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**Diplomarbeit**

**Flow-Based Coordinated Explicit Auctions:  
Revenue Distribution Analysis and Developments in  
Applied European Congestion Management**

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## **Abstract**

EU regulation 1228/2003 (EU, 2003) defines the framework for cross-border transactions within the electricity sector. The regulation reflects the effort of the European Union towards an internal electricity market within the EU. At the same time, regulators of the EU member states tend to evaluate and improve existing proposals for a market based congestion management. For this purpose, the 'Florence-Fora' were established in 1998. These are regular discussion meetings on a semi-yearly and yearly basis. In 2004, on the 11<sup>th</sup> Florence Forum, it was, moreover, decided to arrange regional 'Mini-Fora'. Consequently, the EU states were combined within seven regional sub-segments in order to coordinate and harmonize congestion management methods for several control areas.

One region in the course of this process is the Central East Europe (CEE) region. Based on public available data for this region, the establishment of a flow-based coordinated auction is modeled and simulated. In particular, three topics are analyzed. First of all, different revenue distribution methods are analyzed regarding their incentive signals to TSOs. In order to do so, an incentive compatible set of targets is defined incorporating economical, technical and political issues. Among others, the distribution methods proposed by ETSO (2001, p. 22) are analyzed. Additionally, the impact of netting for the results of a flow-based auction is analyzed. The third topic deals with the question whether a perpetuation of currently applied technical profiles – i.e. pooling of several borders with a single NTC for all of them – as combined border capacities (CBC) is efficient.

The model is a linear optimization problem which is solved in GAMS. It is based on a zonal model of the CEE region including 8 zones and 13 tie-lines.

The analysis shows that the revenue allocation schemes proposed by ETSO do not generate efficient incentives. It can be shown that the most efficient revenues distribution scheme differs with the chosen market structure that means whether the netting is considered or not and whether CBCs are included or not. Altogether, an allocation according to accepted bid flows (ABF) – in order to set the right incentives for maximizing the regional welfare – seems to be a good trade-off for all considered cases. However, the most efficient case from an economic point of view is the cases with netting - without taking into account network reasons – and excluding CBCs.

## Zusammenfassung

Die Verordnung (EG) 1228/2003 (EU, 2003) der Europäischen Union (EU) regelt die Rahmenbedingungen für grenzüberschreitende Transaktionen im Elektrizitätssektor. Die Verordnung folgt den allgemeinen Bestrebungen der EU, die Elektrizitätswirtschaft europaweit als einen integrierten Binnenmarkt zu begreifen und somit die nötigen Rahmenbedingungen zu schaffen bzw. zu spezifizieren. Parallel mit der Europäischen Kommission verfolgen die Regulatoren der Mitgliedsstaaten das Ziel einer Evaluierung und Verfeinerung der bestehenden Vorschläge für ein marktbasierendes Engpassmanagement. Zu diesem Zweck werden seit 1998 ein- bis zweimal jährlich Diskusstreffen abgehalten, den sog. ‚Florence Fora‘. Um zunächst eine Harmonisierung der Marktstrukturen auf regionaler Ebene zu erreichen wurde beim elften Florenz Forum im September 2004 beschlossen, sog. regionale ‚Mini-Fora‘ zu gründen. Dabei wurden die EU-Staaten zu sieben regionalen Teilmärkten zusammengefasst um auf dieser regionalen Ebene regelzonenübergreifende Engpassmanagement-Methoden zu koordinieren bzw. harmonisieren.

Eine dieser Regionen ist die ‚Central East Europe‘ (CEE) Region. Für die vorliegende Analyse wurden öffentlich verfügbare Daten und Informationen dieser CEE Region verwendet. Basierend auf dieser Datengrundlage wird eine lastflussbasierte koordinierte explizite Auktion modelliert und Ergebnisse diskutiert. Dabei werden drei Aspekte vertiefend betrachtet. Zunächst werden verschiedene Methoden zur Auktionserlösverteilung hinsichtlich ihrer Anreizwirkungen untersucht. Dafür wird ein Anreizsystem definiert, das ökonomische, technische und politische Aspekte abbildet. Unter anderem werden die Erlösverteilungsvarianten untersucht, die von der ETSO (2001, S. 22) vorgeschlagen wurden. Ein weiterer Untersuchungsgegenstand ist der Einfluss von ‚Netting‘ auf die Analyseergebnisse. Der dritte Aspekt der Analyse beschäftigt sich mit der Frage wie sich die derzeitige angewendeten technischen Profile – das sind mehrere zu einem NTC-Wert zusammengefasste Grenzen – auf die Ergebnisse einer lastflussbasierten Allokation auswirken, falls diese als so genannte kombinierte Grenzkapazitäten weiter Anwendung finden sollten.

Das Modell ist ein lineares Optimierungsproblem, welches in GAMS gelöst wird. Es handelt sich dabei um ein Zonenmodell mit acht Zonen die durch 13 Verbindungsleitungen verbunden sind.

Die Analyse zeigt, dass die Erlösverteilungsmethoden der ETSO falsche Anreize – in Bezug auf die Maximierung der regionalen Wohlfahrt – setzen. Eine effiziente Erlösverteilungsmethode hängt von der gewählten Marktstruktur ab. Die optimale Variante ändert sich also wenn man sich für oder gegen ‚netting‘ entscheidet bzw. wenn kombinierte Grenzkapazitäten betrachtet werden. Eine Aufteilung von Auktionserlösen – mit dem Ziel die regionale Wohlfahrt zu maximieren – gemäß den Flüssen, die aus den akzeptierten Geboten resultieren, erscheint allerdings als ein gangbarer Mittelweg für alle betrachteten Fälle. Vom ökonomischen Standpunkt aus, ist allerdings der Fall mit ‚Netting‘ - ohne Berücksichtigung von Problemen der Versorgungssicherheit - und ohne kombinierte Kapazitäten der effizienteste.

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## Abbreviations

A	Austria	MP	Marginal Price
AF	Absolute Flows	MW	Megawatts
AF_CP_SP	Absolute Flows_Clearing Price_Shadow Price	MWh	Megawatt hours
AF_RF	Absolute Flows_Relative Flows	N	Norway
AO	Auction Office	NF	Natural Flow
B	Belgium	NL	Netherlands
BC	(Net) Border Capacity	NTC	Net Transfer Capacity
BCE	Base Case Exchange	OF	Outside Flow
CAO	Coordinated Auction Office	OMC	Open Market Coupling
CBC	Combined Border Capacity	P	Portugal
CEE	Central East Europe	PJM	Pennsylvania, New -Jersey, Maryland
CEPS	Czech System Operator	PI	Poland
CH	Switzerland	PSE	Polish System Operator
CP	Clearing Price	PTDF	Power Transfer Distribution Factor
CP_SP	Clearing Price_Shadow Price	R	Russia
CZ	Czech Republic	RF	Relative Flows
D	Germany	RF_LF_CP	Relative Flows_(n-1) Limit Usage_Clearing Price
DK	Denmark	RPV	Revenue per Accepted Bid Volume
E	Spain	S	Sweden
EEX	European Energy Exchange	SEE	South East Europe
ETSO	European Transmission System Operators	SETSO	South-East Europe Transmission System Operators
EU	European Union	SK	Slovakia
F	France	SL	Slovenia
FI	Finland	SP	Shadow Price
FRM	Flow Reliability Margin	TAR	Total Auction Revenue
G	Greece	TBC	Total Border Capacity [already including (n-1)-constraints]
HU	Hungary	TP	Technical profile (see also CBC)
I	Italy		
IR	Ireland		
L	Luxemburg		
LMP	Locational Marginal Pricing		
MS_AF_CP	Market Share_Absolute Flows_Clearing Price		

TSO	Transmission System Operator	UK	United Kingdom
TU	Thermal Usage		
UCTE	Union for the Co-ordination of Transmission of Electricity		

## Nomenclature

### *Symbols*

D	deviation	r	element of the PTDF matrix
$d_a$	accepted quantity per bid	$\rho$	correlation
$d_{bid}$	required quantity per bid	$\sigma$	variance
$D_{max}$	maximum deviation	$v_i$	valuation of good by bidder i
$p_{bid}$	bid price per bid		

### *Indices*

a	accepted	k	zone as sink of a tie-line
b	bid within the auction	max	maximum
bid	requirement per bid	x	zone as source of a bid
i	bidder in an auction	y	zone as sink of a bid
j	zone as source of a tie-line		

# 1 Introduction

In times of vertical integrated monopolistic energy companies, the task of congestion management was to minimize generation cost and network losses while guaranteeing the highest level of network security (Christie et al., 2000, p. 170). In the course of deregulating the electricity sector, the requirements to efficient congestion management changed. The task of the regulated system operator still consists in the warranty of network stability. However – considering most of the congestion methods applied in Europe – the Transmission System Operator (TSO) no longer has influence on the location of generation. The decision about which generator satisfies the existing demand is made by the liberalized energy market. Accordingly, the system operator only has the opportunity to define a framework and prepare appropriate actions in order to achieve a sufficient network security (ibid., p. 170). Moreover, cross-border flows become more and more important. Two main reasons explain this fact. On the one hand, the liberalization of the electricity market facilitates cross-border trade of electrical energy – an important example is the establishment of energy exchanges for standardized products. On the other hand, differences in energy prices between different countries within the EU provide an economic incentive for transporting electrical energy from one country to another. The fundamental reason for these price differences consists in different age structures, generation technologies and locations of the EU countries' power plants as well as in different fuel prices between the countries. In accordance to this tendency towards higher trading activities as well as due to a lack of transmission capacities within few control areas, the necessity for a coordinated cross-border congestion management increases.

Flow-based coordinated explicit auction is one congestion management method which seems to be favored for implementation in many of the European regions. This thesis focuses on the incentive effects of the revenue distribution of such an allocation method. For this purpose, different congestion management methods are introduced and briefly explained (Section 2.1). Then, auction theory in principle is introduced (Section 2.2). As the flow-based coordinated explicit auction is supposed to be applied in a realistic environment, evaluation criteria have to be defined in order to represent the different tasks that have to be fulfilled in the real world. This is done in Section 3. In Section 4 the mathematical model of the problem is formulated and the data set is introduced just as basic assumption for the following analyses. Here also, different auction revenue allocation schemes are introduced. These methods are examined regarding their incentive compatibility to the set of targets defined for an applicable congestion management scheme (Sections 5.1 and 5.2).

The analysis shows that the revenue distribution methods proposed by ETSO (2001, p. 22) are not incentive compatible according to the defined targets. Additionally, it is found that a sound trade-off regarding an applicable revenue distribution method is to allocate revenue according to the flows resulting from accepted bids. Moreover, the analysis shows that the perpetuation of technical profiles –

as combined border capacities – is not efficient and that the auctioning of obligations seems superior to the auctioning of options.

## 2 Literature Review

### 2.1 Survey of congestion management methods

At the beginning, a survey of different congestion management methods is presented in order to give a brief overview of the ongoing discussion and in order to classify flow-based coordinated explicit auctions compared to other methods.

#### 2.1.1 Difference between flow-based and not flow-based methods

In general, flow-based and not flow-based market based congestion management methods can be distinguished (Figure 1). Not flow-based methods do not take into account physical flows that result from demand for transmission capacity – i.e. explicitly in form of bids for transportation from a source node/zone to a sink node/zone or implicitly in form of energy bids.<sup>1</sup>

Among not flow-based methods, mainly bilateral auctions take place in cross-border capacity auctions as the effort for coordination is limited to the two TSOs at the both ends of a cross-border line. Regarding an energy transport from one zone to any other zone, a bidder may have to win in several bilateral auctions in order to transmit across several borders. Moreover, there are also coordinated not flow-based auctions.<sup>2</sup> Thereby, bids across more than one border are allowed but their physical impact is not considered. It is a pure commercial consideration.

In both cases, commercially available capacity is set by the TSOs such that network stability is secured for each possible load case. This can lead to a distorted utilization of the physically available capacity (compare Chao et al., 2000, p. 56).

Regarding flow-based methods, however, physical flows that result from commercial bids are calculated individually and assigned to each line capacity.<sup>3</sup> Then, the optimal network usage is calculated by means of demand and willingness to pay – while also taking into account physical constraints.

#### 2.1.2 Nodal pricing

The economical and technical optimal congestion management method is nodal pricing (compare i.e. Schweppe et al, 1988; Stoft, 2002, S. 391ff.).<sup>4</sup> Nodal pricing means that each node within the network is considered separately. The price for energy at a node represents the incremental cost incurring for

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<sup>1</sup> Hence, it is assumed that electricity can be transported from one specific zone to another specific zone. In reality, however, each input spreads over the entire meshed network according to Ohms' and Kirchhoffs' laws.

<sup>2</sup> An example was the CEPS coordinated auction for Poland, the Czech Republic and Germany/Vattenfall in 2005. For 2006, this auction also includes Germany/EON and Slovakia.

<sup>3</sup> This applies for explicit transmission capacity markets. In an implicit auction, the impact of physical flows is reflected in location-specific energy prices (see for example Schweppe et al., 1988).

<sup>4</sup> Often it is also referred to as locational marginal pricing (LMP).

delivering one more MWh of energy to exactly this node. The energy price is, consequently, the best scarcity signal for the commodity electrical energy at a specific node. Disregarding transmission losses and assuming sufficient generation capacity, the energy price is made up by the incremental cost of generation and scarcity prices of transmission. The prices are equal for each node in case congestion does not occur. In case of congested lines, transmitting electricity becomes a scarce commodity. The price for this commodity produces an extra charge on top of the energy price according to supply and demand at each node. Thus, nodal prices normally vary between different nodes.

### **2.1.3 Market splitting**

Within the market splitting approach, injections and withdrawals of several nodes are represented mutually by a zone; they are assigned to one specific zone. Hence, there is only one energy price per zone. Zones can be interpreted as sub-markets that, ideally, form according to network congestion. In most cases, however, zones are defined by political borders (mostly control areas). Basically, there are two alternative ways to merge nodes together as a zone. The first alternative is similar to the nodal pricing approach. The entire network is considered physically; including the lines within a zone. The difference is that the prices for the nodes within a zone are defined to be equal. The second alternative does not consider the entire network. The nodes of a zone are treated as they were located upon one big copper plate. Hence, congestion within a zone is not regarded. Zones are linked by interconnections.<sup>5</sup> Ehrenmann and Smeers (2004, p. 14ff.) refer to the first alternative as the ideal market splitting, whereas, the second one can only be a second-best approach.

### **2.1.4 Market coupling**

The difference between market coupling and market splitting consists in differing starting conditions (Ehrenmann and Smeers, 2004, p. 23ff.). The market splitting approach assumes an existing integrated market that is split up in sub-markets. The market coupling approach, in contrast, assumes that sub-markets already exist and cannot be merged to one integrated market in a short or medium term. Therefore, market coupling tries to interlink sub-markets as far as possible. Interpreting, again, a sub-market as a zone, market splitting and market coupling do theoretically not differ significantly from each other. Both can be referred to as zonal pricing or zonal models, respectively. However, implications for a practical implementation are different. According to Brunekreeft et al. (2004, p. 18), the advantage of the latter two approaches compared to the subsequent explicit auctions “is that energy transmissions are determined after generators and demands have submitted their information to national power exchanges”. Consequently, the information situation is better which in turn results in a more efficient decision making process in practice (ibid., p. 18).

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<sup>5</sup> The aggregation of the network is a potential source of error as the entire highly meshed grid can hardly be represented by a much smaller model.

### 2.1.5 Flow-based coordinated explicit auctions

Similar to the market coupling approach, coordinated explicit auctions interlink different markets. The difference between a coordinated auction approach to the approaches mentioned above consists in the chronology of the market clearing process and, accordingly, also in the traded commodities. The traded commodity of the methods described above is electrical energy at a specified location – a node or a zone. The market clearing price includes generation cost as well as congestion costs.<sup>6</sup> There is no separate price for transmission; that is why those methods are often also referred to as implicit auctions (Pérez-Arriaga and Olmos, 2004, p. 3). The first step of an explicit coordinated auction, however, is the allocation of transmission capacity. Only after the auctioning of transmission capacity, the energy market opens (Ehrenmann and Smeers, 2004, p. 31) and the required quantities of energy can be bought and transmitted according to the awarded transmission rights. Note that – in contrast to bilateral auctions – bids can be placed for each pair of zones and the award of capacity to a bid includes the transmission rights for each line.

However, coordinated auctions can also be not flow-based. In this case the network topology is not taken into account adequately as commercial congestion may be priced albeit they do not occur as physical flows in reality (compare Section 3.2). Hence, in order to achieve sufficient resource utilization, flow-based methods must be applied.

During the auctioning process of a flow-based coordinated explicit auction, three steps can be defined (see also Brunekreeft et al., 2004, p.18):

1. TSOs inform the Auction Office (AO) about physical network parameters (for PTDF calculation and border capacities). The AO then merges data and opens an auction
2. Market participants (“Bidders”) place their bids for transmission between any of the participating countries.
3. The AO conducts the clearing and notifies Bidders and TSOs about the outcome.<sup>7</sup>

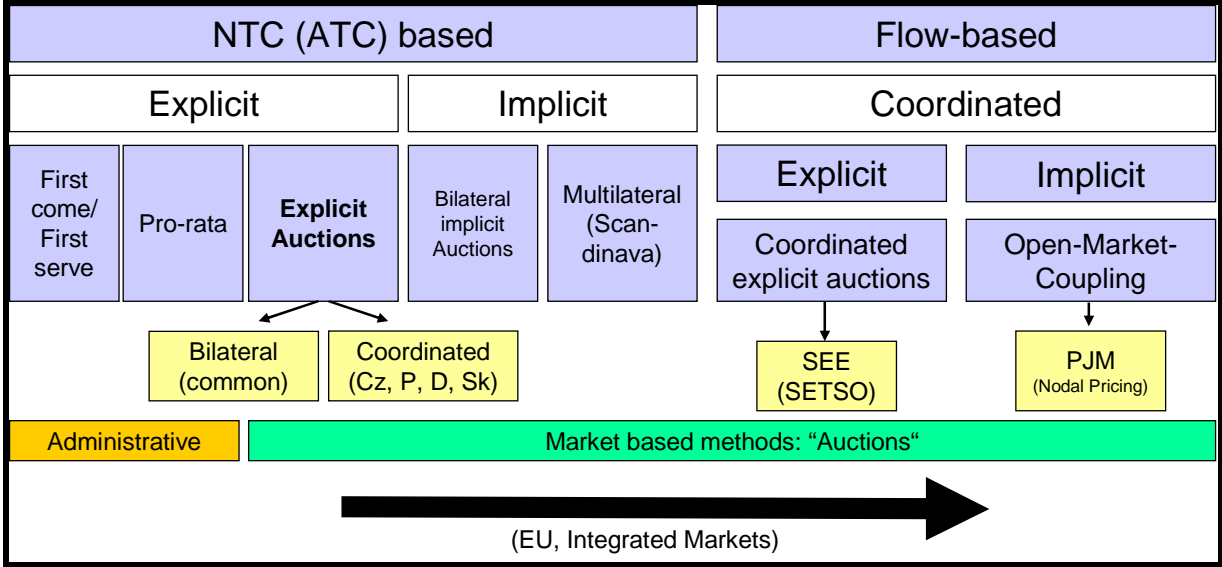
Note that Stoft (2002, p. 231) assumes that a market for transmission is purely bilateral. This argument, whereas, cannot be supported here. A coordinated explicit flow-based auction is also a market for transmission rights but not bilateral.

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<sup>6</sup> Again disregarding transmission losses and assuming sufficient generation capacities.

<sup>7</sup> That means, the AO allocates the available capacity such that the auction revenue is maximized under the given network constraints and according to the auction rules – regarding for example “fill or kill” or block-bids.

**Figure 1: Congestion management methods**



Source: Vujasinovic, 2005, p. 3; own illustration.

