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AUCTION DESIGN, IMPLEMENTATION AND RESULTS OF THE EUROPEAN UNION EMISSIONS TRADING SCHEME

Abstract

This paper assesses the trial phase of the European Union Emissions Trading Scheme (EU ETS) from the point of view of the auctions implemented; and focuses on the design of auctions, the commonalities and differences, the main features of the implementation and the timing of these auctions, and also on the results. The auctions implemented in Phase I of the EU ETS provide experience and lessons for Governments and market participants to prepare for future developments for the Kyoto compliance period.

Four countries, Ireland, Hungary, Lithuania and Denmark, included auctioning in their Phase I National Allocation Plans. Three countries used the same design, a sealed-bid uniform-price auction, while Denmark decided not to have an auction, but organized direct sales through an agent. Auctions appeared to be successful in terms of being implemented, the structure seems to work, however no Member State was able to generate the maximum output in revenue due to the price collapse on the allowance market.

Key terms: auction design, emission allowances, sealed-bid, uniform-price

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Table of contents

Abstract	1
Introduction	3
Theoretical background	4
Auctions implemented in the trial phase	7
Denmark.....	8
Ireland	9
Hungary.....	10
Lithuania	11
Outlook for the Kyoto compliance period	13
Conclusions	14
References	15

List of tables

Table 1. Overview of standard auction types.....	6
Table 2. Allowances set aside for auctioning	7
Table 3. Allowances Actually Auctioned	7
Table 4. Overview and main features of the auctions implemented in Phase I of the EU ETS ...	12
Table 5. Comparing clearing and market prices	14

List of figures

Figure 1. Demand curve.....	6
Figure 2. Spot EUA prices (in Euros).....	8
Figure 3. Prices on the day of the first auction	10

Introduction

This paper studies the auctions implemented during the trial phase of the European Union Emissions Trading Scheme (EU ETS) in Denmark, Hungary, Ireland and Lithuania. It focuses on the design of these auctions, the commonalities and differences, the main features of the implementation and the timing, and also on the results of these auctions. In line with the European Directive 2003/87/EC establishing the EU Greenhouse Gas Emissions Trading Scheme countries are allowed to auction a maximum of 5% of their total allocation in the first trading period (2005-2007), so-called trial phase², and 10% in the second trading period (2008-2012), the Kyoto commitment period.

To the best of my knowledge, this study offers the first empirical analysis of the design and results of the implemented carbon permit auctions. The first part of this paper gives an overview on auction theory in line with emissions trading in particular; the second chapter analysis auctions in four European Member States, finds that all but one used the same design, a sealed-bid uniform-price auction, whereas Denmark organized direct sales through an agent instead of auctioning. Auctions appeared to be successful in terms of being implemented; they used the simplest design; however concerning their revenue generating capacity they could have worked better if were adjusted to emissions data disclosure or implemented on a regular basis. Finally the study gives an outlook on auctions in the Kyoto commitment period based on lessons learned from Phase I auctions.

² The trial period serves as a learning phase for the Kyoto commitment period; lessons and conclusions driven from EU ETS operation in 2005-2007 helps committed participants to prepare for the next phase and benefit the most from the scheme.

Theoretical background

A wide range of economic literature deals with auction design and theory on which EU ETS auctions were based. The first chapter of *Auctions: Theory and Practice* (Klemperer, 2004) provides a survey of the theory, and describes several papers in the subject conducted both earlier and recently; for readers interested *The Economic Theory of Auctions* (Klemperer, 2000) is suggested. Several studies are described below with the scope of this paper.

This study offers the first analysis of the design and results of the implemented carbon permit auctions. In previous work on environmental auction design researchers considered the serious design problems in the SO₂ auction and its effects on the operation of the auction and market (Cason 1995; Cason and Plott 1996; Joskow, Schmalensee and Bailey 1997). The controversy over the SO₂ auctions, which has attracted a significant amount of attention and criticism in the literature, can be most plausibly explained by the distinction whether auctions compose the entire market or only a small part of it, that is the distinction between goods with a market and without a market.

