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IMPLICIT AUCTIONING ON THE KONTEK CABLE:
THIRD TIME LUCKY?

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Abstract

Cross-border capacities in Europe are currently inefficiently used. Implicit auctioning is about eliminating these cross-border trade inefficiencies by internalizing the arbitrage into the auction procedures of the Power Exchanges that are organizing trade nationally. On the Kontek Cable, implicit auctioning has been implemented without price coordination between the involved Power Exchanges. This implementation, referred to as "volume or dome coupling" as opposed to "price coupling", has been argued to be institutionally easier to implement. The Kontek Cable experimented with three different implicit auctioning implementations whose performance we analyze empirically in this paper. We find that the third implementation is significantly outperforming the previous two implementations, but in this third implementation stakeholders partly abandoned the volume coupling approach they initially believed to be a viable alternative to price coupling.

Keywords

Electricity, transmission, congestion management, market coupling

1. Introduction

The European experience is increasingly evidencing the inadequacy of the explicit auctioning method, which is to allocate cross-border capacities to traders and relying on them to arbitrate between the different national electricity markets. Newbery and McDaniel (2002) observe that the prices that are paid in the explicit auctions for rights to trade between France and the UK are significantly lower than the revenue that could be made with cross-border trade. Similar results can be found in Neuhoff (2003) for the explicit auctions between Germany and the Netherlands and in Purchala et al. (2004) for the explicit auctions in the Benelux region. Zachmann (2008) confirms these findings with a detailed statistical analysis of the lack of price convergence in Europe. Frontier economics and Consentec (2004), Turvey (2006), Kristiansen (2007a), Creti et al. (2009), and CRE (2009) study the utilization of the cross-border capacities and observe for different borders and periods that cross-border trade is often in the direction of the average price difference, even if the hourly price spread is frequently in the other direction. As a result, the scarcely available cross-border capacities are currently underused, and frequently also misused increasing price spreads instead of reducing them.

Implicit auctioning is about eliminating these cross-border trade inefficiencies by internalizing the arbitrage into the auction procedures of the Power Exchanges that are organizing trade nationally. Traditionally the debate in the literature has mainly been about explicit versus implicit auctioning. Bohn et al. (1983) demonstrated that implicit auctioning leads to a welfare-maximizing. Chao and Peck (1996) in turn showed that explicit auctioning does not necessarily reduce welfare, if there is continuous trading of electricity and cross-border capacities contracts. Gilbert et al. (2004), Parisio and Bosco (2008) and Ehrenmann and Neuhoff (2009) analyzed the difference between explicit and implicit auctioning under imperfect competition, and conclude that implicit auctioning reduces market power. Hobbs et al. (2005) showed the opposite can be true, arguing that abusive behaviour is more difficult to monitor in implicit auctions.

This paper contributes to the more recent debate on how to implement implicit auctioning in the European context by analyzing the experience on the Kontek Cable. This experience is relevant for three main reasons. First reason, it is the first implementation of implicit auctioning without price coordination between the involved Power Exchanges. This implementation, referred to as “volume or dome coupling” as opposed to “price coupling”, has been promoted by stakeholders[1] as a viable alternative that is institutionally easier to implement. Second reason, contrary to the successful implementations of implicit auctioning within the Nordic area, between Spain and Portugal, and between France, Belgium and the Netherlands, the Kontek Cable experience has not been without problems. Third reason, implicit auctioning in Europe is gaining momentum[2] so that analyzing the Kontek Cable case will help anticipating and remedying the same issues elsewhere.

Several authors have already expressed concerns about the implementation of implicit auctioning in the European context. Their concerns can be categorized into institutional issues (see Perez-Arriaga and Olmos, 2004; Ehrenmann and Smeers, 2005; Neuhoff and Newbery, 2005; and Meeus, 2010) and algorithmic issues (see Meeus et al. 2009a, 2009b; and Tersteegen, 2009). This paper then contributes to this more general literature with an analysis of the Kontek Cable experience, discussing both algorithmic and institutional issues. The paper first presents a detailed empirical analysis (data,

[1] See for instance the 2009 paper by the association of European Power Exchanges (Europex) and the association of European TSOs (ETSO): “development and Implementation of a coordinated model for regional and inter-regional congestion management,” available at www.europex.org.