**2.2 Auctions**

In contrast to implicit methods where energy is allocated and congestion cost are reflected in locationally differing energy prices, in a flow-based coordinated explicit auction, physical transmission rights are allocated (compare Section 2.3) through an auction process. Hence, the following section briefly describes the idea of auctions, different standard auctions, and how a flow-based coordinated auction for transmission capacity fits in there.

**2.2.1 Auction theory**

An auction is an instrument to find a price for a good if the value is not at all or incompletely known (Blum et al., 2006, p. 145). Erhart and Ott (2003, p. 2) add that auctions are conducted for a price determination for multilateral trading without ‘market makers’. They describe an auction as a market institution embracing an explicit set of rules (ibid., p. 4). These rules must not be changed during the process of auctioning and the only input should be the bids (ibid. p. 4). Hence, Klemperer (1999, p. 6) states that the presence of asymmetric information is a crucial feature of auctions. Consequently, auctions support the gain of information – for the bidder as well as for the auctioneer – such as true preferences, willingness to pay and production costs (Erhart and Ott, 2003, p.2). Accordingly, the valuation of the auctioned good plays an important role for the auction model (Table 1).

In a private value auction, the valuation  $v_i$  of a bidder  $i$  only depends on his own appreciation. That means that each bidder knows the value he places on winning the object (Athey and Haile, 2000, p. 1). This value is independent from the valuation of the other bidders  $v_{-i}$  (Blum et al., 2006, p. 147, Klemperer, 1999, p. 6). In a correlated value auction, the utility is different for each bidder (Blum et al., 2006, p. 147) but the valuation of the good is roughly of the same dimension. In a common value

auction, the actual value of the auction is the same for each bidder (Klemperer, 1999, p. 6). However, bids differ as information about the value of an object are unequally spread among bidders (Athey and Haile, 2000, p. 1).

**Table 1: Valuation and auctions**

Model	Correlation
Private value auction	$\rho(v_i, v_{-i}) = 0$
Correlated value auction	$0 < \rho(v_i, v_{-i}) < 1$
Common value auction	$\rho(v_i, v_{-i}) = 1$

Source: Blum et al., 2006, pp. 147 et sqq.

### 2.2.2 Standard auctions

Klemperer (1999) provides an extensive guide to auction theory literature. He states that most of the existing auction theory focuses on single indivisible goods (ibid., p. 26). This must be kept in mind when focusing on the four standard auction forms (Table 2).

Regarding an open-bid auction, bidder  $i$  has all information about the bids of the other bidders  $\neg i$  (Blum et al., 2006, pp. 147 et sqq.). In a sealed-bid auction this does not apply as each bid is placed confidentially. In auctions (1), (2), and (3) the winner will pay the first highest price bidden in the auction – such auctions are called first-price auctions. In auction (4), the second highest price bidden has to be paid – such auctions are called second-price auctions.

- (1) In an ascending-bid auction, bidders place bids higher than the last bid until no one is willing to place a further bid. The last bidder wins the object and pays his bid price.
- (2) In a descending-bid auction, the bid price, starting from a predefined maximum, is decreased successively until a bidder accepts the announced price.
- (3) In a first-price sealed-bid auction, bidders place their bids confidentially. Normally, each bidder places one bid. The highest bid wins and the bidder pays the bid price.
- (4) In a second-price sealed-bid auction, the bidder with the highest bid wins the auction but the winner pays the price of the second highest bid. Bidders place their bids confidentially. Normally, each bidder places one bid.<sup>8</sup>

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<sup>8</sup> However, online platforms like EBay allow bidders to readjust their bid price after placement. This auction can be interpreted as a modified Vickrey auction.

**Table 2: Standard auction forms**

Price	Bid placement	
	open	sealed
First-price	(1) Ascending-bid auction (English auction) (2) Descending-bid auction (Dutch auction)	(3) First-price sealed-bid auction
Second-price	-	(4) Second-price sealed-bid auction (Vickrey auction)

Source: Blum et al., 2006, pp.149 et sqq.; Klemperer, 1999, p. 4.

### 2.2.3 Auctioning transmission capacity

Transmission capacity does not fit to the category of single indivisible goods. If it is brought down to a per MW consideration, it becomes a multiunit auction as during an auction round transmission rights for more than one MW are allocated to several bidders. Consequently, in a flow-based coordinated explicit auction, several bidders may win in the auction and may receive different shares of the total auction capacity while every bidder pays the same price for the same transaction.<sup>9</sup> Additionally, the last accepted MW is curtailed to the marginal bidders.<sup>10</sup> Hence, the auctioned good becomes divisible. As Klemperer (2004, p. 29) states: “The literature on the sale of multiple units is much less well developed [...]”

Accordingly, this thesis sticks to the rather technical idea of an auction of Stoft (2002, p. 218) regarding the characteristics of electricity markets: “All auctions solve some mathematical problem.” In economic terms this means assigning objects to persons through a market mechanism (Bertsekas, n.a., p. 1). Thus, an auction can be interpreted as an assignment problem.<sup>11</sup>

## 2.3 Congestion management and integrated market design

This section provides a link between congestion management and how this is involved in the process of greater market integration.

It seems intuitive that one distinguishes two basic market designs (Ehrenmann and Neuhoff, 2004, p. 2): Integrated markets and not integrated markets. Integrated markets, on the one hand, require a centralized system operator that clears the market for an entire region based on location-specific

<sup>9</sup> An auction where all bidders that are awarded pay the same price (Klemperer, 1999, p. 28) is called uniform-price auction. We will further on refer to this as marginal pricing as each bidder pays the price of the last accepted bid.

<sup>10</sup> This might not apply if a “fill or kill” option is included.

<sup>11</sup> Combining the assignment approach with the idea of Stoft (2002, p.219), the auctioning process can be partitioned into three stages:

1. Submission/Placement of bids and offers.
2. Assigning bids to offers such that a defined objective is minimized or maximized and determining prices.
3. Settlement of accepted bids at calculated prices.

energy bids. On separated markets, on the other hand, physical transmission rights are traded separately from the energy markets. Ehrenmann and Neuhoff (ibid., p. 2) state that under the condition of perfect competition, the outcome on the two markets should be exactly the same. However, due to market distortions on energy markets, the latter does not apply. Ehrenmann and Neuhoff (ibid., p. 2) find that an integrated design should be favorable in order to reduce the ability to exercise market power by strategic generators.

The congestion management method depends directly on the energy market structure. Christie et al. (2000, p. 172) state that “congestion management itself cannot be separated from market considerations”. Leaving aside non-convex issues in generation markets such as start-up and ramping costs, the term congestion management method and energy market structure is in practice often referred to in the same context.<sup>12</sup> Which congestion management method to apply is currently one of the most controversial ongoing discussions – particularly in Europe when focusing on cross-border trade. Regarding different market designs, Stoft (2002, p. 203ff.) distinguishes three crucial matters. “These are:

1. Bilateral markets vs. centralized exchanges and pools.
2. Exchanges vs. pools.
3. Zonal pricing vs. nodal pricing.” (ibid., p.204)

Concerning the coordination question, Stoft argues that bilateral markets are too slow in order to cope with the remarkable complexity on power markets due to a non-existence of a transparent market prices (ibid., p.205). Hence, he pleads for coordinated markets.

In addition, Brunekreeft et al. (2004, p. 1) state that there is a poor correlation of spot prices between EU countries which is due to poorly integrated electricity markets. They argue that a poor integration can be caused either by an inefficient management of interconnectors or insufficient transmission capacity provision (ibid., p. 1). They emphasize that coordination on the European level becomes necessary which embodies many aspects: cross-border trade, investments, management of security as well as legal issues regarding the transmission network (ibid., p. 2).

Hence, factors that influence an applicable European congestion management organization must be considered more in detail in the subsequent section.

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<sup>12</sup> The point, here, is that marginal cost of generation can be assumed and modeled appropriately. Then, line congestions become the main issue to consider.

### **3 From Theory to Practice: Issues in Applied European Congestion Management**

Regarding Section 2, it was shown that there is an ongoing discussion about different market designs and congestion management methods for an integrated European electricity market. This section points out why it is valuable to focus on flow-based coordinated explicit auctions when assessing near-time applicable congestion managements for Europe.

#### **3.1 Political considerations**

Although nodal pricing is already applied on several markets, an implementation in Europe within the next future seems not realistic.<sup>13</sup> However, first studies based on a nodal pricing approach were carried out for European regions that indicate positive effects of a nodal pricing regime also in the considered regions (compare Leuthold et al., 2005, Stigler and Todem, 2005, Weigt et al., 2006, Weigt, 2006). Nonetheless, one problem of this method is the high degree of complexity that may lead to problems concerning market transparency (Alaywan et al, 2004, p. 1) and market liquidity (Ehrenmann and Smeers, 2004, p. 13). Regarding the EU region, there is also the problem of political divergence. The different degrees of market liberalization within the EU-states and the fact that there are many established system operators of which each is responsible for one control area, constrain an implementation of nodal pricing in Europe. Hence, political issues are an important driver in the process and have an influence on the design and course of the upcoming congestion management methods.

In its guidelines, the EU claims for the introduction of flow-based allocation methods regarding cross-border transmission capacity. Additionally, a study commissioned by the European Commission (Consentec and Frontier Economics, 2004, p. 90-97) examined different congestion management methods regarding three benchmark criteria (Consentec and Frontier Economics, 2004, II):

- Compatibility to EU regulation 1228/2003,
- Economic welfare, and
- Practical feasibility.

The study recommends a stepwise implementation of hybrid auctions as congestion management method. Furthermore, the introduction of flow-based explicit auctions is considered to be a purposeful first step towards the right direction (Consentec and Frontier Economics, 2004, IV). A similar recommendation is given by Pérez-Arriaga and Olmos (2004, p. 36) who argue that a flow-based coordinated explicit auction is the best congestion management method under the present regulatory conditions in Europe.

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<sup>13</sup> Nodal pricing is applied for example in New Zealand and in the USA (PJM).

In order to reach greater integration, regulators of the EU member states tend to evaluate and improve existing proposals for a market based congestion management. For this purpose, the ‘Florence-Fora’ were established in 1998. These are regular discussion meetings on a semi-yearly and yearly basis. In 2004, on the 11<sup>th</sup> Florence Forum, it was decided to arrange regional ‘Mini-Fora’. The Mini Fora aim to develop and implement market integration on several regional levels. As a consequence, national regulators have also strong influence in the process.

Subsequently, main political issues arising regarding the application of coordinated congestion management methods in Europe are pointed out. They are, particularly, included into the analyzes when defining the consensus of targets while considering revenue distribution methods (see Sections 4.3.3 and 4.3.4)

### **3.1.1 Political borders define economical borders**

The economic approach to aggregate nodes to a zone is to take nodes with similar prices so that the possible distortion of the aggregation is low, whereas, the easiness of an aggregated model may yield benefits in terms of market transparency and liquidity. The coordination of regional markets in the course of the Mini Fora process means, however, that zone borders are defined by reasons other than economic reasons such as political borders or control areas.<sup>14</sup>

### **3.1.2 Administrative barriers**

The main sources for administrative barriers are environmental and legal issues. Environmental issues, particularly, arise when considering grid extensions. It is possible that although there is the economic need for grid extensions and there is also the willingness to invest by a TSO, the investment can not take place as the permission to construct is not granted by local, regional or national authorities due to environmental concerns.<sup>15</sup> Other administrative barriers – not only for investments – are legal issues. As cross-border trade means that at least two countries are involved, law systems may differ. In a coordinated auction even more countries are involved. The problem, here, is that laws regarding – strategic – infrastructure industries are still often very restrictive. Then the question raises which law to apply and if the applied law is in accordance to all national laws.

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<sup>14</sup> At the end, control areas borders also result from political decisions concerning infrastructure policy in the past.

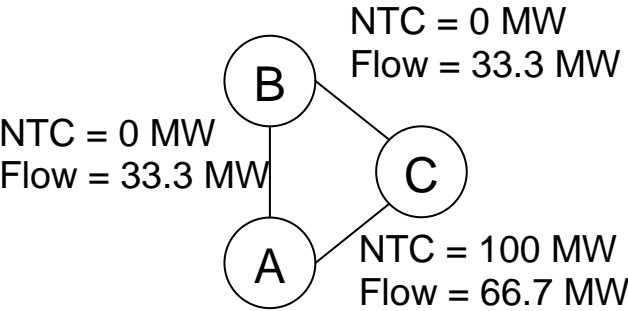
<sup>15</sup> Compare for example the ongoing discussion about the “Steiermarkleitung” in Austria (Stigler and Todem, 2005).

**3.2 Technical consideration**

For 2006, there is a NTC-based coordinated auction applied in a part of the CEE region. This auction is not flow-based. Hence, there is the variance of auctioned capacity and actually occurring flows can be quite big.

For a three zones example (Figure 2), consider the case where the NTC for borders A-B and B-C are zero but the NTC for border A-C is not. Thus, if the auctioned capacity for A-C is 100 MW, the occurring flow will also be 33.3 MW on A-B and B-C according to the PTDFs of the system (Table 3), although the auctioned capacity is zero for each of these two borders.

**Figure 2: Three zones example**



Source: Own illustration.

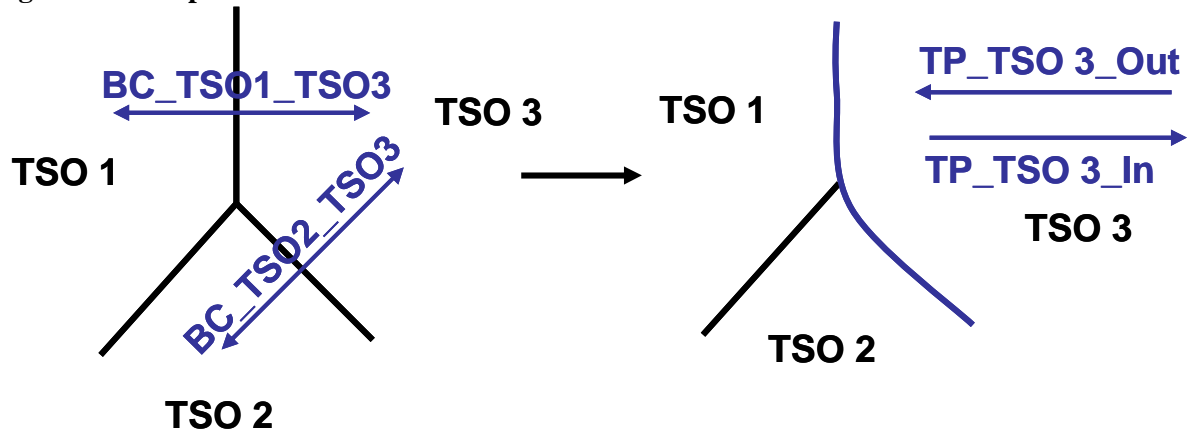
**Table 3: PTDF matrix for three zones example (zone-to-zone notation)**

	A-B	A-C	B-C
A-B	0.667	0.333	-0.333
A-C	0.333	0.667	0.333
B-A	-0.667	-0.333	0.333
B-C	-0.333	0.333	0.667
C-A	-0.333	-0.667	-0.333
C-B	0.333	-0.333	-0.667

Source: Own illustration.

As a consequence, some TSOs currently apply so-called technical profiles (TPs). A technical profile pools several borders and defines a sum NTC for all of them (Figure 3), i.e. all flows leaving a zone. TSOs claim to need technical profiles in order to cope with intra-zonal problems. These technical profiles are also considered in the following analysis. They are referred to as combined border capacities (CBCs) for the flow-based coordinated auction.

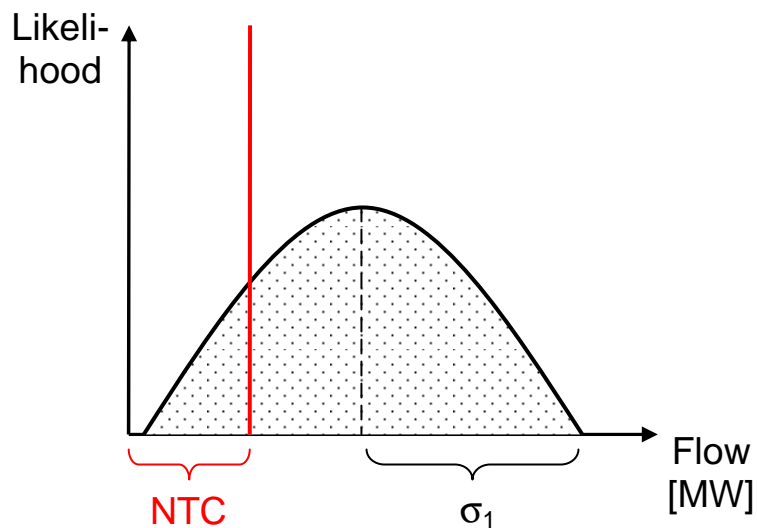
Figure 3: Example for a TP/CBC



Source: PSE, 2005. pp.11-12.

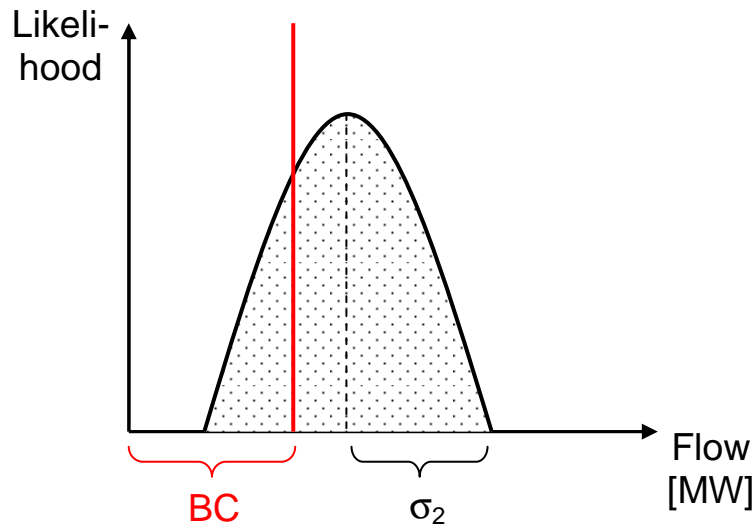
Additionally, it is expected that a flow-based method leads to higher BC values than NTC values for the same border. It is expected that the occurring physical flows are better reflected through a flow-based auction as loop flows are not taken into account in the NTC-based allocation. Hence, the variance of possible occurring flows ( $\sigma_1 > \sigma_2$  in Figure 4 and Figure 5) is less in a flow-based allocation compared to a NTC-based one which means it is a different risk situation.

Figure 4: Risk situation in a NTC-based method



Source: Own illustration.

**Figure 5: Risk situation in a flow-based method**



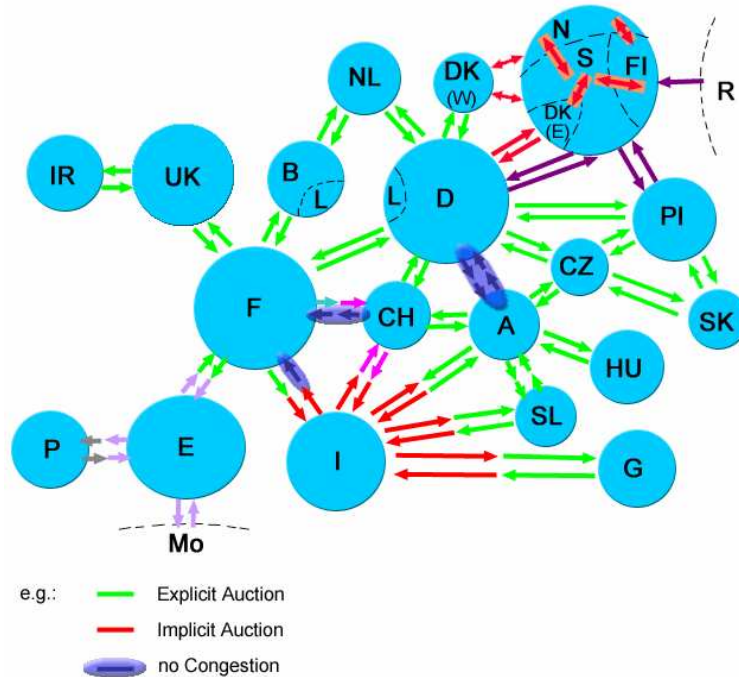
Source: Own illustration.