Cason and Plott (1996) considered auctions to be the whole market, as allowances could have only been purchased through auctions. They conducted a laboratory experiment on the market for SO₂ allowances; and found that auction rules create strong incentives for both buyers and sellers to under-report their true cost of emissions control. They have found that, “compared to more standard uniform price call auctions, the EPA auction generates lower market-clearing prices and extracts less gains from exchange.” (p.157) However as auctions have only constituted a small part of the market transactions, their potential adverse effects repeated in their critiques turned out to be over-stated and had minimal relevance for the overall performance of the market. (Joskow et al, 1998)

Joskow and Schmalensee and Bailey (1998) argue that the theoretical and experimental findings by Cason and Plott are not actually born out in practice in the EPA SO₂ allowance auctions. The participants have a real functioning trading market; auctions are not the only platform to purchase allowances. Their conclusion is that the auctions “fulfilled their primary objective of stimulating the development of private market trading activity” (p. 22), of course it is impossible to say if other auction designs would have performed better. The authors concede that the outcome could have been different if the EPA auction were the only way to acquire allowances.

More recent studies have focused on the CO₂ market. Klemperer (2002) suggests making auction design more robust, and states that “one size does not fit all”. Mandell (2005) addresses the frequency of CO₂ permit auctions; he compares the single auction approach, where one auction is held at the beginning of a commitment period to sell the entire volume of allowances, with the multiple-auction approach, in which several auctions are used throughout the commitment period. He demonstrates that higher frequency allows firms a shorter planning horizon when bidding, leads to higher transaction costs, facilitates cash-flow management; and argues that more frequent auctions are more vulnerable to collusion. His work is relevant in connection to the timing of EU ETS auctions. As described in the next chapter no Member State had frequent auctions; and it turned out that the country who sold the maximum at the beginning of the commitment period generated the most revenue.

Cook et al (2005) provide a consultancy study developed for the UK government on whether to have auctions or sales of surplus allowances in the EU ETS. They consider four scenarios and

give suggestions on the implementation in each case. In the first scenario EU ETS is a liquid market and surplus volume is low, the authors suggest to have a market order³. In the second scenario EU ETS is a liquid market with low moderate volume, a sequence of market orders is recommended. For the third scenario where the EU ETS market is illiquid and surplus volume is low uniform-price sealed-bid auction is proposed. Finally considering the case with high surplus volume or illiquid EU ETS market with moderate surplus volume an ascending clock auction is advised. To conclude an ascending clock auction was recommended as the default method, if the following conditions were met one month prior to the date of auctions: the “volume to dispose is more than 5% of average daily volume” and the “volume to dispose times the average sale price is more than 2 million pound”. The authors argue that otherwise a sequence of market orders should be used.

According to Cook (2005) for designing auctions the following key attributes have to be taken into consideration:

- The product has to be a homogenous, divisible good.
- The product has to be actively traded in secondary markets.
- The market should not be concentrated.

The EU ETS allowances (European Union Allowances, EUAs) meet all three conditions:

- CO₂ is a uniformly mixed, accumulative pollutant. Neither the source of emissions nor their timing is important from an environmental point of view. Allowances are the same throughout the EU ETS, all countries and all sectors; and allowances are sold in units of one tonne of CO₂.
- EUAs are actively traded in secondary markets. To increase liquidity in this market, all permits are the same after their date of issue, and permits are bankable.
- The market for allowances is not concentrated. Even the largest market participants are small relative to the total market. Frank J. Convery and Luke Redmond conclude (Convery and Redmond, 2007) that the company with the largest share of allowances only accounts for 5.9 percent of total allowances. With a HHI⁴ of 0.031 they conclude that the electricity-generating sector does not appear to possess any real market power in the EUA market.

As demonstrated in table 1. two types of auction design may be distinguished, (1) static, also known as sealed-bid auction, and (2) dynamic, also called as clock auction. In a dynamic auction there are several rounds of bidding and bidders can adjust their bids. The ascending clock auction is a multiple round auction whereby the auctioneer sets a price and bidders submit quantity demanded. As the price increases over subsequent rounds the quantity demanded falls until it equals supply. Although an ascending clock auction is generally considered to be more transparent, its implementation is more expensive and complex (Macken, 2006) that may be the reason why it was not chosen by either Member State in the EU ETS. Nonetheless the UK Emissions Trading Scheme Auction in 2002 used a dynamic auction for GHG emission reduction incentives; and the Clear Skies Bill in the US proposed a clock auction for SO₂, NO_x, and mercury emissions allowances, it may however be concluded that the desirable auction form

³ A market order is the offer to sell at the current market price.