[2] 18 March 2010, the Power Exchanges APX-Endex, Belpex, EPEX Spot, GME, Nord Pool Spot, and OMEL announced the creation of a 6 party project aimed at implementing implicit auctioning across the Nordic, Central West and Southern European regions.

methodology and results) and then concludes by deriving the most relevant lessons learned for the many ongoing initiatives to implement implicit auctioning in Europe.

2. Data

The Kontek Cable is in operation since 1995 and connects East Denmark with Germany. The main price references for these markets come from the auctions organized around midday for every hour of the next day by the so-called Power Exchanges. i.e. EEX[3] for Germany, and Nord Pool for East Denmark. Nord Pool is actually the Power Exchange for the whole Nordic region and also implemented implicit auctioning successfully on the internal borders in the Nordic area.

The available capacity on the Kontek Cable is 550 MW in both directions. Most of the capacity was initially reserved, but these priority access contracts meanwhile expired, the first contract expiring in 2005 and the second in 2006. Only in 2002 auctioning started on the Kontek Cable with explicit auctions for the capacity that was not used by the parties with priority access. Then in 2005, Nord Pool implemented implicit auctioning for the first time on the Kontek Cable by extending its market platform into Germany and thereby competing for liquidity with EEX.

In 2008, implicit auctioning was implemented for the second time on the Kontek Cable, replacing the first implementation. Nord Pool closed its German market platform, and began cooperating with EEX by creating a joint venture called the European Market Coupling Company (EMCC). The cooperation involves a coordination procedure, which starts with EEX and Nord Pool sending their order books to EMCC. EMCC consequently calculates the optimal utilization of the Kontek Cable. EEX and Nord Pool then update their order books, i.e. the importing Power Exchange introduces a price taking supply order, and the exporting Power Exchange introduces a price taking demand order. Finally, EEX and Nord Pool independently calculate their prices.

This second implementation of implicit auctioning on the Kontek Cable only lasted for 10 days. The stakeholders then took just over a year to prepare a third implementation of implicit auctioning on the Kontek Cable, delaying several times the launching date. FGH/IAEW (2009) explains that the original intention was only to change the algorithm, but testing with the improved algorithm provided unsatisfying results so that the coordination procedure itself was also modified. In 2009, the third implementation of implicit auctioning that is still running today was finally launched. According to FGH/IAEW (2009), EMCC is now assisting Nord Pool with the price calculation for East Denmark so that there is a degree of price coordination between EEX and Nord Pool, which was not the case in the previous two implementations.

The period that will be analyzed in this paper spans between 29/09/08 and 16/04/10. The period can be divided in three phases that will be analyzed separately. The first phase (29/09/08 - 07/10/08) is the 10 initial days that the cooperation between EEX and Nord Pool was operational (second implementation of implicit auctioning on the Kontek Cable). The second phase (14/10/08[4] - 08/11/09) is the period that the cooperation was suspended and Nord Pool reopened its German market platform (first implementation of implicit auctioning on the Kontek Cable). The third phase (09/11/09 until 16/04/10)[5] is the re-launch of the cooperation between Nord Pool and EEX with an improved

3 European Energy Exchange, which merged with the French Powernext in 2009, creating the European Power Exchange (EPEX).

4 Note that between phase 1 and 2, there are six days (08/10/08-13/10/09) that we do not consider in our analysis because during these days the capacity was not auctioned, instead it was offered intra-day on the basis of first come first serve (Nord Pool's Elbas system).

5 Note that there is one day 11/11/09 that has not been considered in our analysis because on this day the implicit auctioning system experienced a technical problem so that the capacity was not auctioned.

coordination procedure between the two Power Exchanges (third implementation of implicit auctioning on the Kontek Cable).

The data that will be analyzed includes the available Kontek Cable cross-border capacities, the EEX price for Germany, the Nord Pool price for East Denmark, and the utilization of the Cable. Note that this is hourly data that is publicly available on the websites of the respective companies[6].

3. Methodology

Figure 1 illustrates the welfare implications of an inefficient use of the Kontek Cable. The illustration is adapted from Hakvoort and de Jong (2007) who discuss the welfare implications of sub-optimal interconnection capacity investment. The aggregated supply and demand curves are represented as a net export curve for the lower priced region and net import curve for the higher priced region. As illustrated, the prices converge as more energy is exchanged across the Cable.

