necessary upward and downward regulation in the intraday market would eliminate the imbalance netting based on minimum capacities during the regulating power market timeframe in DK1.

E. Transparency

Energinet would have to inform the whole market simultaneously about the needed countertrade in each hour. This could e.g. be done through UMM messages to ensure transparency.

8. Special regulation - Nordic Regulating Power Market

8.1 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 and DK2 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. Today, this option is usually not applied as enough bids are expected to be available in the merit order list on a voluntary basis.

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

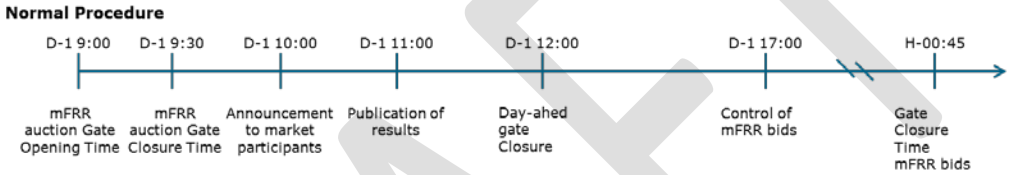

Figure 10: Process for mFRR bids in the Nordic regulating power market

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. If special regulation is chosen as a countertrade model, it would be advised to consider an alternative settlement, and separating the marginal price bids with the pay-as-bid, see section 3.2. 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, as Energinet is part of the common Nordic market, a change in the system will have to be harmonized and agreed with the Nordic TSOs.

As explained in section 3.2, the currently agreed process for special regulation only allows the use of bids from DK1 (and DK2 if capacity in the right direction would be available). 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.

8.2 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. This is no longer possible with the minimum capacity agreement. In these hours countertrade needs to be guaranteed by each TSO on its side of the border. The main disadvantage of this counter-

trade 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 the TSOs 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.

The 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 things being equal, also 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. It is not expected that a purchase of up- or downward regulation capacity each morning will increase the number of bids in DK1, and it will thereby only make the MWh for up- and downward regulation more expensive. Figure 8 shows that currently there is not in all hours enough volume available to cover the demand for countertrade.

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.

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.

Moreover, the complexity that market participants face is even larger. The additional complexity comes firstly from the fact that one more market segment lies between day-ahead and the countertrade. Secondly, market participants need to anticipate if their bids are likely to be selected for balancing (pay as cleared) or Special Regulation (pay as bid) and how they can influence this. In essence, arbitrageurs would need to trade-off between bearing the balancing price (since they would remain short at the end of the intraday phase) and additional earnings through the Special Regulation, in addition to the complexity that is already inherent to the intraday based model(s). Consequently, this model is the most complex one for the market participants.

Energinet can buy the capacity for for the sufficient upward and downwardregulation, 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.

9. Comparison of models – Weighted Scoring Model

For the comparison of the different countertrademodels at the German-Danish border, a Weighted Scoring Model is chosen. To also consider the opinions of interested market parties, the Weighted Scoring Model was presented on the workshop on 8 November 2017 in Copenhagen.

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.

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:	20%	20%	20%	20%	20%	100%
CoCa Model	5	5	5	5	5	5
Intraday auction	5	5	5	5	5	5
Intraday market	5	5	5	5	5	5
Special Regulation	5	5	5	5	5	5

Table 3 Example of the weighted score model