⁴ Herfindahl-Hirschman Index or HHI, is a measure of the size of firms in relationship to the industry and an indicator of the amount of competition among them. It can range from 0 to 1 moving from a very large amount of very small firms to a single monopolistic producer.

for carbon permits is the sealed-bid uniform-price auction due to its simplicity and transparency. (Cramton-Kerr, 2002; Cook et al, 2005)

Static (sealed-bid, or blind) auction		Dynamic (clock) auction		
Uniform-price auction	Pay-as-bid auction, also called as first-price sealed bid auction	Second-price sealed bid auction, also called as Vickrey auction	Ascending-clock auction, also called as open auction, oral auction, English auction, Japanese auction	Descending-clock auction, also called as Dutch auction

Table 1. Overview of standard auction types

A static auction is simple to administer; the market clearing price (P^*) is where aggregate demand is equal to the number of allowances available. All bids at or above the clearing price are accepted. There are three pricing methods commonly associated with sealed-bid auctions: (1) uniform-price auction, (2) pay-as-bid auction, and (3) Vickrey auction; these differ only in the rule used to determine the price paid. (1) Uniform-price auction is the most common approach used for auctions with homogenous divisible goods such as EUAs. (2) Pay-as-bid auction is different in that each successful bidder pays the unit price that they actually bid. (3) At a Vickrey auction the winning bidders are charged the opportunity cost of awarding the product to this bidder.⁵

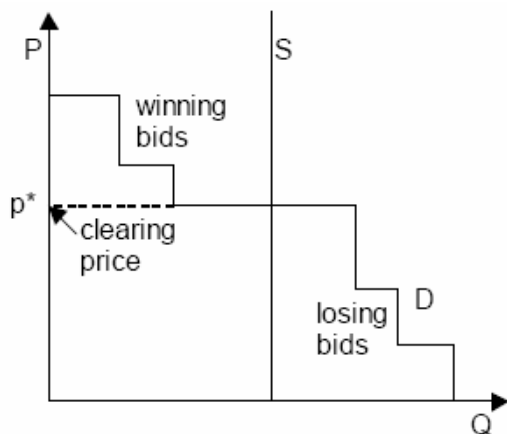


Figure 1. Demand curve (Cramton-Kerr, 2002)

Of the differing approaches to auction the two types considered most relevant for EU ETS allowances are (1) the static sealed-bid or (2) the dynamic ascending bid auction. The difference between the two types is the number of rounds. In static auctions there is only a single round whereby bidders simultaneously submit demand schedules: unit price and quantity demanded. The allowances (lots) are awarded based on the highest bids for the quantity available. Considering the simplicity of static auction design over the dynamic all Member States chose static, sealed-bid auctioning in Phase I of EU ETS.

In the following chapter let us review the details of the auctions implemented in the trial phase.

⁵ The auction is named after William Vickrey, who was the first economist to use the tools of game theory to understand auctions; and received a Nobel Prize in economics in 1996 for his work together with James A. Mirrlees. The Vickrey auction is rarely used in practice due to its complexity. (Vickrey, 1961)

Auctions implemented in the trial phase

Only four countries chose to auction allowances among the twenty-five Member States. Three, Hungary, Ireland and Lithuania used sealed-bid uniform-price auctions. The auctions were open to anyone with an interest in the market, from installations needing to cover shortfalls in allowances to financial players. Denmark had a different experience, after assessing their possibilities they chose not to have an auction after all. Tables 2 and 3 indicate respectively the quantity of allowances set aside for auctioning in the National Allocation Plans and the quantity actually auctioned during the trial period. The latter quantity is larger due to the addition of allowances from closed facilities and unclaimed allowances set aside in new entrant reserves. As can be seen in the case of Ireland, the amounts actually auctioned can be considerably larger than the amount specifically set aside for auction.