The left side illustrates a situation where the available capacity is not enough to equalize prices. EFG is the resulting welfare loss. ADFEA is the increase in welfare from cross-border trading, which consists of a welfare increase for the importing region (ABEA), a welfare increase for the exporting region (CDFC), and a congestion rent (BCFEB). There is a congestion rent because the volume that is exchanged across the border is imported at a higher price than it is exported.

The middle illustrates a situation where the available capacity is not enough to equalize prices and the capacity is underused. HIFEH is the additional welfare loss from this inefficient use of the capacity. HIFEH can be approximated by the price spread (price H – price I) multiplied with the unused capacity (capacity - flow). This approximation can be calculated for the Kontek Cable because the available data includes the capacities (Figure 1, capacity), the utilization of the Cable (Figure 1, flow), and the prices in East Denmark and Germany corresponding to this utilization (Figure 1, price H and I). Note that the approximation overestimates the welfare loss because it does not account for the price convergence, but it provides nevertheless a good indication for the order of magnitude of the welfare loss.

The right side illustrates a situation where the available capacity is not enough to equalize prices and the capacity is misused, i.e. there is a flow in the opposite direction of the price spread (counter flow), increasing the spread instead of reducing it. JKFEJ is the welfare loss from this inefficient use of the capacity. JKFEJ can be approximated by the price spread (price J – price K) multiplied with the unused capacity (capacity – counter flow). As illustrated in the Figure, the approximation error is higher for cases with counter flows to the extent that the counter flow causes prices to diverge.

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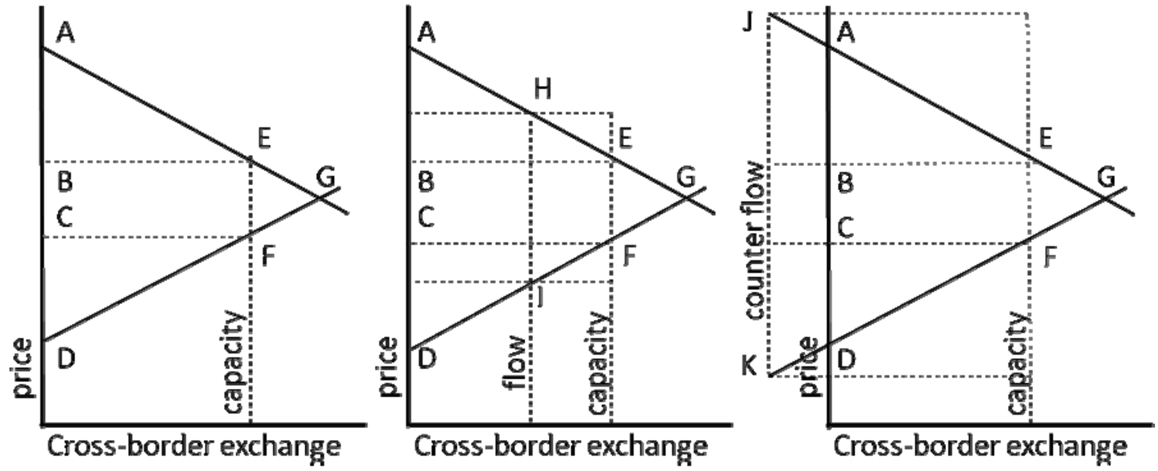
[6] All data can also be found here (website of the Danish TSO): http://www.energinet.dk/en/menu/Market/Download+of+Market+Data/Download+of+Market+Data.htm

Figure 1: welfare implications of an inefficient use of the Kontek Cable



Frontier economics and Consentec (2004), Turvey (2006), Kristiansen (2007a), Creti et al. (2009), and CRE (2009) also distinguish between underused and misused capacity, as in the above illustration. These authors however also recognize that misused capacity is an extreme form of underused capacity. Indeed, a flow in the opposite direction of the price spread implies that the unused capacity in the direction of the price spread is the total capacity plus the flow. In the remainder of this paper, we apply this definition of unused capacity, which implies that the Kontek Cable can have 1100 MW unused capacity, i.e. the double of the maximally available cross-border capacity, in the extreme case where the Cable is fully utilization in the wrong direction.