### 3.3 The economic framework

Considering the economic framework in the EU, it must be stated that there currently is a high demand in Southern Europe – mainly in Italy – combined with a generation surplus in Northern Europe. In addition, there are energy price differences from North to South and from East to West Europe.<sup>16</sup> Consequently, there is an economic incentive for interregional trading activities within Europe. The resulting energy transport from these activities is restricted by the transmission capacities between single countries and regions. An important problem consist in different forms of market organizations from country to country (Figure 6) which requires a market system that is able to incorporate different existing market structures in the first place while moving towards an integrated structure.

<sup>16</sup> These price differences are driving forces for the EU to liberalize electricity markets in order to increase the welfare and foster the efficient use of the existing network resources within Europe.

**Figure 6: Applied congestion management methods in Europe**



Source: ETSO, 2006.

### 3.4 Result: Flow-based coordinated explicit auctions

The conclusions from the above section are manifold. Firstly, it seems clear that a flow-based market system is a requirement in order to reflect an efficient resource allocation. Secondly, the market should be structured in a way that different schemes – such as explicit and implicit auctions – can be incorporated. Thirdly, the transition towards greater market integration is most likely to take place step by step in order to cope with political issues. Consequently, it becomes evident that a first implementation step is the introduction of a flow-based coordinated explicit auction scheme. This is also consistent with the recommendations of prior studies (compare Section 3.1). For these reasons, the analysis focuses on flow-based coordinated explicit auctions –particularly on different revenue distribution schemes for these auctions.

## **4 Basic Assumptions, Methodology and Objectives**

### **4.1 Basic assumptions**

One basic assumption made is that a TSO aims to maximize its individual revenues and does not have an economic incentive to change its BCs such that individual revenue is maximized.

It is further assumed that one TSO is able to stipulate BCs independent from other TSOs and is able to change them, i.e. for network security reasons. Hence, the BC becomes more or less a variable. In contrast, the thermal limit of a line is derived as a physically given parameter. Aiming for an efficient resource allocation, it is economically necessary to put as much capacity at the disposal as possible – by also taking into account security of supply issues. Consequently, a revenue allocation method is favorable if it stimulates TSOs – through respective individual revenue allocation – such that they set their BCs close to or equal to the thermal limit, respectively. Technical necessities can likewise be incorporated by adjusting physical thermal limits by a (n-1)-security margin. Thus, economical and technical goals can be conformed.

### **4.2 Objectives of the analysis**

#### **4.2.1 Incentive signals**

The main objective of this analysis is the evaluation of the incentive mechanisms of different auction revenue distribution schemes that aims to set the right incentives that the single TSOs maximize the offered capacities for the market. This behavior is supposed to maximize regional welfare. The starting point, therefore, are two distribution schemes proposed by ETSO (2001, p. 22). The hypothesis is that these two methods (see Sections 4.3.3.3 and 4.3.3.5) set wrong incentive signals to TSOs regarding capacity provision to the market and utilization of the network.

As pointed out in Section 3, however, there are several requirements to fulfill if one aims to implement a flow-based coordinated explicit auction in Europe or in a region of Europe, respectively. Hence, subsequently, there is a set of targets defined that have to be met by an acceptable revenue distribution method in order to balance the different influencing factors – in terms of politics, economics and technics (compare Section 3). The requirements for an applicable incentive schemes are defined as follows:

1. Giving incentives to for each TSOs for an efficient resource utilization.
2. Create a stability of auction revenues for TSOs compared to currently applied methods – at least for a transition period.
3. Allocating revenue according to right scarcity signals in order to indicate the necessity of network investments at the right location. (At the same time, TSOs need incentives to actually invest in extensions.)
4. Being in line with regulatory requirements of the EU and of national regulators.

Based on these requirements, an additional objective of the analysis is the evaluation of different auction revenue distribution methods in terms of their conformity with the above mentioned targets.

#### **4.2.2 With or without netting: Options or obligations**

Basically, two types of transmission rights exist – obligations and options. Owning an obligation means that one is obliged to use the right and cause an according flow. If the right is not used, a compensation payment is charged. In this case, netting of opposite flows can be taken into account. Thus, the case with netting means that flows over the same with different signs cancel out. Nonetheless, it must be stated that an introduction of netting also causes the need for additional measures - financially and physically - for TSOs in order to be able to guarantee security of supply.

Owning an option, however, means that one has the right to decide whether to actually cause an according flow or not. A compensation charge does not apply if the transmission right is not used. Thus, this is the case without netting which means that flows over the same with different signs do not cancel out because the risk of overstepping technical parameters can not be excluded otherwise. In case of options, netting cannot be considered.

#### **4.2.3 Excluding or including combined border capacities**

At the moment so-called technical profiles are applied (see Section 3.2). These TPs are referred to as CBCs and included into the analysis. It is analyzed how the currently existing TPs affect the results of the flow-based auction if perpetuated as CBCs (compare Section 4.3.1).

### **4.3 Methodology**

#### **4.3.1 Procedure**

The analysis was carried out as described subsequently. First of all, a flow-based coordinated explicit auction was set up. The input data were chosen from public available data and information (see Section 4.3.6). Then, the auction results were calculated for all considered cases (Table 4).

These calculations are the reference bases for further analyzes. In the next step, border capacities for single borders are varied in steps of 50 MW or 100 MW – depending on the expected effect of the change – and the auction results are recalculated until a change in revenue allocation does not occur or is not significant, respectively, any more. The changes of BC are carried out ceteris paribus. Interesting outcomes are, consequently, the revenues of the TSOs that changed the BC as well as the impact of these changes on the total auction revenue (TAR) and on the revenues of all other TSOs. The results presented, here, focus exemplarily on a change of the BC for one border between two TSOs – referred to as TSO1 and TSO2.

In addition to the revenues per TSO, the results yield further information – such as the TAR and the percentage share of accepted to requested bid volume – that are used for an additional analysis about the effect on netting and the inclusion of CBCs (compare Sections 4.2.2 and 4.2.3).

**Table 4: Cases considered in the analysis**

	Excluding CBCs	Including CBCs
With netting	<b>Case 1</b>	<b>Case2</b>
Without netting	<b>Case 3</b>	<b>Case4</b>

### 4.3.2 Mathematical formulation and auction algorithm

The auction algorithm or clearing process is mathematically a constraint optimization problem as shown in equations (1) to (5). The objective function is the overall auction revenue subject to the capacity restrictions of the tie-lines.

This mathematical formulation is similar to one proposed by ETSO (2001).<sup>17</sup> The network includes  $Z$  zones that are linked by interconnections. There are  $B$  bids. For the auction, bids must contain the following information: the bidding path, price and quantity. Hence, price  $p$  and volume  $d_{bid}$  can be written as functions of bid  $b \in B$ , source  $x \in Z$  and destination  $y \in Z$ :  $p(x,y,b)$  and  $d_{bid}(x,y,b)$ . The clearing process provides the accepted volumes per bid  $d_a(x,y,b)$ . The network is represented by a PTDF matrix  $R$  (see Appendices A and B). The elements  $r \in R$  reflect the impact of the bid volumes for a specific pair of zones in terms of flows on an interconnection represented by its source zone  $x \in Z$  and sink zone  $y \in Z$ . Hence, element  $r$  depends on source  $x$ , destination  $y$ , and interconnection  $j-k$ :  $r(x,y,j,k)$ . Accordingly the optimization problem can be written as follows:

$$\max \left\{ \sum_{x,y,b} [p_{bid}(x,y,b) * d(x,y,b)] \right\}; \quad (1)$$

$$\text{s.t.} \quad d_a(x,y,b) \leq d_{bid}(x,y,b); \quad (2)$$

$$d_a(x,y,b) \geq 0; \quad (3)$$

$$\sum_{x,y} \{r(x,y,j,k) * \sum_B [d_a(x,y,b)]\} \leq BC\_F(j,k); \quad (4)$$

$$\sum_{x,y} \{r(x,y,j,k) * \sum_B [d_a(x,y,b)]\} \geq BC\_R(j,k); \quad (5)$$

Where:             $x$                             = zone as source of a bid  
                        $y$                             = zone as sink of a bid

<sup>17</sup> Similar algorithms are used in nodal pricing markets like PJM.

$b$	= bid within the auction
$j$	= zone as source of a tie-line
$k$	= zone as sink of a tie-line
$BC(j,k)$	= border capacity between zone $j$ and zone $k$ for Forward (F) and Reverse (R) direction
$d_a(x,y,b)$	= accepted quantity per bid
$d_{bid}(x,y,b)$	= required quantity per bid
$p_{bid}(x,y,b)$	= bid price per bid
$r(x,y,j,k)$	= element of the PTDF matrix (zone-to-zone notation)

Within the clearing process, a merit bid price order per source-sink combination is generated. Additionally, the maximum resulting flow per tie-line is received by the sum of all bid volumes multiplied by the respective PTDFs. If there are lines where the resulting flow is greater than the available border capacity, the requested bid volume has to be decreased until the flow capacity constraints are fulfilled. Hence, the transaction with the lowest willingness to pay for a congested line in combination with relevant physical sensitivities (compare Box) is decreased first. Then, the bid with the second lowest willingness is decreased and so on. Hence, an overall efficiency criterion is generated and used during the allocation procedure in order to allocate capacity to those bids that have the highest willingness to pay.

If there is no congestion, no market actor is charged (= no congestion, no payment). If there is congestion, some of the transactions will be decreased as described above, and all the transactions that “win” in the auction, will be charged according to their PTDF and marginal price for congested borders (compare Box). The last accepted bid (partially or totally), defines the marginal price that means that this “marginal” bid will pay its bid price. Other accepted transactions will be charged on the basis of the bid price of the marginal bid (= marginal price) but multiplied with the ratio of their PTDF at congested border divided by PTDF of last accepted transaction at congested border.

In case obligations are auctioned, netting of the counter-flows can be considered. In that case, the transactions that relieve congestion – their PTDF is “negative” for a congested direction – will be rewarded according to their PTDF at the corresponding border because they create additional valuable capacity in the congested direction.

Additionally, it must be stated that a ‘fill or kill’ option is not considered in the analysis. As a consequence, the marginal bid can have any accepted volume between zero and its maximum bid volume. If a ‘kill or fill’ option is considered, the problem becomes more complex and mixed-integer programming or other techniques using linear programming methods would be required.

### Box: Clearing Rule<sup>18</sup>

#### Clearing:

IF there is congestion on border **j,k** THEN:

Decrease transaction **a** with lowest ratio  $\text{BidPrice}_a / \text{PTDF}_a(j,k)$  until  $\text{Flow}(j,k) \leq \text{BC}(j,k)$ .

$\text{BidPrice}_a \equiv \text{Marginal Price}(j,k) = \text{MP}_{j,k}$

Charge all transactions **B** that have  $\text{PTDF}_b(j,k) > 0$  proportionally to their PTDF with:  
 $\text{MP}_{j,k} * (\text{PTDF}_b / \text{PTDF}_a)$

IF netting is considered THEN:

Reward transactions **C** with  $\text{PTDF}_c(j,k) < 0$  proportionally to their PTDF:

$\text{MP}_{j,k} * (\text{PTDF}_c / \text{PTDF}_a)$

ELSE:

Do not charge or reward transactions **C** with  $\text{PTDF}_c(j,k) < 0$

END IF

ELSE:

No congestion, no payment.

END IF

### 4.3.3 Revenue distribution methods

This section lists the revenue allocation methods that are objects of the analysis (Table 5). The first step during the calculation is the determination of a share that a TSO receives as source or sink zone according to the respective distribution methods. The calculation of the shares is shown in Sections 4.3.3.1 to 4.3.3.11. After the calculation of the shares, the revenue is then allocated according equations (6) and (7).

$$\text{RevenueSource}(j) = 0.5 * \text{Share}(j) * \text{TAR} \quad (6)^{19}$$

$$\text{RevenueSink}(k) = 0.5 * \text{Share}(k) * \text{TAR} \quad (7)^{19}$$

Where: Share = respective shares of the analyzed methods

TAR = total auction revenue

<sup>18</sup> Note, that the calculation of  $\text{Flow}(j,k)$  is differently for the case with netting than for the case without netting.

<sup>19</sup> For method ETSO1,  $j$  is replaced by  $x$  and  $k$  is replaced by  $y$ .

**Table 5: Analyzed revenue allocation methods**

Method	Allocation according to
AF_CP_SP	50% Absolute Flows (sq)
	25% Clearing Price
	25% Shadow Price
AF_RF	50% Absolute Flows (lin)
	50% Relative Flows (sq)
AF	100% Absolute Flows (lin)
CP	100% Clearing Price
RF	100% Relative Flows (lin)
CP_SP	50% Clearing Price
	50% Shadow Price
ETSO1	100% Bid Zones
MS_AF_CP	25% Market Share (lin)
	50% Absolute Flows (sq)
	25% Clearing Price
RF_LF_CP	25% Relative Flows (lin)
	25% (n-1) Limit Usage (sq)
	50% Clearing Price
SP (ETSO2)	100% Shadow Price
TU	100% Thermal Usage (sq)

#### 4.3.3.1 Absolute Flow Fraction (= AF)

First, the share of a tie-line flow in respect to the sum of all line flows is calculated. Then, the revenue is allocated proportionally to these shares and equally to the TSOs owning the line (normally: the TSOs in-between a line).

$$Share_{AF}(j) = \sum_K \{ [ABF(j,k)] / \sum_{J,K} [ABF(j,k)] \} \quad (8)$$

$$Share_{AF}(k) = \sum_J \{ [ABF(j,k)] / \sum_{J,K} [ABF(j,k)] \} \quad (9)$$

Where: ABF(j,k) = accepted bid flow over a line (represented by its source and sink)

#### 4.3.3.2 Clearing Price (= CP)

First of all, the clearing price for each line based on the shadow prices of congested lines is calculated. The absolute flows are, then, multiplied by the absolute clearing prices. Next, the sum of these weighted flows is calculated. Next, the individual share of a line in respect to the weighted sum is determined. The revenue is allocated according to these shares and equally distributed to the TSOs owning the line (normally: the TSOs in-between a line).

$$CP(x, y) = \sum_{J,K} MP(j, k) * PTDF(x, y, j, k) \quad (10)$$

Where: CP(x,y) = clearing price for each possible combination x-y  
x,y = source and sink of a bid  
j,k = source and sink of a line  
MP(j,k)= marginal price per line (represented by its source and sink)  
PTDF = flow factors of the network

$$Share_{CP}(j) = \sum_K \left\{ \frac{[|CP(j, k)| * |ABF(j, k)|]}{\sum_{J,K} [ |CP(j, k)| * |ABF(j, k)| ]} \right\} \quad (11)$$

$$Share_{CP}(k) = \sum_J \left\{ \frac{[|CP(j, k)| * |ABF(j, k)|]}{\sum_{J,K} [ |CP(j, k)| * |ABF(j, k)| ]} \right\} \quad (12)$$

Where: CP(j,k) = clearing price for a line (represented by its source and sink)  
ABF(j,k) = accepted bid low over a line (represented by its source and sink)

#### 4.3.3.3 ETSO1

The revenue is allocated to the TSOs that are sources or sinks of bids – the distribution happens so to say according to supply and demand zones. Hence, the accepted bid volumes for each source-sink combination are multiplied by the respective prices. These revenues per combination are distributed in equal shares to the source and sink TSOs.

$$Share_{ETSO1}(x) = \sum_{B,Y} [p_a(x, y) * d_a(x, y, b)] / TAR \quad (13)$$

$$Share_{ETSO1}(y) = \sum_{B,X} [p_a(x, y) * d_a(x, y, b)] / TAR \quad (14)$$

Where:  $x,y$  = source and sink of a bid  
 $p_a(x,y)$  = accepted bid price per bid path  
TAR = total auction revenue

#### 4.3.3.4 Relative Flow Fraction (= RF)

First of all, the ratio of border flow to border capacity is determined. This yields the relative line usage. Then, all line usages are summed up and the share of individual line usage in respect to the sum of line usages is calculated. The revenue is allocated according to these shares and equally distributed to the TSOs owning the line (normally: the TSOs in-between a line).

$$Share_{RF}(j) = \sum_K \left\{ \frac{[ABF(j,k) / BC(j,k)]}{\sum_{J,K} [ABF(j,k) / BC(j,k)]} \right\} \quad (15)$$

$$Share_{RF}(k) = \sum_J \left\{ \frac{[ABF(j,k) / BC(j,k)]}{\sum_{J,K} [ABF(j,k) / BC(j,k)]} \right\} \quad (16)$$

Where:  $BC(j,k)$  = border capacity of a line (represented by its source and sink)  
 $ABF(j,k)$  = accepted bid low over a line (represented by its source and sink)

#### 4.3.3.5 Shadow Prices (= SP, ETSO2)

The sum of all shadow prices is calculated. Then, the individual share of a lines shadow prices in respect to the sum of shadow prices is determined. The revenue is allocated according to these shares and equally distributed to the TSOs owning the line (normally: the TSOs in-between a line).

$$Share_{ETSO2}(j) = \sum_K \{MP(j,k) / \sum_{J,K} [MP(j,k)]\} \quad (17)$$

$$Share_{ETSO2}(k) = \sum_J \{MP(j,k) / \sum_{J,K} [MP(j,k)]\} \quad (18)$$

Where:  $j,k$  = source and sink of a line  
 $MP(j,k)$  = marginal price per line (represented by its source and sink)

#### 4.3.3.6 Thermal Usage Fraction (= TU)

First, the ratio of border flow to thermal limit is determined. This yields the thermal limit usage. Then, all thermal limit usages are summed up and the share of individual thermal limit usage in respect to the sum of usages is calculated. The revenue is allocated according to these shares and equally distributed to the TSOs owning the line (normally: the TSOs in-between a line).

$$Share_{TU}(j) = \sum_K \left\{ \frac{[ABF(j,k)/TL(j,k)]}{\sum_{J,K} [ABF(j,k)/TL(j,k)]} \right\} \quad (19)$$

$$Share_{TU}(k) = \sum_J \left\{ \frac{[ABF(j,k)/TL(j,k)]}{\sum_{J,K} [ABF(j,k)/TL(j,k)]} \right\} \quad (20)$$

Where:            ABF(j,k)            = accepted bid low over a line (represented by its source and sink)  
                          TL(j,k)                = thermal limit of a line (represented by its source and sink)

#### 4.3.3.7 Absolute Flow Fraction & Clearing Price & Shadow Price (= AF\_CP\_SP)

The absolute flow fractions (see method AF) are weighted quadratic. Then, 50% of the revenue is allocated according to these quadratic AF shares, 25 % are allocated proportionally to method CP, and 25 % proportionally to method SP.

$$Share_{AF\_CP\_SP}(j) = 0.5 * [Share_{AF}(j)]^2 / \sum_J [Share_{AF}(j)]^2 + 0.25 * Share_{CP}(j) + 0.25 * Share(j)_{SP} \quad (21)$$

$$Share_{AF\_CP\_SP}(k) = 0.5 * [Share_{AF}(k)]^2 / \sum_J [Share_{AF}(k)]^2 + 0.25 * Share_{CP}(k) + 0.25 * Share(k)_{SP} \quad (22)$$

#### 4.3.3.8 Absolute Flow Fraction & Relative Flow Fraction (= AF\_RF)

The share of individual absolute line usages (see method RF) is weighted quadratic. Then, 50% of the revenue is allocated according to these quadratic RF shares and 50 % are allocated according to method AF.