EUAs	EU25	Denmark	Ireland	Hungary	Lithuania
Phase 1	7,499,201	5,025,000	502,201	1,420,000	552,000
%		5%	0.75%	2.5%	1.5%

Table 2. Allowances set aside for auctioning

EUAs	EU25	Denmark	Ireland	Hungary	Lithuania
2005	0	0	0	0	0
2006	2,410,000	2,762,500	250,000 + 963,000	1,197,000	0
2007	5,029,500	2,262,500	0	1,177,500	552,000
Phase 1	7,439,500	5,025,000	1,213,000	2,374,500	552,000
%		5%	1.81%	4.18%	1.5%

Table 3. Allowances actually auctioned

In fact, none of the four auctioning countries made the most of the opportunity, given that carbon prices at their highest in Phase I of the scheme exceeded €30 before crashing when the 2005 figures revealed that allocations had been too generous. (see Figure 2.)

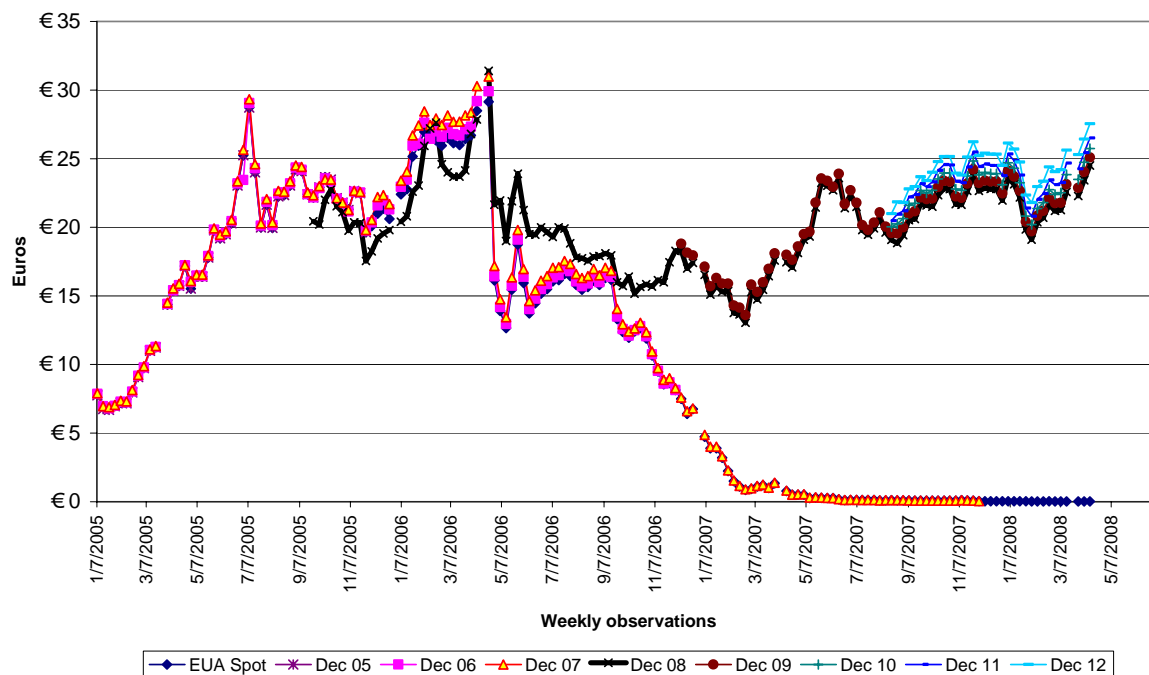


Figure 2. Spot EUA prices (in Euros)

Source: Point Carbon

Denmark

Denmark set aside a pool of a total of 5,025,000 allowances for sale by auction during the first period, corresponding to 5% of the total number of allowances. Initially the auction was to be publicized both nationally and internationally; and open to all potential purchasers. Proceeds from the auctions were to have accrued to the Danish treasury after deducting the related costs. However Denmark finally did not perform an auction; they found the best way to proceed to be a direct sale in the market via an agent to maximize state revenues. According to Sigurd Lauge Pedersen, Senior adviser at the Danish Energy Agency, Ministry of Climate and Energy, the rationale behind the Danish decision was that a professional broker should be able to sell the bulk of the allowances in high price periods. At least better than if a number of (un-professional) Government officials decide when to sell.⁶