4. Results

Table 1 summarizes the welfare loss under the three implementations of implicit auctioning on the Kontek Cable. The welfare loss has been calculated using the methodology introduced in the previous section and the results have been annualized to allow comparison with other studies. CRE (2009) applies the same methodology to the explicit auctions on the French borders. For 2008, the welfare loss on the French border with England is 44M Euros, 96M Euros on the border with Germany, 128M Euros on the border with Italy, 33M Euros on the border with Spain, and 95M Euros on the border with Switzerland.

The implicit auctioning implementations on the Kontek Cable (Table 1, welfare loss annualized) seem to perform better than the explicit auctions on the French borders, with an annualized welfare loss of respectively about 10M Euros, 28M Euros, and 0,5M Euros for the first, second and third implementation. This could however be partly explained by the fact that less cross-border capacity needs to be auctioned on the Kontek Cable than on these French borders. If we correct for capacity, expressing the annualized welfare loss per unit of capacity (Euros/MW)[7], the result for the border with England is 22k Euros, 39k Euros for the border with Germany, 78k Euros for the border with Italy, 39k Euros for the border with Spain, and 43k Euros for the border with Switzerland. Expressed in this way, the results for the first two implementations of implicit auctioning on the Kontek Cable, respectively 20k and 54k Euros, are similar to those of the explicit auctions, but the third implementation still outperforms the explicit auctions with an annualized welfare loss per unit of

[7] We took the 2008 summer NTC values for the capacities, as published by ENTSO-E. If there is a different value for a different direction, we took the average of the two values.

capacity of only 1k Euros. Therefore the indication from Table 1 is that the third implementation outperforms the previous two implementations.

Table 1: main results for the three implicit auctioning implementations on the Kontek Cable.

	First implementation	**Second implementation**	**Third implementation**
Observations	Phase 2 data	Phase 1 data	Phase 3 data
Welfare loss annualized	10,755,301	28,436,443	589,105
Welfare loss annualized per unit of capacity	19,555	51,702	1071

Table 2 summarizes the results of statistical tests having been used to verify the Table 1 indications. First, an F-test of the null hypothesis that two samples have the same variances is conducted. The p-value is zero in all cases (i.e. the null hypothesis has to be rejected). This information is needed to know which type of T-test to run. Second, the T-test determines whether two samples are likely to have come from the same underlying population having the same mean. The p-values again are zero, meaning that the average hourly welfare losses in the three implementations are significantly different. Both tests therefore strongly confirm the indications from Table 1, i.e. the third implementation of implicit auctioning on the Kontek Cable is outperforming the previous two implementations.

Table 2: statistical tests to compare the performance of the three implicit auctioning implementations on the Kontek Cable.

Welfare loss	**First implementation**	**Second implementation**	**Third implementation**
Mean	1,228	3,246	67
Variance	67,262,461	5,554,463	509,755
F-test	$\mu_1 = \mu_2$: 0.00%	$\mu_2 = \mu_3$: 0.00%	$\mu_3 = \mu_1$: 0.00%
T-test	$\mu_1 = \mu_2$: 0.02%	$\mu_2 = \mu_3$: 0.00%	$\mu_3 = \mu_1$: 0.00%
Z-test	$\mu_1 > 0$: 99.99%	$\mu_2 > 0$: 100.00%	$\mu_3 > 0$: 99.99%

CRE (2009) also reports that on the border with Belgium, the day-ahead explicit auction has been replaced by an implicit auction in 2006, which has eliminated the inefficient utilization of the cross-border capacity on this border completely in every hour[8]. Still, this is not the case on the Kontek Cable. As shown by the Z-test in Table 2, the probability that the hourly welfare loss is greater than zero on average is 100% for the three implementations of implicit auctioning on the Kontek Cable. In what follows, we therefore discuss the possible reasons for these inefficiencies for the three implementations separately.

4.1 First implementation

As discussed in Section 2, the first implementation of implicit auctioning on the Kontek Cable replaced in 2005 the explicit auctions that had been running since 2002. It was Nord Pool, the Power Exchange of the Nordic region, that implemented implicit auctioning by opening a German market platform.

This implied that the arbitrage between Nord Pool East Denmark and EEX Germany, was replaced by arbitrage between Nord Pool Germany and EEX Germany. Therefore, this implementation is in between explicit and implicit auctioning. The explicit auction for cross-border capacity was stopped

[8] Vandenborre (2008) discusses this regional market initiative, referred to as the Trilateral Market Coupling initiative, which besides France and Belgium, also involves the Netherlands, and is currently being extended to Germany.