$$Share_{AF\_RF}(j) = 0.5 * \frac{[Share_{RF}(j)]^2}{\sum_J [Share_{RF}(j)]^2} + 0.5 * Share_{AF}(j) \quad (23)$$

$$Share_{AF\_RF}(k) = 0.5 * \frac{[Share_{RF}(k)]^2}{\sum_K [Share_{RF}(k)]^2} + 0.5 * Share_{AF}(k) \quad (24)$$

#### 4.3.3.9 Clearing Price & Shadow Price (= CP\_SP)

Half of the revenue is allocated according to method CP and the other half is allocated according to method SP.

$$Share_{CP\_SP}(j) = 0.5 * Share_{CP}(j) + 0.5 * Share(j)_{SP} \quad (25)$$

$$Share_{CP\_SP}(k) = 0.5 * Share_{CP}(k) + 0.5 * Share(k)_{SP} \quad (26)$$

#### 4.3.3.10 Market Share & Absolute Flow Fraction & Clearing Price (=MS\_AF\_CP)

The market share of the participating TSOs is estimated. This market share is exogenous to the calculation. Then, the share of individual absolute line usages (see method AU) are weighted quadratic. Finally, 50% of the revenue is allocated according to this quadratic AU method, 25% are allocated according to the MS share and 25% according to method CP.

$$Share_{MS\_AF\_CP}(j) = 0.5 * [Share_{AF}(j)]^2 / \sum_J [Share_{AF}(j)]^2 + 0.25 * MS(j) + 0.25 * Share_{CP}(j) \quad (27)$$

$$Share_{MS\_AF\_CP}(k) = 0.5 * [Share_{AF}(k)]^2 / \sum_J [Share_{AF}(k)]^2 + 0.25 * MS(k) + 0.25 * Share_{CP}(k) \quad (28)$$

#### 4.3.3.11 Relative Usage & Limit Usage & Clearing Price (= RF\_LU\_CP)

The ratio of line flow to the (N-1) limit is calculated – similar to method TU. This yields the (N-1) limit usage. Then, summing up all LUs and calculating the share of individual (N-1) limit usage in respect to the sum of usages. These shares are weighted quadratic. Then, 50% of the revenue is allocated according to method CP, 25% are allocated according to a quadratic weighting of method LU and 25% according to method RF.

$$Share_{RF\_LU\_CP}(j) = 0.5 * [Share_{LU}(j)]^2 / \sum_J [Share_{LU}(j)]^2 + 0.25 * Share_{RF}(j) + 0.25 * Share_{CP}(j) \quad (29)$$

$$Share_{RF\_LU\_CP}(k) = 0.5 * [Share_{LU}(k)]^2 / \sum_J [Share_{LU}(k)]^2 + 0.25 * Share_{RF}(k) + 0.25 * Share_{CP}(k) \quad (30)$$

#### 4.3.3.12 Physical Flows

There is also the possibility to distribute the revenues according to the actually occurring physical flows. These flows could be measured and the revenues distributed ex ante according to the measured flows. However, this approach is not followed, here. On the hand, this is because there is no consistent data set available. On the hand, it must be stated that the proportion of outside and natural flows is presently quite high. Hence, the physical flows do not correlate enough with the flows resulting from the auction to justify a revenue distribution to these methods as the incentive scheme would be distorted. Consequently, an according method is not applied.

### 4.3.4 Evaluation criteria for revenue distribution methods

In order to evaluate the above listed revenue distribution methods, four criteria were defined in Section 4.2.1. For each case, the revenues per TSO are calculated in absolute and in relative numbers – revenue shares (see Appendices C and D). Each method is evaluated as described subsequently according to the four criteria. Additionally, for some criteria a rating is made for absolute revenues and revenue shares. These ratings are not pointed out explicitly. They are merged according to the rule that the inferior rating result defines the merged rating.

#### 4.3.4.1 Resource utilization incentives

This criterion regards the change in revenues and revenue shares when changing BCs. The idea behind is that TSOs should be incentivized to provide as much installed capacity to the market as possible. Hence, a method is favorable if the revenues and revenue share of those TSOs responsible for a BC change are positive when increasing BCs and negative when decreasing them (Table 6).

**Table 6: Measures for criterion "Resource utilization incentives"**

Observation	Rating
Revenue/Revenue share always increase while increasing BC	++
Revenue/Revenue share mainly increase while increasing BC	+
Revenue/Revenue stagnate while increasing BC	o
Revenue/Revenue decrease and stagnate while increasing BC	-
Revenue/Revenue decrease while increasing BC	--

#### 4.3.4.2 Network investments

The evaluation whether a method is likely to foster network investments or not takes place according to two factors. The first criterion regards scarcity signals. Hence, if a method allocates revenues according to a scarcity measure – a price – it can be seen where investments are most urgent. The second criterion regards the revenues after a grid extension. If the extension causes a significant decrease in revenues, the TSOs might not have an incentive to invest – there is no return on the investment.

#### 4.3.4.3 Stability of revenues

The stability of revenues is defined by the maximum deviation  $D_{max}$  in revenue or revenue share, respectively, while changing BCs (Table 7). It is a measure in how far the change of a BC can affect the revenues of all market players. For political reasons, it is not desirable that TSOs can be too much better off by changing their BCs compared to the other TSOs. On the other, TSOs are not supposed to be worse off, either. Hence, not only the negative but the entire maximum deviation must be considered (compare Section 4.3.4.4).

**Table 7: Measures for criterion "Stability of revenues"**

Max deviation in absolute Revenue [per unit]	Max deviation in relative Revenue [%-points]	Rating
$D_{\max} \leq 2.5$	$D_{\max} \leq 5$	++
$2.5 < D_{\max} \leq 5$	$5 < D_{\max} \leq 10$	+
$5 < D_{\max} \leq 7.5$	$10 < D_{\max} \leq 15$	o
$7.5 < D_{\max} \leq 10$	$15 < D_{\max} \leq 20$	-
$10 < D_{\max}$	$20 < D_{\max}$	--

#### 4.3.4.4 Continuity with current revenues

The current revenues of TSOs result from NTC-based coordinated explicit auctions or bilateral auctions, respectively. As pointed out in Section 3.2, setting BCs equal to NTCs causes some distortions regarding risk of actual occurring flows. Hence, the absolute revenues from the NTC-based auction should not be compared to the absolute revenues from a flow-based auction. Therefore, for the continuity with current revenues only revenue shares are compared for the scenario that the BCs equal the present NTC values. As is assumed that a positive deviation in revenue share is considered positive by all market players, only the maximum negative deviations are considered (Table 8).

**Table 8: Measures for criterion "Continuity with current revenues"**

Max negative deviation in relative Revenue [%-points]	Rating
$D_{\max}^- \leq 10$	++
$10 < D_{\max}^- \leq 15$	+
$15 < D_{\max}^- \leq 20$	o
$20 < D_{\max}^- \leq 25$	-
$25 < D_{\max}^-$	--

#### 4.3.5 Evaluation criteria for netting and CBCs

In order to analyze the effect of netting the perpetuation of CBCs further measures are used. First of all, the percentage of total accepted bid volumes is considered. This is a measure to which degree the existing demand can be satisfied. The TAR is regarded. The TAR can be interpreted as the cost of congestion. Additionally, the measure revenue per accepted volume (RPV) is introduced. It is the ratio

of TAR divided by accepted bid volume – in absolute numbers. It is a measure that describes how much of the demand is accepted at the respective TAR. As there are only congestion costs included in the analysis (compare Section 4.3.6), it is favorable to satisfy as much demand as possible at TAR level. Hence, for the RPV must be stated: The lower, the better.

#### 4.3.6 Data

The data set focuses on Central East Europe (CEE) in order to get realistic information. However, some simplifications have to be made regarding the calculation of BCs and the PTDF matrix. Furthermore, it must be stated that losses are not regarded due to the fact that each control area has to cover the losses and balance its system. Hence, losses are not relevant for this aggregated zonal consideration. As a consequence, the costs for transmission only depend on the costs of congestion in form of the auctioned physical transmission right (compare also Joskow and Tirole, 2000, p. 452). If there is no congestion, the transmission is free of charge which means that the TAR is the total cost for cross-border transmission.

##### 4.3.6.1 Border capacities

The border capacities can be calculated based on a base case exchange (BCE). This requires cooperation between the participating TSOs. They are required to send exchange programs. These exchange programs are then merged and, the border capacities are calculated according to (31).

$$BC = TBC - [FRM + (NF - OF)] \quad (31)$$

Where:

- BC = (net) border capacity
- TBC = total border capacity [already including (n-1)-constraints]
- FRM = flow reliability margin
- NF = natural flow
- OF = outside flow

However, these BCE data are not publicly available. Hence, for the analysis, the NTC values for 2006 are assumed to be also the BC values.<sup>20</sup> Note that this can lead to distortions if one tries to compare NTC and flow-based results (compare Section 3.2). For the cases including CBCs, also the 2006 NTC data for CBCs are applied.<sup>21</sup>

<sup>20</sup> Source: CEPS Auction Office (2006) and Auction-Office (2006).

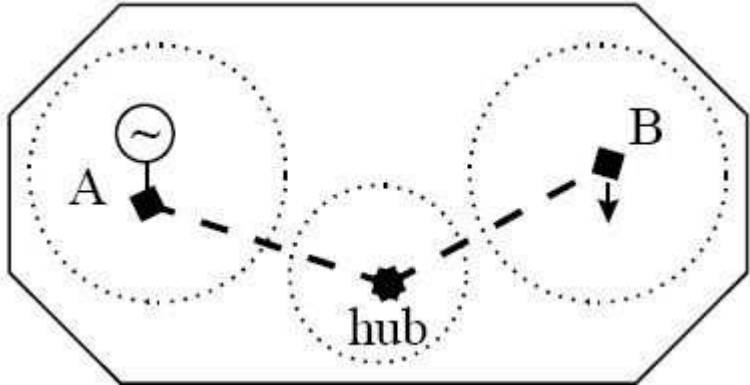
<sup>21</sup> Source: CEPS Auction Office (2006).

**4.3.6.2 PTDF matrix**

The PTDFs matrix is the representation of the physical network. The PTDFs are based on a DC power flow approximation of the network.<sup>22</sup> The PTDFs are coefficients that describe the relationship between a bid volume and the resulting flow on a tie-line. PTDFs are often also called sensitivity factors (Christie et al., 2000, p. 174) as it describes the sensitivity of accepted bid volumes to line flow.

There are two different notations for a PTDF matrix. Firstly, the PTDF value can be calculated in respect to a global hub (Figure 7). The hub can be a zone within or without the considered network. The result will be the same as the numbers are now relative number in respect to the hub. Taking again the three zones example from Section 3.2, the PTDF matrix could also be calculated defining zone A as the hub (Table 9). Additionally, in the model the case without netting is represented through an adjusted PTDF matrix. The adjustment takes place by replacing all negative PTDFs. If a PTDF is negative for on connection and direction it is replaced by zero. Instead, there is another row introduced to the matrix for the same connection but opposite direction. Hence, the entire PTDF matrix for the case without netting becomes positive (Table 10). However, the number of rows might double at the maximum compared to the netting PTDF matrix.

**Figure 7: Zone-to-hub network**



Source: ETSO, 2001, p. 9

**Table 9: Zone-to-hub PTDF matrix with netting**

		A-B	A-C	B-C
A	B	0.667	0.333	-0.333
	C	0.333	0.667	0.333

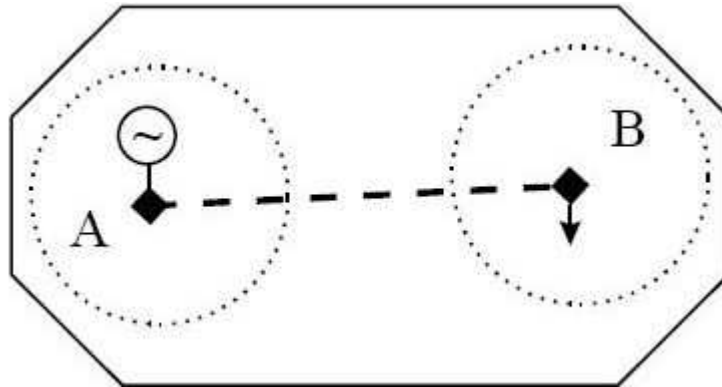
<sup>22</sup> For an explanation how to use the DC Load Flow model for economic analyzes see Hsu (1997), Schweppe et al. (1988), and Stigler and Todem (2005).

**Table 10: Zone-to-hub PTDF matrix without netting**

		A-B	A-C	B-C	C-B
A	B	0.667	0.333	0.000	0.333
	C	0.333	0.667	0.333	0.000

Secondly, it is possible to write the PTDF matrix in zone-to-zone notation (Figure 8). Then, each possible combination for a transaction between each two zones and their sensitivity factors on each line have to be listed explicitly (Table 11 and Table 12). The zone-to-zone matrix value for a connection can be calculated by taking the zone-to-hub PTDF value of the source to the hub and adding the PTDF value for a transaction from the hub to the sink. Calculating this for each pair of sources and sinks yields the zone-to-zone PTDF.

**Figure 8: Zone-to-zone network**



Source: ETSO, 2001, p. 9

**Table 11: Zone-to-zone PTDF with netting**

	A-B	A-C	B-C
A-B	0.667	0.333	-0.333
A-C	0.333	0.667	0.333
B-A	-0.667	-0.333	0.333
B-C	-0.333	0.333	0.667
C-A	-0.333	-0.667	-0.333
C-B	0.333	-0.333	-0.667

**Table 12: Zone-to-zone PTDF without netting**

	A-B	A-C	B-C	B-A	C-A	C-B
A-B	0.667	0.333	0.000	0.000	0.000	0.333
A-C	0.333	0.667	0.333	0.000	0.000	0.000
B-A	0.000	0.000	0.333	0.667	0.333	0.000
B-C	0.000	0.333	0.667	0.333	0.000	0.000
C-A	0.000	0.000	0.000	0.333	0.667	0.333
C-B	0.333	0.000	0.000	0.000	0.333	0.667

For the analysis, exemplarily, the CEE region (Figure 9) is mapped on a zonal basis in order to get a reliable PTDF matrix. It embraces eight zones and 13 tie-lines. Each control area defines one zone in the analysis. The surrounding UCTE grid is modeled as a ring grid. However, the PTDF matrix is determined based on an empty grid.

**Figure 9: CEE region<sup>23</sup>**



Source: Own illustration.

<sup>23</sup> Only two of the four German control areas are part of the CEE region (EON Netz and Vattenfall Europe Transmission). In Austria, only APG is part of the CEE.

### **4.3.6.3 Bids**

In order to receive a reliable data set for the demand, the available public data for the NTC-based coordinated explicit for five zones within the CEE region are considered.<sup>24</sup> The demand data are available in form of a demand function for a yearly auction for 2006. The demand is represented in steps of five MW with the respective prices. Additionally, for the rest of the CEE region, the bids for the yearly bilateral auctions are considered.<sup>25</sup> This yields roughly 1500 bids for the analysis.

## **5 Results**

### **5.1 Revenue distribution methods according to the ETSO**

#### **5.1.1 ETSO1**

This method distributes the revenue to the TSOs that are source and sink of bid – so to say: to supply and demand zones nodes (compare Section 4.3.3.3). Congestion, whereas, are likely to occur somewhere else. Surprisingly, this does not negatively affect resource utilization in the cases excluding CBCs. Here, incentives are given in order to increase BCs. However, it is unfavorable for the cases including CBCs (see Table 13).

More important, however, is the fact that network investment issues are not taken into account. On the one hand, there are no scarcity signals where network investments are most urgent. On the other hand, there is no return on investments, either. Those TSOs that are source and sink of a congested connection are not the ones who receive the payments. In contrast, they have to pay in order to maximize the total auction revenue (and network usage) in cases with netting and may even have negative revenues (Appendix D). This negative external effect is not acceptable. As TSOs cannot influence the demand for transmission capacity, they would have to face these negative revenues for several periods.

Total revenues and revenue shares do not deviate negatively for the cases with netting. But they differ strongly for the cases without netting.

The continuity with current revenues is given for case 3 but not for the other cases.

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<sup>24</sup> Source: CEPS Auction Office (2006).

<sup>25</sup> Source: CEPS Auction Office (2006) and own estimations.

**Table 13: Rating for method ETSO1**

Criterion	Rating			
	Case 1 <sup>26</sup>	Case 2 <sup>26</sup>	Case 3	Case 4
Resource utilization incentives	+	-	+	-
Network investments	--			
Stability of revenues	+	+	--	--
Continuity with current revenues	-	-	++	<b>o</b>

### 5.1.2 Shadow Prices (= SP, ETSO2)

This method assigns revenues only to lines that have a shadow price – where congestion occurs (compare Section 4.3.3.5). Hence, TSOs have basically an incentive to set BCs in a way that they are sink or source of a congested line. There is no incentive to increase BCs as this will lead to decreasing revenues if congestion is relieved. This becomes very evident for the cases without netting (Table 14). For cases 2, 3, and 4, TSOs clearly have an incentive to lower BCs. For the cases with netting, the result differs. Surprisingly, for case 1, there is a light incentive to increase BCs. The explanation is that even though the both TSOs relieve congestion on one line by increasing BC on this line, congestion on other lines – in which they participate – become more serious and balance the revenue loss from the first line. This only occurs for case 1 as other restrictions do not apply such as CBCs or the ignorance of netting.

Regarding investments, in this method the revenues are distributed to the locations where investments are most urgent. But there is no real incentive to invest in transmission capacity as this may relieve a congested interconnection permanently. Hence, there will be no return on this investment.

Total revenues and revenue shares do not deviate negatively for the cases with netting. But they differ strongly for the cases without netting.

Continuity with current revenues is not given.

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<sup>26</sup> This method causes negative revenues in the cases with netting for some TSOs in order to maximize the total auction revenue but other TSOs benefit from that.

**Table 14: Rating for method SP/ETSO2**

Criterion	Rating			
	Case 1	Case 2	Case 3	Case 4
Resource utilization incentives	+	-	--	--
Network investments	0			
Stability of revenues	+	+	--	-
Continuity with current revenues	0	0	--	--

## 5.2 Additional revenue distribution methods

### 5.2.1 Results for cases with netting

#### *Resource utilization incentives*

Considering resource utilization incentives (Table 15), the best rating for the cases with netting is given to method TU. This method assigns revenues according to the usage of the thermal limit of lines. It seems to be quite favorable from the point of view that the thermal limit is a physical parameter that cannot be changed voluntarily. In method AF, however, only resulting bid flows (= accepted bid flows, ABF) are considered. For this method, there is not primarily an incentive to lower BCs in order to create congestion because this results in reduced flows and lower revenues. Furthermore, TSOs are incentivized to provide as much capacity as possible for it can only lead to stagnation or an increase of revenues but not to a reduction. Particularly when excluding CBCs, there is an incentive to increase BCs. The same rating can be found for methods CP, CP\_SP, and MS\_AF\_CP. In method CP, the ABFs are weighted with the clearing prices for the respective connection. For the cases with netting, TSOs are at least not incentivized to withdraw capacity from the market. For method MS\_AF\_CP, there is, additionally, another measure introduced. The market share is supposed to represent a measure more or less independent from the cross-border flows but related to demand and supply.<sup>27</sup>

In contrast, method RF distributes revenues to those lines that have a high usage of their BC. For the cases with netting, it appears that this creates an incentive to set the BC in a way that the expected usage is close 100%. Hence, there is an expected optimal BC for each line that is far from the maximum capacity and orients at the expected ABFs. Consequently, this method does not set right incentives in terms of resource utilization. The same applies for those methods that only include a share of method RF such as AF\_RF and RF\_LU\_CP. For method RF\_LU\_CP it must be stated that the influence of method LU cannot compensate this effect.