In late May 2006 a tender was issued, and then in early October 2006 the Danish Environmental Agency contracted with two agents. The first allowances were sold mid-October 2006. The agents used both spot market and forward market. The allowances were transferred from the Danish National account to an account operated by the agent. There were no restrictions, neither in terms of nationality, nor in terms of company type on who the buyers may be. (Pedersen, 2007) Denmark sold 2.762 thousand tonnes through the brokered market in 2006 when the price ranged from €0.90-€2.20. Sales are organized onwards as there are still a few unsold allowances to be sold before April 30, 2008. According to Mr. Pedersen “the full set-aside that was allowed

⁶ Based on personal e-mails with Mr. Pedersen

for auctioning was used, no surplus from the New Entrants' Reserve (NER) was sold, nor remaining allowances after the closure of installations; hence were these lost.”

Although the direct sale did not provide a price signal opposed to auctioning, however, since prices were easily available on several exchanges and other market services, this was not really a serious drawback of direct sales. Price risk was reduced considerably by selling directly compared to auctioning; as changing prices between the announcement and the auction did not constitute a problem. The actual weighted average selling price of the Danish allowances had been higher than the average market price, meaning the average over the period of time during which the broker made the sales. It appears that the chosen method with sales using professional agents was clearly better than selling at a flat rate, in effect selling at the average market price.

Ireland

Ireland was the first Member State to auction over one million allowances, in two auctions.⁷ Ireland's National Allocation Plan contained a provision to auction up to one per cent of total allowances in order to fund the administration of the scheme; 502,201 allowances were set aside, approximately 0.75% of the total allocation. The Government also directed that unused allowances arising as a result of closures and remaining allowances from the NER were also to be auctioned with the proceeds going to the exchequer. In designing the auction, regulators emphasized simplicity. In order to diffuse the risks it was decided that a “non-disclosed” reserve price be set for the auction. The auction methodology set a specific lot size sufficient to accommodate smaller bidders, at 500 allowances. In order to reduce the risk of auctioning during a “low” in market prices it was decided to spread the risk by running two auctions. The first such auction took place in January 2006, the second in December 2006. Hindsight this strategy resulted to be the optimal as the market price was still high, more than €26 in January. In total more than a million allowances were auctioned, 1.81% of the total allocation. The source for the surplus allowances was the NER and allowances of closing installations.

Opening the auction to the broadest market was to ensure sufficient demand to fund the administrative costs of the scheme. The auction was open to all bidders with a valid account in the EU ETS registry system; and at the end fairly low overhead costs were incurred. Nonetheless such opening of the market exposes the auction to the risk of speculative bidding and creates difficulties in bid validation. To reduce these risks, it was decided that potential bidders be subject to a pre-qualification process. (Macken, 2007) The Irish auction was different from the two others in that they required a pre-qualification process. However collecting a deposit was common in all designs. €3,000 was collected in the pre-qualification stage to dissuade bogus bidding. The deposit was deducted from the amount owed by auction winners and refunded to auction losers. Any winners not honoring their bids would forfeit their deposits.

There were several lessons learned from the first auctions which lead to the change in design for the second auction. (1) The time-lines for electronic funds transfer were very fast; two days appeared to be sufficient instead of five used in the first auction. (2) Refunds to unsuccessful bidders were straightforward for those in the eurozone, but slower for those outside the eurozone.

⁷ The Irish EPA launched the third and final auction of 445.000 EU ETS allowances for the pilot phase on March 6, 2008 and solicited pre-qualification applications and deposits, but that there has been no further information about the conduct, quantities or price obtained in the auction. Given the market price for the first period allowances, little revenue could have been expected.

(3) The auction was vulnerable to market changes; the deposit of €3,000 was insufficient to ensure payment of accounts; so in the second auction it was increased to €15,000. (Macken, 2007)

Hungary

In the Hungarian National Allocation Plan, the Hungarian government set aside 2.5% of the total allocation, amounting to 31.6 million tonnes, or 790,000 tonnes for auctioning. On November 27, 2006 the Hungarian government announced the sale of EUAs in accordance with the Government decree 109/2006 (V.5.). Hungary sold a total of 2.4 million emission credits at two auctions; the first one in December 2006 and the second in March 2007. The sources for the additional allowances were unclaimed NER allowances and those from closures.