(as in implicit auctioning), but the performance of this implementation continued to dependent on perfect foresight by arbitrageurs (as in explicit auctioning).

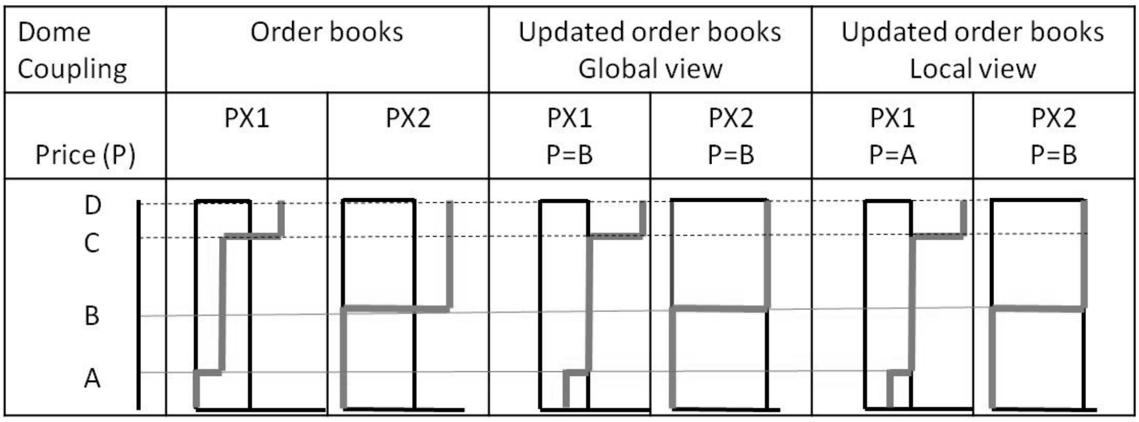
Even though it could have been expected that arbitrage between Nord Pool Germany and EEX Germany would have been more efficient than previously between Nord Pool East Denmark and EEX Germany, simply because arbitrage within Germany is not constrained by cross-border capacity, Kristiansen (2007b) shows that this was not the case. His study shows that this first implementation resulted in two significantly different prices in Germany, i.e. one quoted by Nord Pool and supported by very low volumes and the other quoted by EEX where most of the volume continued to be traded. Furthermore, the Nord Pool price for Germany was more correlated to the Nord Pool price for East Denmark than to the EEX price for Germany.

4.2 Second implementation

As discussed in section 2, the second implementation of implicit auctioning on the Kontek Cable replaced in 2008 the first implementation for 10 days, after which the first implementation was reinstalled. During these 10 days, the Power Exchanges cooperated to optimize the clearing of their order books, but they also continued to independently calculate their own prices. As discussed in the introduction, this approach is referred to as volume or dome coupling.

Figure 1 illustrates why the second implementation inherently creates inefficiencies in the presence of a limited amount of discrete orders. Figure 1 on the left illustrates the aggregated supply and demand curves that can be derived from the order books of Power Exchanges PX1 and PX2. Under the dome coupling approach, the Power Exchanges cooperate by sending their order books to a third entity (EMCC in the case of Nord Pool and EEX). As illustrated in Figure 1 in the middle, this third entity then calculates the optimal exchange between the involved Power Exchanges, having a “global view” of the two order books. In this illustration this implies that PX1 imports from PX2 and the illustration assumes that there is enough capacity to host this exchange. As illustrated in Figure 1 on the right, the PXs would then calculate their own prices from their “updated local view”. The update consists of accommodating the import of PX1 from PX2 by adding a price taking supply bid to the order book of PX1 and a price taking demand bid to the order book of PX2, which is illustrated by respectively shifting the supply and demand curve of PX1 and PX2.

Figure 1: illustrating how the second implementation can lead to inefficiencies



Even if both Power Exchanges apply the same price rule, like taking the lowest price possible, it can result in inefficiencies. In the above illustration, taking the lowest price possible for PX1 implies taking A as its price (from the possible set A-C), while for PX2 it implies taking B as its price (from the possible set B-D). The outcome is that there is a price difference between the Power Exchanges, even though prices could have been levelled at prices between A and B. There is inefficiency because there is a price spread, while there is also unused capacity. Note also that PX1 is importing from PX2, while it has a lower price (A<B) so that this example also includes a counter flow.