<sup>27</sup> A fairly simply way was chosen in order to estimate the market share. The numbers for the market share numbers base on the national electricity consumption of the countries – according to UCTE (2005, pp. 12-87) – in which the TSOs operate.

**Table 15: Rating for criterion "Resource utilization incentives"; with netting**

Method	Rating	
	Case 1	Case 2
AF	+	0
CP	+	0
RF	-	--
TU	+	+
AF_CP_SP	+	-
AF_RF	-	-
CP_SP	+	0
MS_AF_CP	+	0
RF_LU_CP	--	-

Network investments

Regarding network investments (Table 16), for method AF, on the one hand, there is no scarcity signal in terms of a price that indicates where investments are most urgent. On the other hand, an extension of the grid and relieving congestion does not automatically reduce revenues. So if an investment leads to higher flows, revenues increase. Hence, there is no reluctance to invest in new line capacities. In method CP, however, there is a scarcity signal considered in terms of a price that indicates where investments are most urgent. These signals are not as strong as the shadow prices for the clearing prices are shadow prices weighted with the PTDFs. Hence, relieving congestion by network investments may change the set of shadow prices but does not withdraw the entire revenues because there is still a price based on all other shadow prices. The clearing price may decrease but the ABF may increase. The reluctance to investments can be considered low. Consequently, methods AF\_CP\_SP, CP\_SP, and MS\_AF\_CP combine some of the above mentioned methods with other measures. In method AF\_CP\_SP, the shares of methods CP and SP add a scarcity signal to the properties of method AF. Hence, TSOs can rely on the revenues from methods AF after relieving an investment. Investment issues seem to be reflected appropriately. However, method CP\_SP does not include a share of method AF. The idea is to add the more reliable revenue distribution of method CP to method SP. As a result, investment issues are considered appropriately as scarcity signals are included and a return of investments can be assumed due to returns from the CP share. Lastly, method MS\_AF\_CP includes weak scarcity signals in form of clearing prices and an according revenue

allocation. On the other hand, there is a return on investment particularly from the MS and AF shares. Altogether, the combined method can not improve the rating of the stand-alone methods significantly. Hence, they all receive the same rating.

Regarding method TU, the problem occurs that an extension of the existing thermal capacity leads to a lower thermal usage. Hence, there is no incentive for TSOs to invest into the grid as it leads to lower revenues. This method may, on the other hand, send appropriate scarcity signals if the BC is set close to the thermal limit. At the moment, this does not occur. For method RF, a similar problem occurs as for criterion resource utilization incentives. Network investment could occur for a line if the ABF is higher than the installed capacity but there is no incentive for that as the relative usage is then already at 100% for a congested line.

**Table 16: Rating for criterion "Network investments"; with netting**

Method	Rating	
	Case 1	Case 2
AF	+	
CP	+	
RF	--	
TU	-	
AF_CP_SP	+	
AF_RF	-	
CP_SP	+	
MS_AF_CP	+	
RF_LU_CP	o	

Stability of revenues

Regarding the stability of revenues (Table 17), it is remarkable that most of the considered methods provide appropriate results which means that the negative deviations in total revenues and revenue shares are low for most of the methods. Hence, the efficiency gain from netting (compare Section 0) and the netting effect seem to absorb effects that occur in the cases without netting (compare Section 5.2.2). Only for case 2 and for method RF, revenues have a strong negative deviation.

**Table 17: Rating for criterion "Stability of revenues"; with netting**

Method	Rating	
	Case 1	Case 2
AF	+	+
CP	+	+
RF	0	--
TU	+	0
AF_CP_SP	+	+
AF_RF	+	+
CP_SP	+	+
MS_AF_CP	+	+
RF_LU_CP	+	+

Continuity with current revenues

Regarding continuity with current revenues (Table 18), there are some methods that fulfill this target significantly such as methods AF\_CP\_SP, CP, CP\_SP, and RF\_LU\_SP. Further, there is a midfield of two methods that fulfill the target still acceptably such as methods AF, AF\_RF, and MS\_AF\_CP. The rest cannot guarantee sufficient revenue adequacy.

**Table 18: Rating for criterion "Continuity with current revenues"; with netting**

Method	Rating	
	Case 1	Case 2
AF	0	0
CP	+	++
RF	0	-
TU	--	--
AF_CP_SP	+	+
AF_RF	0	0
CP_SP	+	+
MS_AF_CP	0	+
RF_LU_CP	+	+

**5.2.2 Results for cases without netting**

Resource utilization incentives

Considering resource utilization incentives (Table 19), it must be stated that the results without netting differ significantly compared to the result with netting. Method TU, for example, only sets appropriate incentives for efficient network utilization for the cases with netting. The only method that can hold its rating is method AF as it rewards the occurrence of higher ABFs. Hence, there is still an incentive to higher BCs in order to create higher ABFs. For the other methods, this incentive is not given. For the method CP and those methods including a share of CP or SP, there is an incentive to create new congestion rather than increase BCs. One explanation seems to be that if netting is not considered, the volume of accepted bids is very low (compare Section 0). Hence, only bids with a high willingness of pay can be accepted. Consequently, the incentive to create such ‘expensive’ congestion is high. For method RF, it, again, appears that it creates an incentive to set the BC in a way that the expected usage is close to 100%. Hence, there is an expected optimal BC for each line that is far from the maximum capacity.

**Table 19: Rating for criterion "Resource utilization incentives"; without netting**

Method	Rating	
	Case 3	Case 4
AF	+	0
CP	0	--
RF	--	--
TU	--	0
AF_CP_SP	--	0
AF_RF	--	-
CP_SP	--	--
MS_AF_CP	-	-
RF_LU_CP	-	-

### Network investments

Regarding network investments, the results are the same as for the cases with netting. This is due to the fact that the criteria used to evaluate network investment issues are not significantly case sensitive. Therefore, the ratings remain the same for all cases (compare Section 4.3.4.2).

### Stability of revenues

Regarding the stability of revenues (Table 20), it can be stated that the results differ significantly for the cases without netting from the cases with netting. Without netting, there is no method that fulfills this target. However, methods AF and RF show acceptable results. Combining these methods (AF\_RF) does not yield better results. The negative deviations in total revenues and revenue shares are high for methods CP and methods including a share of CP and SP. This can, again, be explained by the fact that – for the same demand data – the prices at congested borders tend to be higher in the case without netting. Relieving congestion, therefore, leads to higher changes in prices. Furthermore, there is no netting effect that can absorb this effect. As a consequence, revenues are much more volatile while changing BCs.

**Table 20: Rating for criterion "Stability of revenues"; without netting**

Method	Rating	
	Case 3	Case 4
AF	0	0
CP	-	-
RF	0	0
TU	-	-
AF_CP_SP	-	-
AF_RF	0	-
CP_SP	-	0
MS_AF_CP	0	-
RF_LU_CP	-	-

### Continuity with current revenues

Regarding continuity with current revenues (Table 21), the results are very similar to the results for the cases with netting. For method CP\_SP, the results differ significantly. Method TU shows better

results. Others – like method MS\_AF\_CP – receive a bit worse rating. However, the ranking among the methods only changes for CP\_SP.

**Table 21: Rating for criterion "Continuity with current revenues"; without netting**

Method	Rating	
	Case 3	Case 4
AF	o	o
CP	+	+
RF	-	-
TU	-	o
AF_CP_SP	+	+
AF_RF	o	+
CP_SP	-	o
MS_AF_CP	+	++

**5.3 Results concerning netting and CBCs**

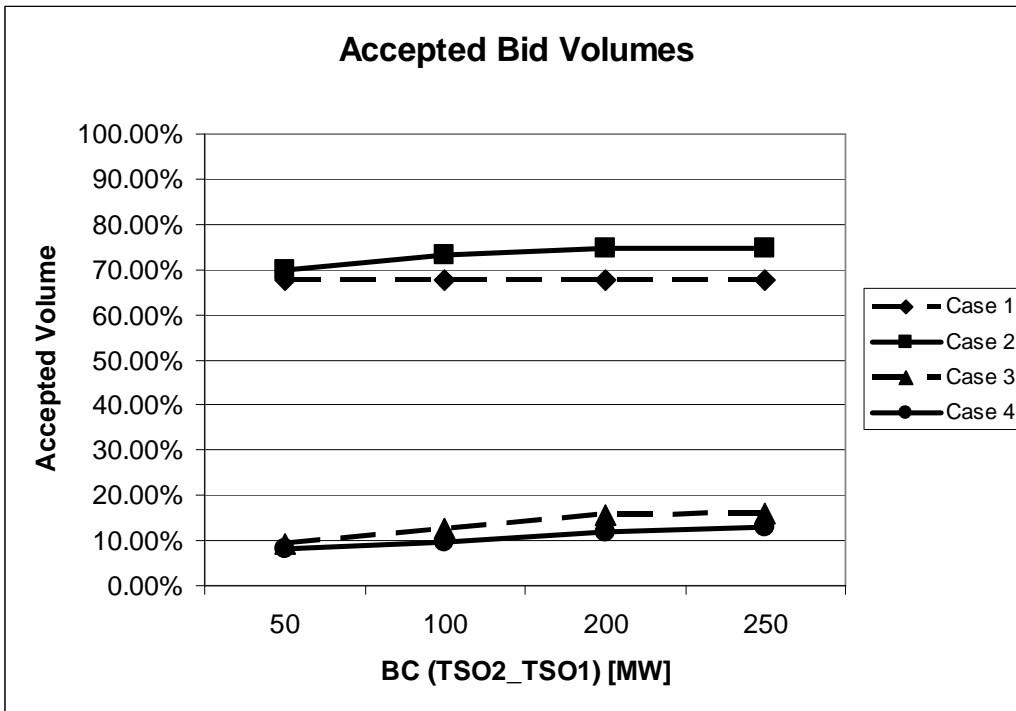
The analysis shows that in cases of the consideration of netting, the accepted bid volumes are much higher than in the cases of without netting (Figure 10). The accepted bid volume – for all bids – is for with netting between 67.92% and 74.87% (Appendix E). The accepted bid volume for without netting amounts between 8.23% and 15.93% (Appendix E). This tremendous difference shows the effect of netting on the amount demand that can be accepted. The additional available capacity through netting leads to a much more efficient utilization of the network. This netting effect works as follows. If bids are accepted that cause opposite flows over a line, resulting flows cancel out. Hence, the capacity is still available for further bids. Consequently, more bids – also with lower bid prices – can be accepted before the line flow constraints become binding. In addition, the RPV (see Section 4.3.5) must also be considered.

Regarding the perpetuation of CBCs, it can be stated that the RPV is lower for the cases excluding CBCs than for the respective cases including CBCs (Table 22). Hence, CBCs lead to a less efficient outcome from an economic point of view. From a technical point of view, CBCs cannot be justified, either, as flow-based allocations reflect the physical network better than NTC-based allocation. Hence, this reasoning for CBCs is not valid any more.

**Table 22: RPV for the cases with netting**

		BC (TSO2_TSO1) [MW]			
		50	100	200	250
RPV [per unit]	Case 1	65.64	65.64	65.64	65.64
	Case 2	74.06	74.71	74.51	74.51
	Case 3	304.12	328.79	340.37	332.29
	Case 4	425.21	491.95	458.81	390.77

**Figure 10: Accepted Bid Volumes**



## 6 Conclusions

In this thesis, a flow-based coordinated explicit auction for the CEE region is introduced and the results are analyzed. It is assumed that incentives in order to behave efficiently are given to TSOs by distributing auction revenue to them. However, congestion management and market structure of the electricity market are still very political in the EU. Therefore, the definition of appropriate incentives must incorporate political, economical and technical issues.

The analysis shows that the revenue distribution methods proposed by ETSO are not incentive compatible with the defined set of targets. In particular, method ETSO1 causes negative external effects for the case with netting that may lead to negative revenues for some TSOs. Method ETSO2 (SP), whereas, does not set right incentives concerning the capacity provision to the market and, thus, in terms of resource utilization.

Furthermore, different revenue distribution schemes were analyzed. From this analysis, it can be concluded that it is helpful to know other market conditions such as the inclusion or exclusion of CBC or whether netting is allowed, respectively. The most favorable distribution method differs with these market conditions. In order to find an acceptable trade-off, two methods can be taken into account.

The first one allocates revenues on basis of the ABFs (Method AF). Hence, even relieving congestion does not decrease revenues to the respective TSOs. Revenues may stagnate but TSOs are not reluctant to increase BCs.

The second method weights the ABFs with the clearing prices for the respective tie-line (Method CP). As the CPs are calculated on basis of the shadow prices, this leads to a higher volatility of revenues when changing BCs. However, this method also seems to be an interesting trade-off, particularly for the case that the market structure will be defined as excluding CBCs and considering netting (case 1).

In addition to the evaluation of different distribution schemes, evidence was found that the case with netting leads to a much higher network utilization than without netting while the cost of congestion – that is the TAR – is lower, too.

The perpetuation of technical profiles as CBCs is not desirable as they tend to higher the cost of congestion and distort prices. Considering the case with netting, however, it must be stated that the netting effect seems to compensate effects that occur much more clearly in the cases without netting. The revenues, for instance, become less vulnerable to BC changes for many of the considered distribution methods. Consequently, if the actual market structure is defined, it might be helpful to consider some of the revenue distributions again that were now negated.

Also, policymakers and regulators have to clarify their expectations in terms of the evaluation criteria (compare Section 4.3.4), i.e. which volatility of revenues and revenues share is acceptable. Considering again these criteria, it becomes evident that they are only useful for a transition phase that is needed in order to create a framework for a further market integration. Hence, the flow-based coordinated explicit auction approach can also be considered as a first step towards stronger market integration.

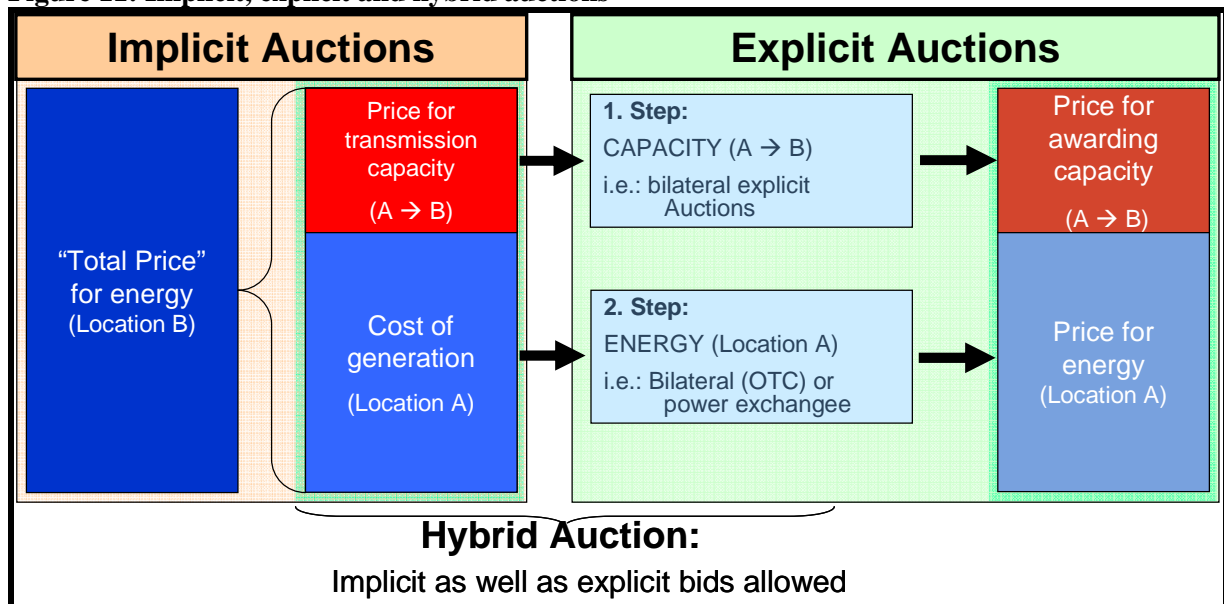
## 7 Possible Further Developments

As pointed out in Section 6, the flow-based coordinated explicit auction means a first step towards greater market integration. In order to move forwards, other market organization must be applied.

### 7.1 Hybrid auctions or open market coupling

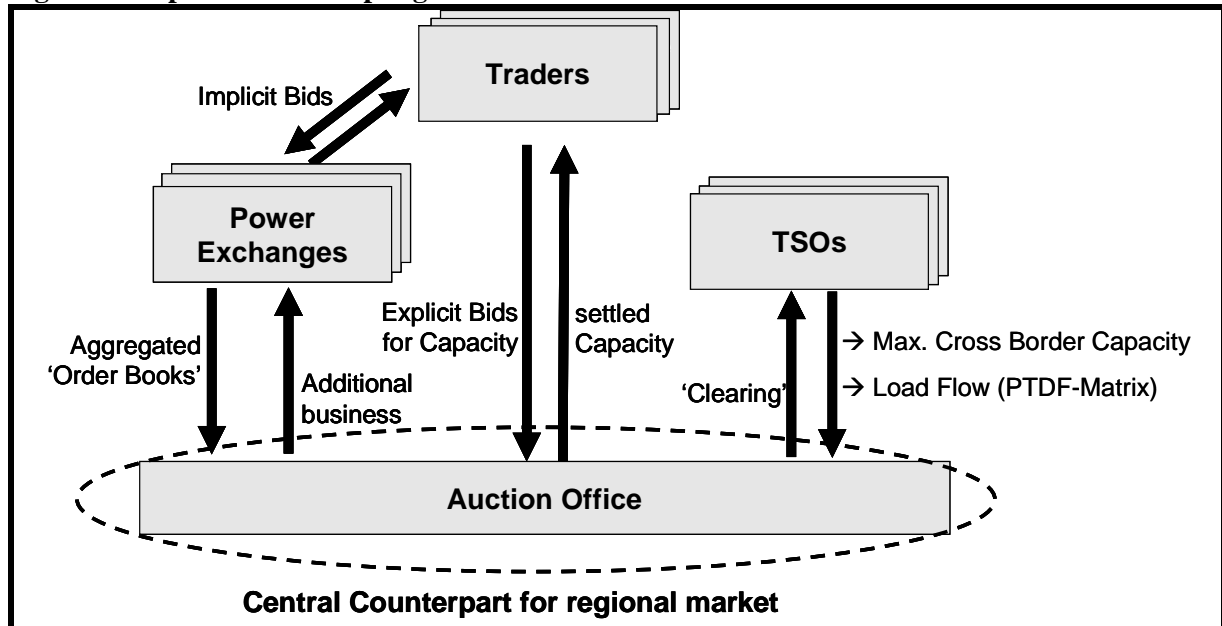
A realistic next step – starting from the flow-based coordinated explicit auction – is the integration of power exchanges into the system. Thus, the zonal approach remains the same but now also energy bids are included. One according market design is called open market coupling (OMC). OMC is a form of hybrid auctions. A hybrid auction allows for explicit and implicit bids (Figure 11). Energy exchanges in different zones report their order books to the Coordinating Auction Office (CAO). These order books are bids for energy (implicit bids). In addition, traders can send bids for only transmission capacity directly to the CAO (explicit bids). The energy price differences between zones resulting from implicit bids make up the benchmark whether to accept an explicit bid for transmission between two specific zones or not. After the clearing the CAO announces the prices back to the exchanges and the accepted bid offers for the explicit bids. An important fact is that the CAO acts as legal counterpart for the parties within the regional markets (Figure 12).

**Figure 11: Implicit, explicit and hybrid auctions**



Source: Own illustration.

**Figure 12: Open market coupling**



Source: EEX, 2005; own illustration.

## 7.2 Types of allocated transmission rights

In this analysis the cases with and without netting are compared. Thereby, with netting refers to the case that obligations are auctioned and without netting means that options are auctioned. In principle, obligations are the desirable type of transmission rights as they lead to a more efficient allocation and create additional capacity which fosters interzonal exchange of energy within Europe. However, it must be analyzed to which extent obligations are acceptable in order to secure network stability. The problem is that even though it is an obligation, TSOs have to ensure network security for the scenario that a party does not hold its obligation. One proposal that is made here is that the available redispatch capacity defines which share of a BC can be auctioned as obligations. The rest must, then, be auctioned as options. This approach implicates a partial netting (compare Purchala et al., 2003) algorithm that can be solved in a single process.