The first auction took place on December 11, 2006 and sold a total of 1,197,000 EUAs for a price of €7.42 per tonne. Bids for 3.42 million allowances were received. On 26 March 2007 a total of 1,177,500 emission allowances were on offer. Buyers have been bidding a volume of 2.4 million EUAs and the total volume offered for sale was sold, for a price of €0.88 per tonne.

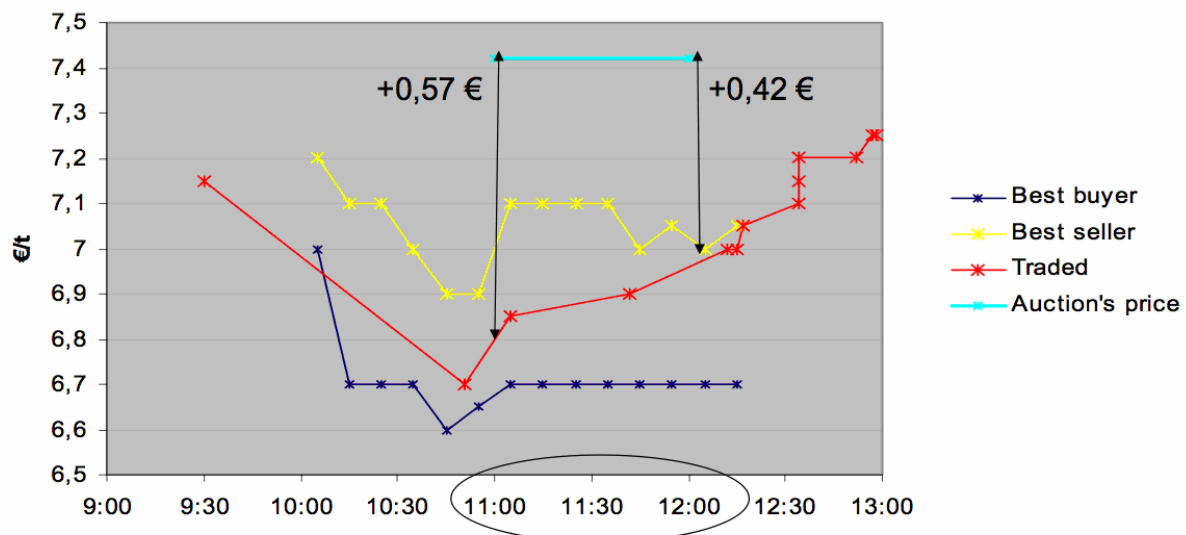


Figure 3. Prices on the day of the first auction
Source: Kaderjak, 2007

The electronic auction was implemented on the euets.com CO₂ trading platform. All entities or individuals holding an account at an emissions trading registry of any of the EU member states were able to participate in the auction through one of the Climex Alliance partners. Participants submitted bids for any quantity of emissions allowances up to the limit of the total number of allowances offered for sale. The electronic auction would have comprised a maximum of two sessions; if the whole amount of allowances were not sold during the first session; but at both auctions one was sufficient to sell all offered EUAs.

The auction was a uniform-price auction where the single price was set by the lowest bid accepted by the auctioneer. The clearing price could not be lower than the minimum price determined by the auctioneer. The minimum price for the first auction was set at the Point Carbon 2007 EUA closing price index of the day before the auction minus 90 cents. Taking time value into account, this was around 60 cents less than the spot market price. (vertisfinance.com)

In the second auction the minimum price for the allowances for each round was 85% of the closing December 2007 forward price for the day before the particular auction round, rounded off to 2 decimals.

Bidders had to place their bids in the given time period and could not withdraw them after the termination of the bidding phase. The bids were not visible to other bidders, which is known as a blind auction. The bidders needed to deposit their collateral with the clearing house of euets.com, APX B.V. or that of the Climex Alliance two working days before the date of the auction. The clearing and settlement of the transaction entered into during the auction was completed in two business days following the auction. Successful bidders could request the transfer of the purchased allowances by the clearing house to their holding accounts one business day after clearing. Bidders could request the refund of any unused collateral one business day after clearing.

Lithuania

The Lithuanian Environmental Investment Fund offered 552,000 EU allowances for sale. The online auction on September 10, 2007 was the last to be held during the first phase of the EU's Greenhouse Gas Emissions Trading Scheme; unfortunately the price did not work in their favor by then, the market price was at six eurocents.