While the second implementation was ongoing, a “dead band” has also been introduced. It implies that EMCC only uses the Kontek Cable capacity to the extent that the resulting congestion rent can finance the grid losses caused by the exchanges. This is likely to explain part of the inefficiencies.

A lack of price cap harmonization can also cause inefficiencies. At the time of the second implementation, the prices on EEX could go from -3,000 €/MWh to +3,000 €/MWh, while prices on Nord Pool could only go from 0€/MWh to +2,000 €/MWh. Using the terminology of Figure 1, it is then possible that the price to be taken from the optimal global point of view, is not allowed from an updated local point of view. During the 10 days that the second implementation was operational (240 hours), the EEX price went beyond the more binding price caps of Nord Pool in 3 consecutive hours. The hours featured negative prices on EEX, but the Nord Pool price was 59,9 €/MWh and there was no exchange between the zones, which cannot be explained by the issue with price caps. Therefore this does not seem to have been a real issue.

Finally, FGH/IAEW (2009) discusses several algorithmic issues that have caused inefficiencies during the second implementation. The algorithms run by Nord Pool, EEX and EMCC were for instance not calculating with the same precision causing rounding errors. Another problem has been currency conversion as the EEX order book is in Euros, while the Nord Pool order book is partly Danish, Norwegian and Swedish Crown and EMCC was not applying the same currency rate as Nord Pool when converting the order book into Euros, etc. This is also likely to explain part of the inefficiencies, but based on publicly available information this effect cannot be distinguished from the other relevant effects indentified in this section, i.e. missing price coordination, and dead band.

4.3 Third implementation

The third implementation of implicit auctioning on the Kontek Cable was intended to address the algorithmic issues of the second implementation, while keeping the “institutional” constraints (no price coordination, no price cap harmonization, and keeping the dead band). However, testing with the new algorithm provided unsatisfying results so that also the institutional constraints have been (partly) addressed.

According to FGH/IAEW (2009), EMCC is now giving an indication to Nord Pool about the EEX price. We can explain what this implies based on Figure 1. Let’s first assume that Nord Pool is PX1 and EEX is PX2. This would imply that PX1 (Nord Pool) is informed about the updated local view of PX2 (EEX), anticipating that PX2 (EEX) will have price B, and could decide to overrule the price that it would normally take based on its own updated local view. PX1 (Nord Pool) would then also accept price B and by doing so avoid a welfare loss on the Kontek Cable. However, if we now assume that Nord Pool is PX2 and EEX is PX1, PX2 (Nord Pool) would anticipate that PX1 (EEX) will have a price A, but this price is infeasible for PX1 (Nord Pool) so that it will keep the price B, and the result is the same prices as in the situation without price coordination. In other words, coordination in one direction is not enough and this can partly explain the inefficiencies of the third implementation.

The death band is also still in operation, which is another source of inefficiencies of the third implementation. The lack of price cap harmonization also continues to be a potential source of inefficiencies, but in the 5-month period we analyzed, we could not find hours where this could have caused inefficiencies. Note also that the more binding price caps of Nord Pool have been partly addressed, i.e. prices on Nord Pool can now also become negative, but down to -200€/MWh, while on EEX this is -3000€/MWh.

5. Conclusions and policy implications

The first implementation of implicit auctioning on the Kontek Cable integrated the pricing of the cross-border capacities with the pricing of the energy contracts auctioned by Nord Pool. The second implementation went a step further by optimizing the clearing of the Nord Pool and EEX order books, but the Power Exchanges continued to calculate their own prices independently. The third implementation went another step further by partly coordinating the pricing of the Power Exchanges, but it is only Nord Pool that coordinates, while EEX simply continues to calculate its own price independently.

The main result of the empirical analysis is that the third implementation still has inefficiencies with a annualized loss of welfare of about 0,5 M Euros, but it does significantly outperform the previous two implementations where this loss was respectively of the order of 10 M and 28 M Euros per year. The third implementation that is still running today therefore did turn out to be lucky (hence the paper title), but in this third implementation the pricing of the involved Power Exchanges is (partly) integrated. In other words, the stakeholders abandoned the pure “volume coupling” or “dome coupling” approach they believed to be a viable alternative to the institutionally more difficult to implement “price coupling” approach. This is an important lesson learned for the many ongoing initiatives to implement implicit auctioning in Europe.

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