Furthermore, financial transmission rights for European markets are another interesting field of further developments. The flow-based coordinated explicit auction allocates only physical transmission rights. Another type of transmission rights are financial transmission rights. It can be argued that financial transmission rights are the basis for an integration of energy markets as they are necessary for a hedging of long-term energy products (Chao et al., 2000, p. 43). In contrast to physical transmission rights, financial transmission rights are purely financial products. The holder of a financial transmission right has to be pay or gets paid, respectively, if congestion occurs. She does not have to cause any physical transactions.

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## Appendix A: Implementing the optimization problem in GAMS

The GAMS language models a mathematical problem such that they can be solved by pre-installed solvers. Technical machine-specific issues do not have to be considered by the user. These issues are taken into account implicitly by the solver.<sup>28</sup> The linear optimization problems are solved by CPLEX.

However, the overall goal was to find one code that can solve all of the considered problems. In order to fulfill this goal, many detours had to be made. Basically, two types of codes were used. In one code, tie-lines were not considered explicitly. They were modeled by defining zones as a lines source and sink. In the other code, tie-lines are modeled explicitly as set which of course required changes in other parts of the code. For the first problem two codes were necessary: one for with netting and one for without netting. Subsequently, only the first code is shortly describes as it was the one that was used for the analysis.

**Table 23: Spreadsheet for notation in GAMS, code with netting**

Spreadsheet: Notation in GAMS, code with netting	
Term in GAMS	Description
BorderSource	Set of modeled TSOs/Zones Here as source of a border
BorderSink	Set of modeled TSOs/Zones Here as sink of a border
BidSource	Set of modeled TSOs/Zones Here as source of a bid
BidSink	Set of modeled TSOs/Zones Here as source of a bid
Bids	Set of bids
BorderCapacityForward(BorderSource, BorderSink)	Maximum allowable transmission capacity per border in positive direction
BorderCapacityReverse(BorderSource, BorderSink)	Maximum allowable transmission capacity per border in negative direction
BidPrice (Bids, BidSource, BidSink)	Maximum price per bid for the transmission from a BidSource to a BidSink
BidVol (Bids, BidSource, BidSink)	Maximum quantity per bid for the

<sup>28</sup> Compare [www.gams.com](http://www.gams.com)

	transmission from a BidSource to a BidSink
PTDF (BidSource,BidSink,BorderSource,BorderSink)	PTDF-Matrix in zone-to-zone notation (for with netting)
BidVolVar (Bids,BidSource,BidSink)	Variable: Quantity per bid for a transmission from a BidSource to a BidSink
AuctionRevenueVar	Variable to be maximized (BidVolVar times BidPrice)
FinalBidPrice (BidSource,BidSink)	Prices for the transmission from a BidSource to a BidSink (calculated based on the optimization results)
TotalAuctionRevenue	The actual auction revenue according to marginal pricing (calculated based on the optimization results)

**Table 24: Spreadsheet for notation in GAMS, code without netting**

<b>Spreadsheet: Notation in GAMS, code without netting</b>	
<b>Term in GAMS</b>	<b>Description</b>
BorderSource	Set of modeled TSOs/Zones Here as source of a border
BorderSink	Set of modeled TSOs/Zones Here as sink of a border
BidSource	Set of modeled TSOs/Zones Here as source of a bid
BidSink	Set of modeled TSOs/Zones Here as sink of a bid
Bids	Set of bids
BorderCapacity (BorderSource,BorderSink)	Maximum allowable transmission capacity per border; each border is listed twice (both directions)
BidPrice (Bids,BidSource,BidSink)	Maximum price per bid for the transmission from a BidSource to a BidSink
BidVol (Bids,BidSource,BidSink)	Maximum quantity per bid for the transmission from a BidSource to a

	BidSink
PTDF (BidSource,BidSink,BorderSource,BorderSink)	PTDF-Matrix in zone-to-zone notation (for without netting)
BidVolVar (Bids,BidSource,BidSink)	Variable: Quantity per bid for a transmission from a BidSource to a BidSink
AuctionRevenueVar	Variable to be maximized (BidVolVar times BidPrice)
FinalBidPrice (BidSource,BidSink)	Prices for the transmission from a BidSource to a BidSink (calculated based on the optimization results)
TotalAuctionRevenue	The actual auction revenue according to marginal pricing (calculated based on the optimization results)

**Appendix B: NTC-based revenue distribution for 2006**

**Table 25: Revenue distribution for the 2006 NTC-based auctions**

	<b>Revenue [per unit]</b>	<b>Revenue share</b>
<b>TSO1</b>	2.908	4.14%
<b>TSO2</b>	19.637	27.95%
<b>TSO3</b>	0.000	0.00%
<b>TSO4</b>	13.081	18.62%
<b>TSO5</b>	1.172	1.67%
<b>TSO6</b>	13.987	19.91%
<b>TSO7</b>	0.261	0.37%
<b>TSO8</b>	19.220	27.35%

## Appendix C: Revenues without netting

### Method AF

**Table 26: Relative revenue distribution without netting, method AF excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.90%	8.64%	13.98%	14.15%
<b>TSO2</b>	28.95%	31.13%	27.70%	27.96%
<b>TSO3</b>	1.21%	0.91%	3.04%	2.98%
<b>TSO4</b>	7.36%	9.10%	10.58%	10.74%
<b>TSO5</b>	7.19%	5.92%	6.54%	6.53%
<b>TSO6</b>	15.35%	14.88%	14.06%	13.49%
<b>TSO7</b>	17.46%	14.05%	10.48%	10.78%
<b>TSO8</b>	13.58%	15.36%	13.63%	13.37%

**Table 27: Relative revenue distribution without netting, method AF including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.15%	7.89%	12.91%	14.35%
<b>TSO2</b>	26.71%	30.40%	29.52%	29.32%
<b>TSO3</b>	1.10%	0.46%	1.94%	2.34%
<b>TSO4</b>	7.03%	10.17%	11.55%	11.97%
<b>TSO5</b>	5.73%	3.86%	4.99%	5.30%
<b>TSO6</b>	22.02%	20.38%	15.44%	13.99%
<b>TSO7</b>	12.71%	7.24%	8.43%	8.76%
<b>TSO8</b>	16.54%	19.60%	15.22%	13.96%

**Table 28: Revenue distribution without netting, method AF excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.563	3.632	7.450	7.492
<b>TSO2</b>	8.339	13.091	14.762	14.798
<b>TSO3</b>	0.350	0.383	1.622	1.576
<b>TSO4</b>	2.121	3.826	5.637	5.685
<b>TSO5</b>	2.070	2.491	3.484	3.457
<b>TSO6</b>	4.419	6.258	7.494	7.140
<b>TSO7</b>	5.029	5.910	5.588	5.707
<b>TSO8</b>	3.910	6.461	7.264	7.079

**Table 29: Revenue distribution without netting, method AF including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.853	3.711	7.062	7.241
<b>TSO2</b>	9.348	14.298	16.146	14.792
<b>TSO3</b>	0.386	0.216	1.062	1.180
<b>TSO4</b>	2.460	4.781	6.315	6.039
<b>TSO5</b>	2.007	1.815	2.728	2.674
<b>TSO6</b>	7.707	9.587	8.442	7.058
<b>TSO7</b>	4.446	3.405	4.610	4.422
<b>TSO8</b>	5.788	9.218	8.326	7.043

## Method CP

**Table 30: Relative revenue distribution without netting, method CP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.02%	8.35%	9.17%	9.57%
<b>TSO2</b>	25.37%	28.79%	31.76%	31.91%
<b>TSO3</b>	0.40%	0.26%	0.84%	1.33%
<b>TSO4</b>	5.66%	6.97%	10.80%	11.04%
<b>TSO5</b>	7.89%	5.49%	2.41%	2.06%
<b>TSO6</b>	23.10%	21.56%	19.48%	18.98%
<b>TSO7</b>	9.91%	8.01%	5.00%	4.61%
<b>TSO8</b>	19.65%	20.57%	20.52%	20.51%

**Table 31: Relative revenue distribution without netting, method CP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	6.88%	4.82%	7.64%	7.68%
<b>TSO2</b>	24.57%	31.47%	32.80%	33.20%
<b>TSO3</b>	0.31%	0.13%	0.56%	0.92%
<b>TSO4</b>	5.30%	7.21%	9.32%	9.78%
<b>TSO5</b>	5.14%	1.64%	2.07%	2.00%
<b>TSO6</b>	27.19%	28.31%	24.58%	24.55%
<b>TSO7</b>	8.10%	5.11%	5.43%	5.22%
<b>TSO8</b>	22.51%	21.32%	17.61%	16.65%

**Table 32: Revenue distribution without netting, method CP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.308	3.512	4.890	5.068
<b>TSO2</b>	7.306	12.107	16.931	16.890
<b>TSO3</b>	0.116	0.110	0.448	0.703
<b>TSO4</b>	1.629	2.930	5.759	5.844
<b>TSO5</b>	2.273	2.307	1.285	1.090
<b>TSO6</b>	6.653	9.067	10.382	10.044
<b>TSO7</b>	2.853	3.368	2.667	2.440
<b>TSO8</b>	5.660	8.650	10.940	10.855

**Table 33: Revenue distribution without netting, method CP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.408	2.265	4.179	3.873
<b>TSO2</b>	8.599	14.799	17.938	16.751
<b>TSO3</b>	0.107	0.061	0.306	0.465
<b>TSO4</b>	1.855	3.393	5.095	4.933
<b>TSO5</b>	1.798	0.773	1.132	1.008
<b>TSO6</b>	9.516	13.313	13.442	12.384
<b>TSO7</b>	2.833	2.401	2.969	2.633
<b>TSO8</b>	7.879	10.026	9.629	8.402

## Method ETSO1

**Table 34: Relative revenue distribution without netting, method ETSO1 excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	0.94%	0.71%	16.06%	16.83%
<b>TSO2</b>	20.60%	29.74%	31.20%	31.90%
<b>TSO3</b>	0.12%	0.09%	0.32%	0.16%
<b>TSO4</b>	19.79%	29.14%	18.32%	17.44%
<b>TSO5</b>	0.83%	0.62%	3.17%	2.69%
<b>TSO6</b>	28.46%	19.55%	15.32%	15.25%
<b>TSO7</b>	0.99%	0.75%	0.46%	0.47%
<b>TSO8</b>	28.27%	19.41%	15.15%	15.25%

**Table 35: Relative revenue distribution without netting, method ETSO1 including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	0.75%	1.14%	14.00%	14.52%
<b>TSO2</b>	11.75%	24.53%	28.19%	26.46%
<b>TSO3</b>	0.11%	0.07%	0.06%	0.00%
<b>TSO4</b>	10.97%	24.02%	14.63%	12.32%
<b>TSO5</b>	0.64%	0.55%	0.38%	0.38%
<b>TSO6</b>	37.50%	24.84%	21.36%	23.16%
<b>TSO7</b>	0.93%	0.00%	0.00%	0.00%
<b>TSO8</b>	37.35%	24.84%	21.36%	23.16%

**Table 36: Revenue distribution without netting, method ETSO1 excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	0.272	0.297	8.562	8.910
<b>TSO2</b>	5.932	12.507	16.630	16.884
<b>TSO3</b>	0.033	0.036	0.169	0.087
<b>TSO4</b>	5.701	12.253	9.764	9.234
<b>TSO5</b>	0.238	0.261	1.688	1.424
<b>TSO6</b>	8.196	8.222	8.164	8.073
<b>TSO7</b>	0.285	0.314	0.248	0.250
<b>TSO8</b>	8.143	8.163	8.077	8.073

**Table 37: Revenue distribution without netting, method ETSO1 including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	0.264	0.536	7.657	7.326
<b>TSO2</b>	4.111	11.538	15.417	13.346
<b>TSO3</b>	0.040	0.034	0.034	0.000
<b>TSO4</b>	3.838	11.295	8.003	6.214
<b>TSO5</b>	0.224	0.259	0.210	0.193
<b>TSO6</b>	13.123	11.684	11.684	11.684
<b>TSO7</b>	0.325	0.000	0.000	0.000
<b>TSO8</b>	13.071	11.684	11.684	11.684

**Method RF**

**Table 38: Relative revenue distribution without netting, method RF excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	16.74%	14.43%	19.67%	19.23%
<b>TSO2</b>	27.96%	30.20%	25.16%	24.92%
<b>TSO3</b>	2.39%	2.03%	7.13%	7.25%
<b>TSO4</b>	2.18%	2.89%	2.92%	3.10%
<b>TSO5</b>	7.48%	6.51%	7.98%	8.16%
<b>TSO6</b>	21.80%	21.57%	18.98%	18.82%
<b>TSO7</b>	14.31%	12.70%	9.62%	9.80%
<b>TSO8</b>	7.15%	9.66%	8.52%	8.72%

**Table 39: Relative revenue distribution without netting, method RF including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	24.72%	20.14%	24.23%	25.17%
<b>TSO2</b>	31.06%	37.78%	31.06%	29.17%
<b>TSO3</b>	3.27%	1.78%	7.49%	9.06%
<b>TSO4</b>	4.10%	7.62%	7.72%	7.83%
<b>TSO5</b>	9.24%	5.87%	7.78%	8.33%
<b>TSO6</b>	16.20%	18.59%	14.11%	12.94%
<b>TSO7</b>	9.05%	5.13%	5.26%	5.33%
<b>TSO8</b>	2.37%	3.08%	2.35%	2.16%

**Table 40: Revenue distribution without netting, method RF excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	4.820	6.070	10.483	10.178
<b>TSO2</b>	8.053	12.701	13.412	13.192
<b>TSO3</b>	0.688	0.854	3.803	3.835
<b>TSO4</b>	0.628	1.217	1.557	1.639
<b>TSO5</b>	2.153	2.737	4.256	4.320
<b>TSO6</b>	6.277	9.072	10.118	9.961
<b>TSO7</b>	4.120	5.339	5.130	5.189
<b>TSO8</b>	2.060	4.063	4.543	4.618

**Table 41: Revenue distribution without netting, method RF including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.650	9.473	13.251	12.699
<b>TSO2</b>	10.870	17.770	16.987	14.718
<b>TSO3</b>	1.143	0.836	4.096	4.569
<b>TSO4</b>	1.434	3.582	4.221	3.949
<b>TSO5</b>	3.233	2.761	4.253	4.204
<b>TSO6</b>	5.669	8.745	7.718	6.530
<b>TSO7</b>	3.167	2.414	2.878	2.688
<b>TSO8</b>	0.828	1.450	1.287	1.092

**Method SP**

**Table 42: Relative revenue distribution without netting, method SP excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	37.45%	34.79%	13.46%	10.99%
<b>TSO2</b>	48.75%	48.24%	41.33%	39.01%
<b>TSO3</b>	0.00%	0.00%	0.18%	5.11%
<b>TSO4</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO5</b>	0.00%	0.00%	8.49%	5.89%
<b>TSO6</b>	12.55%	15.21%	17.63%	17.71%
<b>TSO7</b>	1.25%	1.76%	0.00%	0.00%
<b>TSO8</b>	0.00%	0.00%	18.91%	21.30%

**Table 43: Relative revenue distribution without netting, method SP including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.84%	0.17%	0.07%	0.01%
<b>TSO2</b>	17.89%	16.78%	16.71%	16.66%
<b>TSO3</b>	0.00%	0.00%	0.00%	0.01%
<b>TSO4</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO5</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO6</b>	48.16%	49.83%	49.93%	49.99%
<b>TSO7</b>	16.05%	16.61%	16.64%	16.66%
<b>TSO8</b>	16.05%	16.61%	16.64%	16.66%

**Table 44: Revenue distribution without netting, method SP excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	10.786	14.628	7.172	5.820
<b>TSO2</b>	14.040	20.286	22.028	20.647
<b>TSO3</b>	0.000	0.000	0.097	2.703
<b>TSO4</b>	0.000	0.000	0.000	0.000
<b>TSO5</b>	0.000	0.000	4.525	3.117
<b>TSO6</b>	3.614	6.398	9.397	9.373
<b>TSO7</b>	0.360	0.740	0.000	0.000
<b>TSO8</b>	0.000	0.000	10.082	11.274

**Table 45: Revenue distribution without netting, method SP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	0.642	0.079	0.038	0.008
<b>TSO2</b>	6.261	7.891	9.140	8.406
<b>TSO3</b>	0.000	0.000	0.000	0.008
<b>TSO4</b>	0.000	0.000	0.000	0.000
<b>TSO5</b>	0.000	0.000	0.000	0.000
<b>TSO6</b>	16.855	23.436	27.307	25.217
<b>TSO7</b>	5.618	7.812	9.102	8.406
<b>TSO8</b>	5.618	7.812	9.102	8.406

**Method TU**

**Table 46: Relative revenue distribution without netting, method TU excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	4.71%	4.58%	13.03%	13.53%
<b>TSO2</b>	28.09%	33.35%	33.46%	33.43%
<b>TSO3</b>	0.32%	0.17%	2.47%	2.37%
<b>TSO4</b>	1.49%	2.66%	3.73%	3.78%
<b>TSO5</b>	11.00%	7.27%	6.87%	7.32%
<b>TSO6</b>	11.68%	10.28%	8.36%	7.79%
<b>TSO7</b>	23.88%	13.20%	7.79%	8.53%
<b>TSO8</b>	18.83%	28.50%	24.28%	23.26%

**Table 47: Relative revenue distribution without netting, method TU including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	3.81%	4.15%	11.64%	14.65%
<b>TSO2</b>	23.46%	34.59%	35.34%	35.28%
<b>TSO3</b>	0.26%	0.06%	1.26%	1.86%
<b>TSO4</b>	1.55%	3.03%	3.70%	3.96%
<b>TSO5</b>	6.59%	2.20%	4.50%	5.24%
<b>TSO6</b>	23.55%	15.22%	10.01%	8.26%
<b>TSO7</b>	11.71%	3.38%	5.83%	6.64%
<b>TSO8</b>	29.07%	37.38%	27.72%	24.12%

**Table 48: Revenue distribution without netting, method TU excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.356	1.927	6.943	7.161
<b>TSO2</b>	8.091	14.024	17.832	17.695
<b>TSO3</b>	0.092	0.070	1.319	1.253
<b>TSO4</b>	0.429	1.117	1.991	1.999
<b>TSO5</b>	3.169	3.056	3.663	3.873
<b>TSO6</b>	3.363	4.322	4.458	4.123
<b>TSO7</b>	6.878	5.549	4.151	4.516
<b>TSO8</b>	5.422	11.987	12.944	12.313

**Table 49: Revenue distribution without netting, method TU including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.332	1.950	6.367	7.390
<b>TSO2</b>	8.210	16.269	19.326	17.796
<b>TSO3</b>	0.091	0.026	0.691	0.939
<b>TSO4</b>	0.543	1.425	2.023	1.998
<b>TSO5</b>	2.307	1.035	2.459	2.642
<b>TSO6</b>	8.243	7.157	5.472	4.165
<b>TSO7</b>	4.097	1.588	3.189	3.351
<b>TSO8</b>	10.173	17.581	15.162	12.166

Method AF\_CP\_SP

**Table 50: Relative revenue distribution without netting, method AF\_CP\_SP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	13.13%	12.68%	10.47%	10.19%
<b>TSO2</b>	33.87%	35.57%	34.88%	34.36%
<b>TSO3</b>	0.18%	0.11%	0.98%	2.31%
<b>TSO4</b>	3.66%	6.04%	9.00%	9.17%
<b>TSO5</b>	4.85%	3.41%	4.74%	4.14%
<b>TSO6</b>	16.56%	16.76%	15.93%	15.36%
<b>TSO7</b>	14.51%	8.87%	4.48%	4.74%
<b>TSO8</b>	13.24%	16.55%	19.52%	19.73%

**Table 51: Relative revenue distribution without netting, method AF\_CP\_SP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.64%	2.86%	6.08%	7.32%
<b>TSO2</b>	22.30%	27.31%	29.00%	29.30%
<b>TSO3</b>	0.14%	0.05%	0.51%	0.78%
<b>TSO4</b>	3.52%	6.61%	8.52%	9.18%
<b>TSO5</b>	2.90%	1.02%	1.82%	2.05%
<b>TSO6</b>	34.08%	30.77%	26.33%	25.05%
<b>TSO7</b>	10.36%	6.57%	7.77%	8.13%
<b>TSO8</b>	23.05%	24.82%	19.97%	18.20%

**Table 52: Revenue distribution without netting, method AF\_CP\_SP excluding CBCs [per unti]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.780	5.331	5.579	5.395
<b>TSO2</b>	9.756	14.959	18.594	18.186
<b>TSO3</b>	0.053	0.047	0.522	1.221
<b>TSO4</b>	1.053	2.541	4.797	4.854
<b>TSO5</b>	1.397	1.436	2.525	2.193
<b>TSO6</b>	4.769	7.048	8.490	8.129
<b>TSO7</b>	4.180	3.729	2.390	2.511
<b>TSO8</b>	3.812	6.962	10.404	10.444

**Table 53: Revenue distribution without netting, method AF\_CP\_SP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	1.274	1.345	3.326	3.692
<b>TSO2</b>	7.804	12.842	15.858	14.781
<b>TSO3</b>	0.049	0.022	0.277	0.395
<b>TSO4</b>	1.232	3.109	4.659	4.630
<b>TSO5</b>	1.016	0.478	0.997	1.032
<b>TSO6</b>	11.925	14.471	14.401	12.640
<b>TSO7</b>	3.627	3.091	4.251	4.099
<b>TSO8</b>	8.067	11.671	10.920	9.180

Method AF\_RF

**Table 54: Relative revenue distribution without netting, method AF\_RF excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	10.13%	9.11%	14.64%	14.67%
<b>TSO2</b>	29.32%	31.42%	29.19%	29.09%
<b>TSO3</b>	1.28%	1.06%	4.29%	4.32%
<b>TSO4</b>	3.33%	5.75%	7.76%	7.96%
<b>TSO5</b>	6.62%	5.30%	6.00%	6.24%
<b>TSO6</b>	18.54%	18.35%	16.14%	15.60%
<b>TSO7</b>	18.88%	12.77%	8.05%	8.49%
<b>TSO8</b>	11.90%	16.24%	13.92%	13.64%

**Table 55: Relative revenue distribution without netting, method AF\_RF including CBCs**

	CBC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	13.82%	11.69%	16.27%	17.98%
<b>TSO2</b>	27.22%	34.14%	32.15%	31.42%
<b>TSO3</b>	1.70%	0.90%	4.11%	5.08%
<b>TSO4</b>	4.24%	8.62%	10.05%	10.65%
<b>TSO5</b>	6.24%	3.54%	5.19%	5.71%
<b>TSO6</b>	23.34%	20.53%	14.76%	12.89%
<b>TSO7</b>	8.85%	3.71%	4.89%	5.32%
<b>TSO8</b>	14.59%	16.87%	12.58%	10.95%

**Table 56: Revenue distribution without netting, method AF\_RF excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.917	3.831	7.805	7.763
<b>TSO2</b>	8.445	13.211	15.560	15.398
<b>TSO3</b>	0.368	0.447	2.288	2.287
<b>TSO4</b>	0.960	2.417	4.136	4.213
<b>TSO5</b>	1.905	2.227	3.200	3.301
<b>TSO6</b>	5.341	7.717	8.604	8.255
<b>TSO7</b>	5.437	5.371	4.288	4.496
<b>TSO8</b>	3.427	6.831	7.420	7.220

**Table 57: Revenue distribution without netting, method AF\_RF including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	4.836	5.496	8.897	9.071
<b>TSO2</b>	9.524	16.055	17.582	15.851
<b>TSO3</b>	0.594	0.425	2.249	2.562
<b>TSO4</b>	1.485	4.052	5.496	5.371
<b>TSO5</b>	2.184	1.665	2.841	2.882
<b>TSO6</b>	8.167	9.656	8.073	6.505
<b>TSO7</b>	3.098	1.745	2.672	2.683
<b>TSO8</b>	5.107	7.936	6.881	5.524

Method CP\_SP

**Table 58: Relative revenue distribution without netting, method CP\_SP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	22.73%	21.57%	11.31%	10.28%
<b>TSO2</b>	37.06%	38.52%	36.55%	35.46%
<b>TSO3</b>	0.20%	0.13%	0.51%	3.22%
<b>TSO4</b>	2.83%	3.48%	5.40%	5.52%
<b>TSO5</b>	3.95%	2.74%	5.45%	3.97%
<b>TSO6</b>	17.82%	18.39%	18.55%	18.34%
<b>TSO7</b>	5.58%	4.88%	2.50%	2.30%
<b>TSO8</b>	9.83%	10.28%	19.72%	20.90%

**Table 59: Relative revenue distribution without netting, method CP\_SP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	4.36%	2.49%	3.86%	3.85%
<b>TSO2</b>	21.23%	24.12%	24.76%	24.93%
<b>TSO3</b>	0.15%	0.06%	0.28%	0.47%
<b>TSO4</b>	2.65%	3.61%	4.66%	4.89%
<b>TSO5</b>	2.57%	0.82%	1.03%	1.00%
<b>TSO6</b>	37.68%	39.07%	37.25%	37.27%
<b>TSO7</b>	12.07%	10.86%	11.04%	10.94%
<b>TSO8</b>	19.28%	18.96%	17.13%	16.66%

**Table 60: Revenue distribution without netting, method CP\_SP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	6.547	9.070	6.031	5.444
<b>TSO2</b>	10.673	16.197	19.480	18.768
<b>TSO3</b>	0.058	0.055	0.272	1.703
<b>TSO4</b>	0.815	1.465	2.880	2.922
<b>TSO5</b>	1.136	1.154	2.905	2.103
<b>TSO6</b>	5.133	7.733	9.890	9.709
<b>TSO7</b>	1.607	2.054	1.334	1.220
<b>TSO8</b>	2.830	4.325	10.511	11.065

**Table 61: Revenue distribution without netting, method CP\_SP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.525	1.172	2.108	1.940
<b>TSO2</b>	7.430	11.345	13.539	12.578
<b>TSO3</b>	0.053	0.030	0.153	0.236
<b>TSO4</b>	0.928	1.697	2.548	2.466
<b>TSO5</b>	0.899	0.386	0.566	0.504
<b>TSO6</b>	13.186	18.374	20.375	18.800
<b>TSO7</b>	4.226	5.107	6.036	5.519
<b>TSO8</b>	6.749	8.919	9.366	8.404

Method MS\_AF\_CP

**Table 62: Relative revenue distribution without netting, method MS\_AF\_CP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	6.11%	6.33%	9.45%	9.79%
<b>TSO2</b>	24.24%	26.07%	27.11%	27.16%
<b>TSO3</b>	0.71%	0.64%	1.46%	1.56%
<b>TSO4</b>	11.31%	13.69%	16.65%	16.82%
<b>TSO5</b>	6.44%	5.00%	4.20%	4.26%
<b>TSO6</b>	18.83%	18.37%	16.93%	16.34%
<b>TSO7</b>	15.29%	9.52%	5.58%	5.84%
<b>TSO8</b>	17.06%	20.38%	18.62%	18.23%

**Table 63: Relative revenue distribution without netting, method MS\_AF\_CP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	5.53%	5.17%	8.41%	9.66%
<b>TSO2</b>	20.38%	25.67%	27.37%	27.69%
<b>TSO3</b>	0.67%	0.57%	1.03%	1.31%
<b>TSO4</b>	11.17%	14.26%	16.17%	16.83%
<b>TSO5</b>	4.49%	2.60%	3.41%	3.63%
<b>TSO6</b>	27.45%	23.72%	19.26%	17.97%
<b>TSO7</b>	7.44%	3.51%	4.71%	5.05%
<b>TSO8</b>	22.87%	24.49%	19.63%	17.86%

**Table 64: Revenue distribution without netting, method MS\_AF\_CP excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	1.761	2.663	5.038	5.185
<b>TSO2</b>	6.981	10.961	14.448	14.376
<b>TSO3</b>	0.205	0.268	0.779	0.824
<b>TSO4</b>	3.256	5.758	8.875	8.904
<b>TSO5</b>	1.854	2.104	2.240	2.254
<b>TSO6</b>	5.424	7.724	9.025	8.651
<b>TSO7</b>	4.405	4.003	2.973	3.090
<b>TSO8</b>	4.915	8.571	9.924	9.651

**Table 65: Revenue distribution without netting, method MS\_AF\_CP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	1.936	2.431	4.602	4.875
<b>TSO2</b>	7.133	12.070	14.969	13.967
<b>TSO3</b>	0.233	0.270	0.565	0.659
<b>TSO4</b>	3.909	6.707	8.843	8.489
<b>TSO5</b>	1.572	1.225	1.866	1.833
<b>TSO6</b>	9.605	11.157	10.535	9.066
<b>TSO7</b>	2.605	1.652	2.573	2.549
<b>TSO8</b>	8.002	11.518	10.737	9.009

Method RF\_LU\_CP

**Table 66: Relative revenue distribution without netting, method RF\_LU\_CP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	9.48%	9.00%	12.87%	13.09%
<b>TSO2</b>	26.62%	30.45%	30.69%	30.68%
<b>TSO3</b>	0.89%	0.68%	2.85%	3.09%
<b>TSO4</b>	3.75%	4.86%	7.03%	7.20%
<b>TSO5</b>	8.85%	6.31%	4.99%	4.97%
<b>TSO6</b>	19.74%	18.48%	16.35%	15.93%
<b>TSO7</b>	14.34%	10.35%	6.82%	6.84%
<b>TSO8</b>	16.33%	19.87%	18.40%	18.19%

**Table 67: Relative revenue distribution without netting, method RF\_LU\_CP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	10.65%	8.53%	12.90%	13.92%
<b>TSO2</b>	26.23%	34.26%	33.25%	32.91%
<b>TSO3</b>	1.04%	0.52%	2.48%	3.21%
<b>TSO4</b>	4.07%	6.25%	7.48%	7.79%
<b>TSO5</b>	6.68%	2.87%	4.15%	4.44%
<b>TSO6</b>	23.16%	22.18%	18.02%	17.33%
<b>TSO7</b>	9.30%	4.70%	5.48%	5.59%
<b>TSO8</b>	18.87%	20.68%	16.22%	14.81%

**Table 68: Revenue distribution without netting, method RF\_LU\_CP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.731	3.784	6.862	6.931
<b>TSO2</b>	7.668	12.804	16.359	16.241
<b>TSO3</b>	0.256	0.287	1.517	1.636
<b>TSO4</b>	1.081	2.044	3.746	3.810
<b>TSO5</b>	2.549	2.653	2.658	2.631
<b>TSO6</b>	5.685	7.772	8.717	8.431
<b>TSO7</b>	4.130	4.353	3.634	3.623
<b>TSO8</b>	4.702	8.355	9.808	9.630

**Table 69: Revenue distribution without netting, method RF\_LU\_CP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	3.728	4.013	7.057	7.023
<b>TSO2</b>	9.181	16.112	18.187	16.604
<b>TSO3</b>	0.364	0.246	1.357	1.619
<b>TSO4</b>	1.423	2.940	4.089	3.932
<b>TSO5</b>	2.339	1.351	2.271	2.241
<b>TSO6</b>	8.103	10.432	9.857	8.742
<b>TSO7</b>	3.254	2.212	2.999	2.818
<b>TSO8</b>	6.603	9.725	8.872	7.470

## Appendix D: Revenues with netting

### Method AF

**Table 70: Relative revenue distribution with netting, method AF excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	9.43%	9.43%	9.43%	9.43%
<b>TSO2</b>	21.69%	21.69%	21.69%	21.69%
<b>TSO3</b>	2.19%	2.19%	2.19%	2.19%
<b>TSO4</b>	7.90%	7.90%	7.90%	7.90%
<b>TSO5</b>	10.78%	10.78%	10.78%	10.78%
<b>TSO6</b>	12.33%	12.33%	12.33%	12.33%
<b>TSO7</b>	20.03%	20.03%	20.03%	20.03%
<b>TSO8</b>	15.65%	15.65%	15.65%	15.65%

**Table 71: Relative revenue distribution with netting, method AF including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	9.90%	9.86%	9.65%	9.65%
<b>TSO2</b>	22.23%	24.40%	25.91%	25.91%
<b>TSO3</b>	2.15%	1.42%	0.76%	0.76%
<b>TSO4</b>	8.48%	9.23%	9.69%	9.69%
<b>TSO5</b>	10.04%	9.30%	8.80%	8.80%
<b>TSO6</b>	11.61%	12.08%	12.66%	12.66%
<b>TSO7</b>	18.91%	14.58%	11.78%	11.78%
<b>TSO8</b>	16.68%	19.13%	20.76%	20.76%

**Table 72: Revenue distribution with netting, method AF excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	2.563	3.632	7.450	7.492
<b>TSO2</b>	8.339	13.091	14.762	14.798
<b>TSO3</b>	0.350	0.383	1.622	1.576
<b>TSO4</b>	2.121	3.826	5.637	5.685
<b>TSO5</b>	2.070	2.491	3.484	3.457
<b>TSO6</b>	4.419	6.258	7.494	7.140
<b>TSO7</b>	5.029	5.910	5.588	5.707
<b>TSO8</b>	3.910	6.461	7.264	7.079

**Table 73: Revenue distribution with netting, method AF including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.692	3.692	3.692	3.692
<b>TSO2</b>	8.489	8.489	8.489	8.489
<b>TSO3</b>	0.859	0.859	0.859	0.859
<b>TSO4</b>	3.092	3.092	3.092	3.092
<b>TSO5</b>	4.219	4.219	4.219	4.219
<b>TSO6</b>	4.826	4.826	4.826	4.826
<b>TSO7</b>	7.839	7.839	7.839	7.839
<b>TSO8</b>	6.124	6.124	6.124	6.124

## Method CP

**Table 74: Relative revenue distribution with netting, method CP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.13%	8.13%	8.13%	8.13%
<b>TSO2</b>	18.29%	18.29%	18.29%	18.29%
<b>TSO3</b>	2.02%	2.02%	2.02%	2.02%
<b>TSO4</b>	7.61%	7.61%	7.61%	7.61%
<b>TSO5</b>	7.34%	7.34%	7.34%	7.34%
<b>TSO6</b>	20.56%	20.56%	20.56%	20.56%
<b>TSO7</b>	4.99%	4.99%	4.99%	4.99%
<b>TSO8</b>	31.06%	31.06%	31.06%	31.06%

**Table 75: Relative revenue distribution with netting, method CP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	6.26%	6.10%	5.65%	5.65%
<b>TSO2</b>	20.14%	23.65%	25.89%	25.89%
<b>TSO3</b>	0.86%	0.40%	0.17%	0.17%
<b>TSO4</b>	8.84%	10.23%	10.81%	10.81%
<b>TSO5</b>	3.44%	2.53%	2.09%	2.09%
<b>TSO6</b>	23.32%	21.42%	20.37%	20.37%
<b>TSO7</b>	2.56%	1.45%	1.08%	1.08%
<b>TSO8</b>	34.58%	34.22%	33.94%	33.94%

**Table 76: Revenue distribution with netting, method CP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	3.184	3.184	3.184	3.184
<b>TSO2</b>	7.160	7.160	7.160	7.160
<b>TSO3</b>	0.792	0.792	0.792	0.792
<b>TSO4</b>	2.977	2.977	2.977	2.977
<b>TSO5</b>	2.873	2.873	2.873	2.873
<b>TSO6</b>	8.046	8.046	8.046	8.046
<b>TSO7</b>	1.951	1.951	1.951	1.951
<b>TSO8</b>	12.155	12.155	12.155	12.155

**Table 77: Revenue distribution with netting, method CP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	3.070	3.197	3.022	3.022
<b>TSO2</b>	9.874	12.390	13.852	13.852
<b>TSO3</b>	0.423	0.209	0.092	0.092
<b>TSO4</b>	4.332	5.358	5.783	5.783
<b>TSO5</b>	1.686	1.324	1.117	1.117
<b>TSO6</b>	11.432	11.220	10.899	10.899
<b>TSO7</b>	1.257	0.760	0.580	0.580
<b>TSO8</b>	16.953	17.926	18.156	18.156

**Method ETSO1**

**Table 78: Relative revenue distribution with netting, method ETSO1 excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	-12.26%	-12.26%	-12.26%	-12.26%
<b>TSO2</b>	22.36%	22.36%	22.36%	22.36%
<b>TSO3</b>	-6.00%	-6.00%	-6.00%	-6.00%
<b>TSO4</b>	33.33%	33.33%	33.33%	33.33%
<b>TSO5</b>	-8.14%	-8.14%	-8.14%	-8.14%
<b>TSO6</b>	41.78%	41.78%	41.78%	41.78%
<b>TSO7</b>	-1.81%	-1.81%	-1.81%	-1.81%
<b>TSO8</b>	30.73%	30.73%	30.73%	30.73%

**Table 79: Relative revenue distribution with netting, method ETSO1 including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	-4.22%	1.04%	3.52%	3.52%
<b>TSO2</b>	9.86%	8.76%	7.71%	7.71%
<b>TSO3</b>	-3.55%	-2.24%	-1.65%	-1.65%
<b>TSO4</b>	22.51%	18.40%	16.11%	16.11%
<b>TSO5</b>	-0.94%	0.85%	1.46%	1.46%
<b>TSO6</b>	42.53%	41.16%	40.96%	40.96%
<b>TSO7</b>	-3.11%	-2.07%	-2.05%	-2.05%
<b>TSO8</b>	36.92%	34.11%	33.95%	33.95%

**Table 80: Revenue distribution with netting, method ETSO1 excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	-4.798	-4.798	-4.798	-4.798
<b>TSO2</b>	8.753	8.753	8.753	8.753
<b>TSO3</b>	-2.350	-2.350	-2.350	-2.350
<b>TSO4</b>	13.046	13.046	13.046	13.046
<b>TSO5</b>	-3.187	-3.187	-3.187	-3.187
<b>TSO6</b>	16.352	16.352	16.352	16.352
<b>TSO7</b>	-0.707	-0.707	-0.707	-0.707
<b>TSO8</b>	12.028	12.028	12.028	12.028

**Table 81: Revenue distribution with netting, method ETSO1 including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	-2.070	0.543	1.882	1.882
<b>TSO2</b>	4.835	4.587	4.123	4.123
<b>TSO3</b>	-1.743	-1.175	-0.882	-0.882
<b>TSO4</b>	11.037	9.639	8.617	8.617
<b>TSO5</b>	-0.459	0.447	0.780	0.780
<b>TSO6</b>	20.851	21.562	21.912	21.912
<b>TSO7</b>	-1.526	-1.085	-1.095	-1.095
<b>TSO8</b>	18.102	17.866	18.164	18.164

**Method RF**

**Table 82: Relative revenue distribution with netting, method RF excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	6.43%	18.65%	16.63%	15.53%
<b>TSO2</b>	17.51%	26.01%	24.47%	23.62%
<b>TSO3</b>	1.35%	5.55%	5.91%	6.10%
<b>TSO4</b>	11.71%	2.28%	2.43%	2.51%
<b>TSO5</b>	9.10%	10.58%	11.26%	11.63%
<b>TSO6</b>	17.88%	13.52%	14.39%	14.86%
<b>TSO7</b>	15.43%	11.92%	12.69%	13.11%
<b>TSO8</b>	20.59%	11.49%	12.23%	12.64%

**Table 83: Relative revenue distribution with netting, method RF including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	5.66%	27.97%	29.02%	26.98%
<b>TSO2</b>	21.17%	23.39%	26.09%	25.64%
<b>TSO3</b>	0.61%	7.02%	4.74%	2.79%
<b>TSO4</b>	14.24%	5.52%	7.58%	9.98%
<b>TSO5</b>	5.24%	14.81%	16.04%	18.13%
<b>TSO6</b>	19.74%	4.28%	2.93%	3.42%
<b>TSO7</b>	5.95%	13.79%	9.82%	8.59%
<b>TSO8</b>	27.40%	3.21%	3.77%	4.47%

**Table 84: Revenue distribution with netting, method RF excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	2.515	7.298	6.510	6.077
<b>TSO2</b>	6.855	10.180	9.577	9.246
<b>TSO3</b>	0.529	2.173	2.312	2.389
<b>TSO4</b>	4.582	0.892	0.950	0.981
<b>TSO5</b>	3.560	4.140	4.406	4.552
<b>TSO6</b>	6.999	5.291	5.631	5.818
<b>TSO7</b>	6.038	4.667	4.966	5.131
<b>TSO8</b>	8.060	4.498	4.787	4.945

**Table 85: Revenue distribution with netting, method RF including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.030	13.713	15.203	14.434
<b>TSO2</b>	11.327	11.467	13.669	13.717
<b>TSO3</b>	0.326	3.442	2.484	1.494
<b>TSO4</b>	7.618	2.707	3.972	5.342
<b>TSO5</b>	2.802	7.262	8.401	9.699
<b>TSO6</b>	10.559	2.099	1.537	1.827
<b>TSO7</b>	3.182	6.763	5.143	4.598
<b>TSO8</b>	14.658	1.574	1.975	2.390

**Method SP**

**Table 86: Relative revenue distribution with netting, method SP excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	20.65%	20.65%	20.65%	20.65%
<b>TSO2</b>	29.35%	29.35%	29.35%	29.35%
<b>TSO3</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO4</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO5</b>	20.65%	20.65%	20.65%	20.65%
<b>TSO6</b>	6.71%	6.71%	6.71%	6.71%
<b>TSO7</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO8</b>	22.65%	22.65%	22.65%	22.65%

**Table 87: Relative revenue distribution with netting, method SP including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	0.24%	0.12%	0.05%	0.05%
<b>TSO2</b>	24.24%	24.92%	24.98%	24.98%
<b>TSO3</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO4</b>	0.00%	0.00%	0.00%	0.00%
<b>TSO5</b>	0.11%	0.07%	0.05%	0.05%
<b>TSO6</b>	27.19%	25.13%	24.98%	24.98%
<b>TSO7</b>	1.54%	0.13%	0.00%	0.00%
<b>TSO8</b>	46.68%	49.63%	49.95%	49.95%

**Table 88: Revenue distribution with netting, method SP excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	8.081	8.081	8.081	8.081
<b>TSO2</b>	11.488	11.488	11.488	11.488
<b>TSO3</b>	0.000	0.000	0.000	0.000
<b>TSO4</b>	0.000	0.000	0.000	0.000
<b>TSO5</b>	8.081	8.081	8.081	8.081
<b>TSO6</b>	2.625	2.625	2.625	2.625
<b>TSO7</b>	0.000	0.000	0.000	0.000
<b>TSO8</b>	8.863	8.863	8.863	8.863

**Table 89: Revenue distribution with netting, method SP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	0.117	0.061	0.026	0.026
<b>TSO2</b>	11.883	13.056	13.362	13.362
<b>TSO3</b>	0.000	0.000	0.000	0.000
<b>TSO4</b>	0.000	0.000	0.000	0.000
<b>TSO5</b>	0.055	0.038	0.026	0.026
<b>TSO6</b>	13.332	13.164	13.362	13.362
<b>TSO7</b>	0.756	0.066	0.000	0.000
<b>TSO8</b>	22.886	25.999	26.724	26.724

**Method TU**

**Table 90: Relative revenue distribution with netting, method TU excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.90%	2.90%	2.90%	2.90%
<b>TSO2</b>	17.92%	17.92%	17.92%	17.92%
<b>TSO3</b>	1.14%	1.14%	1.14%	1.14%
<b>TSO4</b>	1.33%	1.33%	1.33%	1.33%
<b>TSO5</b>	20.13%	20.13%	20.13%	20.13%
<b>TSO6</b>	10.07%	10.07%	10.07%	10.07%
<b>TSO7</b>	30.00%	30.00%	30.00%	30.00%
<b>TSO8</b>	16.52%	16.52%	16.52%	16.52%

**Table 91: Relative revenue distribution with netting, method TU including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	3.37%	3.87%	4.95%	4.95%
<b>TSO2</b>	21.00%	23.89%	27.17%	27.17%
<b>TSO3</b>	1.13%	0.49%	0.13%	0.13%
<b>TSO4</b>	1.54%	1.89%	2.25%	2.25%
<b>TSO5</b>	16.59%	13.12%	10.43%	10.43%
<b>TSO6</b>	10.39%	11.97%	12.02%	12.02%
<b>TSO7</b>	25.89%	17.27%	11.39%	11.39%
<b>TSO8</b>	20.08%	27.50%	31.66%	31.66%

**Table 92: Revenue distribution with netting, method TU excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.133	1.133	1.133	1.133
<b>TSO2</b>	7.014	7.014	7.014	7.014
<b>TSO3</b>	0.445	0.445	0.445	0.445
<b>TSO4</b>	0.520	0.520	0.520	0.520
<b>TSO5</b>	7.878	7.878	7.878	7.878
<b>TSO6</b>	3.942	3.942	3.942	3.942
<b>TSO7</b>	11.740	11.740	11.740	11.740
<b>TSO8</b>	6.466	6.466	6.466	6.466

**Table 93: Revenue distribution with netting, method TU including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.654	2.025	2.647	2.647
<b>TSO2</b>	10.298	12.514	14.536	14.536
<b>TSO3</b>	0.554	0.257	0.072	0.072
<b>TSO4</b>	0.756	0.991	1.204	1.204
<b>TSO5</b>	8.134	6.874	5.578	5.578
<b>TSO6</b>	5.095	6.271	6.428	6.428
<b>TSO7</b>	12.692	9.044	6.095	6.095
<b>TSO8</b>	9.846	14.407	16.940	16.940

Method AF\_CP\_SP

**Table 94: Relative revenue distribution with netting, method AF\_CP\_SP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	9.24%	9.24%	9.24%	9.24%
<b>TSO2</b>	22.30%	22.30%	22.30%	22.30%
<b>TSO3</b>	0.83%	0.83%	0.83%	0.83%
<b>TSO4</b>	4.06%	4.06%	4.06%	4.06%
<b>TSO5</b>	12.67%	12.67%	12.67%	12.67%
<b>TSO6</b>	14.15%	14.15%	14.15%	14.15%
<b>TSO7</b>	14.34%	14.34%	14.34%	14.34%
<b>TSO8</b>	22.43%	22.43%	22.43%	22.43%

**Table 95: Relative revenue distribution with netting, method AF\_CP\_SP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.78%	3.46%	3.33%	3.33%
<b>TSO2</b>	22.30%	23.42%	24.86%	24.86%
<b>TSO3</b>	0.53%	0.24%	0.08%	0.08%
<b>TSO4</b>	4.69%	5.71%	6.59%	6.59%
<b>TSO5</b>	5.52%	4.45%	3.66%	3.66%
<b>TSO6</b>	20.03%	20.52%	20.57%	20.57%
<b>TSO7</b>	12.74%	7.89%	4.85%	4.85%
<b>TSO8</b>	30.40%	34.31%	36.06%	36.06%

**Table 96: Revenue distribution with netting, method AF\_CP\_SP excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.615	3.615	3.615	3.615
<b>TSO2</b>	8.728	8.728	8.728	8.728
<b>TSO3</b>	0.324	0.324	0.324	0.324
<b>TSO4</b>	1.588	1.588	1.588	1.588
<b>TSO5</b>	4.959	4.959	4.959	4.959
<b>TSO6</b>	5.537	5.537	5.537	5.537
<b>TSO7</b>	5.611	5.611	5.611	5.611
<b>TSO8</b>	8.778	8.778	8.778	8.778

**Table 97: Revenue distribution with netting, method AF\_CP\_SP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	1.853	1.812	1.779	1.779
<b>TSO2</b>	10.935	12.268	13.301	13.301
<b>TSO3</b>	0.260	0.127	0.044	0.044
<b>TSO4</b>	2.300	2.991	3.525	3.525
<b>TSO5</b>	2.707	2.330	1.959	1.959
<b>TSO6</b>	9.822	10.752	11.003	11.003
<b>TSO7</b>	6.245	4.135	2.597	2.597
<b>TSO8</b>	14.907	17.971	19.291	19.291

Method AF\_RF

**Table 98: Relative revenue distribution with netting, method AF\_RF excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	11.36%	10.36%	9.80%	9.69%
<b>TSO2</b>	23.39%	22.62%	22.20%	22.11%
<b>TSO3</b>	3.10%	3.27%	3.37%	3.39%
<b>TSO4</b>	3.30%	3.37%	3.41%	3.42%
<b>TSO5</b>	10.96%	11.30%	11.49%	11.53%
<b>TSO6</b>	14.09%	14.52%	14.76%	14.81%
<b>TSO7</b>	19.05%	19.43%	19.64%	19.69%
<b>TSO8</b>	14.75%	15.12%	15.32%	15.36%

**Table 99: Relative revenue distribution with netting, method AF\_RF including CBCs**

	CBC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	16.14%	16.42%	15.39%	14.93%
<b>TSO2</b>	22.90%	24.32%	24.96%	24.48%
<b>TSO3</b>	3.83%	2.51%	1.44%	1.49%
<b>TSO4</b>	5.24%	6.94%	8.88%	9.08%
<b>TSO5</b>	12.04%	11.82%	12.19%	12.56%
<b>TSO6</b>	9.55%	10.35%	10.94%	11.01%
<b>TSO7</b>	18.61%	12.41%	8.88%	9.05%
<b>TSO8</b>	11.69%	15.23%	17.32%	17.41%

**Table 100: Revenue distribution with netting, method AF\_RF excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	4.448	4.054	3.837	3.792
<b>TSO2</b>	9.156	8.854	8.689	8.654
<b>TSO3</b>	1.212	1.281	1.320	1.328
<b>TSO4</b>	1.290	1.319	1.335	1.338
<b>TSO5</b>	4.290	4.423	4.496	4.512
<b>TSO6</b>	5.514	5.684	5.778	5.797
<b>TSO7</b>	7.456	7.606	7.688	7.705
<b>TSO8</b>	5.772	5.916	5.996	6.012

**Table 101: Revenue distribution with netting, method AF\_RF including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	7.913	8.599	8.234	7.987
<b>TSO2</b>	11.229	12.741	13.356	13.094
<b>TSO3</b>	1.876	1.317	0.768	0.798
<b>TSO4</b>	2.570	3.637	4.751	4.858
<b>TSO5</b>	5.903	6.190	6.522	6.717
<b>TSO6</b>	4.680	5.424	5.852	5.888
<b>TSO7</b>	9.123	6.499	4.751	4.844
<b>TSO8</b>	5.734	7.977	9.266	9.314

Method CP\_SP

**Table 102: Relative revenue distribution with netting, method CP\_SP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	14.39%	14.39%	14.39%	14.39%
<b>TSO2</b>	23.82%	23.82%	23.82%	23.82%
<b>TSO3</b>	1.01%	1.01%	1.01%	1.01%
<b>TSO4</b>	3.80%	3.80%	3.80%	3.80%
<b>TSO5</b>	13.99%	13.99%	13.99%	13.99%
<b>TSO6</b>	13.63%	13.63%	13.63%	13.63%
<b>TSO7</b>	2.49%	2.49%	2.49%	2.49%
<b>TSO8</b>	26.85%	26.85%	26.85%	26.85%

**Table 103: Relative revenue distribution with netting, method CP\_SP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.25%	3.11%	2.85%	2.85%
<b>TSO2</b>	22.19%	24.29%	25.43%	25.43%
<b>TSO3</b>	0.43%	0.20%	0.09%	0.09%
<b>TSO4</b>	4.42%	5.11%	5.40%	5.40%
<b>TSO5</b>	1.78%	1.30%	1.07%	1.07%
<b>TSO6</b>	25.25%	23.27%	22.67%	22.67%
<b>TSO7</b>	2.05%	0.79%	0.54%	0.54%
<b>TSO8</b>	40.63%	41.93%	41.94%	41.94%

**Table 104: Revenue distribution with netting, method CP\_SP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	5.632	5.632	5.632	5.632
<b>TSO2</b>	9.324	9.324	9.324	9.324
<b>TSO3</b>	0.396	0.396	0.396	0.396
<b>TSO4</b>	1.488	1.488	1.488	1.488
<b>TSO5</b>	5.477	5.477	5.477	5.477
<b>TSO6</b>	5.335	5.335	5.335	5.335
<b>TSO7</b>	0.976	0.976	0.976	0.976
<b>TSO8</b>	10.509	10.509	10.509	10.509

**Table 105: Revenue distribution with netting, method CP\_SP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	1.594	1.629	1.524	1.524
<b>TSO2</b>	10.878	12.723	13.607	13.607
<b>TSO3</b>	0.212	0.105	0.046	0.046
<b>TSO4</b>	2.166	2.679	2.891	2.891
<b>TSO5</b>	0.870	0.681	0.572	0.572
<b>TSO6</b>	12.382	12.192	12.130	12.130
<b>TSO7</b>	1.007	0.413	0.290	0.290
<b>TSO8</b>	19.919	21.962	22.440	22.440

Method MS\_AF\_CP

**Table 106: Relative revenue distribution with netting, method MS\_AF\_CP excluding CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	6.43%	6.43%	6.43%	6.43%
<b>TSO2</b>	17.51%	17.51%	17.51%	17.51%
<b>TSO3</b>	1.35%	1.35%	1.35%	1.35%
<b>TSO4</b>	11.71%	11.71%	11.71%	11.71%
<b>TSO5</b>	9.10%	9.10%	9.10%	9.10%
<b>TSO6</b>	17.88%	17.88%	17.88%	17.88%
<b>TSO7</b>	15.43%	15.43%	15.43%	15.43%
<b>TSO8</b>	20.59%	20.59%	20.59%	20.59%

**Table 107: Relative revenue distribution with netting, method MS\_AF\_CP including CBCs**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	6.07%	5.78%	5.66%	5.66%
<b>TSO2</b>	18.80%	19.74%	21.17%	21.17%
<b>TSO3</b>	1.06%	0.77%	0.61%	0.61%
<b>TSO4</b>	12.34%	13.36%	14.24%	14.24%
<b>TSO5</b>	7.08%	6.02%	5.24%	5.24%
<b>TSO6</b>	18.65%	19.65%	19.74%	19.74%
<b>TSO7</b>	13.44%	8.95%	5.95%	5.95%
<b>TSO8</b>	22.56%	25.72%	27.40%	27.40%

**Table 108: Revenue distribution with netting, method MS\_AF\_CP excluding CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.515	2.515	2.515	2.515
<b>TSO2</b>	6.855	6.855	6.855	6.855
<b>TSO3</b>	0.529	0.529	0.529	0.529
<b>TSO4</b>	4.582	4.582	4.582	4.582
<b>TSO5</b>	3.560	3.560	3.560	3.560
<b>TSO6</b>	6.999	6.999	6.999	6.999
<b>TSO7</b>	6.038	6.038	6.038	6.038
<b>TSO8</b>	8.060	8.060	8.060	8.060

**Table 109: Revenue distribution with netting, method MS\_AF\_CP including CBCs [per unit]**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	2.976	3.027	3.030	3.030
<b>TSO2</b>	9.216	10.341	11.327	11.327
<b>TSO3</b>	0.518	0.402	0.326	0.326
<b>TSO4</b>	6.051	6.998	7.618	7.618
<b>TSO5</b>	3.472	3.152	2.802	2.802
<b>TSO6</b>	9.142	10.296	10.559	10.559
<b>TSO7</b>	6.592	4.691	3.182	3.182
<b>TSO8</b>	11.062	13.476	14.658	14.658

**Method RF\_LU\_CP**

**Table 110: Relative revenue distribution with netting, method RF\_LU\_CP excluding CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	9.50%	9.00%	8.72%	8.67%
<b>TSO2</b>	19.95%	19.56%	19.35%	19.30%
<b>TSO3</b>	2.71%	2.80%	2.85%	2.86%
<b>TSO4</b>	4.71%	4.75%	4.77%	4.77%
<b>TSO5</b>	11.83%	12.00%	12.09%	12.11%
<b>TSO6</b>	15.85%	16.07%	16.19%	16.21%
<b>TSO7</b>	13.09%	13.28%	13.39%	13.41%
<b>TSO8</b>	22.36%	22.55%	22.65%	22.67%

**Table 111: Relative revenue distribution with netting, method RF\_LU\_CP including CBCs**

	<b>BC (TSO2_TSO1) [MW]</b>			
	<b>50</b>	<b>100</b>	<b>200</b>	<b>250</b>
<b>TSO1</b>	11.03%	11.34%	10.88%	10.65%
<b>TSO2</b>	21.07%	24.47%	26.43%	26.19%
<b>TSO3</b>	2.50%	1.52%	0.82%	0.85%
<b>TSO4</b>	6.19%	7.48%	8.45%	8.55%
<b>TSO5</b>	9.97%	8.82%	8.36%	8.54%
<b>TSO6</b>	14.99%	14.01%	13.58%	13.61%
<b>TSO7</b>	11.24%	7.54%	5.59%	5.68%
<b>TSO8</b>	23.01%	24.82%	25.87%	25.92%

**Table 112: Revenue distribution with netting, method RF\_LU\_CP excluding CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	3.719	3.522	3.414	3.392
<b>TSO2</b>	7.806	7.656	7.573	7.555
<b>TSO3</b>	1.061	1.096	1.115	1.119
<b>TSO4</b>	1.843	1.857	1.865	1.867
<b>TSO5</b>	4.631	4.697	4.734	4.741
<b>TSO6</b>	6.204	6.289	6.335	6.345
<b>TSO7</b>	5.123	5.197	5.239	5.247
<b>TSO8</b>	8.752	8.824	8.864	8.872

**Table 113: Revenue distribution with netting, method RF\_LU\_CP including CBCs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>TSO1</b>	5.408	5.941	5.823	5.700
<b>TSO2</b>	10.332	12.820	14.142	14.011
<b>TSO3</b>	1.224	0.795	0.438	0.453
<b>TSO4</b>	3.034	3.919	4.523	4.577
<b>TSO5</b>	4.890	4.622	4.474	4.571
<b>TSO6</b>	7.348	7.337	7.265	7.283
<b>TSO7</b>	5.511	3.949	2.993	3.039
<b>TSO8</b>	11.281	13.001	13.842	13.866

# Appendix E: Accepted Bid Volumes and Total Auction Revenues

**Table 114: Accepted Bid Volumes**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>Case 1</b>	67.62%	67.62%	67.62%	67.62%
<b>Case 2</b>	69.96%	73.42%	74.87%	74.87%
<b>Case 3</b>	9.47%	12.79%	15.66%	15.93%
<b>Case 4</b>	8.23%	9.56%	11.92%	12.91%

**Table 115: TARs [per unit]**

	BC (TSO2_TSO1) [MW]			
	50	100	200	250
<b>Case 1</b>	67.62%	67.62%	67.62%	67.62%
<b>Case 2</b>	69.96%	73.42%	74.87%	74.87%
<b>Case 3</b>	9.47%	12.79%	15.66%	15.93%
<b>Case 4</b>	8.23%	9.56%	11.92%	12.91%