The auction was arranged by Vertis and was executed on the Climex trading platform. The bidding period lasted for one hour. During this time bidders were free to modify or withdraw their bids. The submitted bids, however, could not be withdrawn or changed after the end of the bidding phase. The auction was blind, which means that the order book was not visible to bidders.

Similarly to the procedure used in Hungary, the auctioneer set a uniform price to all successful bidders, the clearing price. For setting the clearing price, the bids were listed in descending order by price. The bids were marked from the top of the ranked list and their volume added up until the level where the sum of the total volume reached the total number of allowances to be sold. The last marked bid's price is deemed as the clearing price, and all marked bids are changed so that the bid price is equal to the clearing price.

A total volume of 552,000 EUAs was transacted at a price of €0.06 per tonne, the total amount offered was sold for a total of €33,120 which barely covered its administrative costs.

	Ireland	Hungary	Lithuania
Number of auctions	2	2	1
Date of auctions	January 27, 2006 and December, 2006	December 11, 2006 and March 27, 2007	September 10, 2007
Total for auction (allowances)	set aside 502,201 250,000 in January 2006, 963,000 in December 2006	set aside 791,523 and sold 2,400,000 1,197,000 in December 2006 and 1,177,500 in March 2007	552,000
% of total allocation	0.75%	2.5%	1.5%
% of auctioning	1.81%	7.5%	1.5%
lot size	500 in January 2006 1000 in December 2006	500	1000
deposit	3000 in January 2006 15000 in December 2006	100% collateral	100% collateral
auction design	sealed bid	sealed bid	sealed bid
minimum bid (EUA)	500 in January 2006 1000 in December 2006	1000	1000
minimum bid increment	n.a.	1 eurocent	1 eurocent
minimum price	n.a.	Dec.06: set at the Point Carbon 2007 EUA closing price index of the day before the auction minus 90 cents March 07: 85% of the closing Dec.07 forward price for the day before the particular auction round rounded off to 2 decimals.	85% of the market price
participants	registry account owners listed on CTL	registry account owners listed on CTL	registry account owners listed on CTL
auction type	uniform-price auction	uniform-price auction	uniform-price auction
reserve price	undisclosed	undisclosed	undisclosed
settlement time	5 days in Jan, 2 days in Dec	1 day	1 day
pre-qualification	on-line, website	not needed	not needed
clearing price (€/per tonne)	26.32 in January 2006 6.87 in December 2006	7.42 in December 2006, 0.88 in March 2007	0.06

Table 4. Overview and main features of the auctions implemented in Phase I of the EU ETS

Outlook for the Kyoto compliance period

The Directive 2003/87/EC allows the auctioning or sale of up to 10% of the allowances allocated by the Member State in the second trading period. Several Member States intend to increase the share of auctioning in combination with a more demanding allocation to power generators. In some Member States auctioning is still under consideration. The Commission considers that the participation in any auction should be open without restrictions to all persons in the Community. (COM/2006/0725) 100% auction is proposed for Phase III, starting after the end of Kyoto compliance period, in 2012. Introducing 100% auctions will necessitate a shift from company “compliance thinking” to meet a limit, to an overall emissions strategy.

Half of the EU countries are planning to use auctioning from 2008, about 3% of allowances in the 2008-2012 scheme, a minimum of 389 million tonnes will be auctioned. There is a distinction however between Member States that are setting aside allowances to auction and those that are using an auction to sell unclaimed NER allowances or allowances from closures. Also, after the Commission's approval of NAPIIs several Member States have deleted their auction reserves due to the cuts of the total allocation sums. Based upon the NAPIIs on the Commission's website and information available the following countries have included auctioning for the 2008-2012 period. Eight countries have set aside allowances to auction:

- Austria: 400,000 allowances per year (2 million total) will be auctioned, that is a share of 1,22 %. A sealed bid procedure and yearly auctions are currently under consideration.
- Belgium: Flanders will auction 922,000 ton of emission allowances during the second trading period in one or several sessions. This corresponds to 0,29% of the total Belgian allocation for the period 2008-2012. Revenues will be used to purchase ERUs, CERs, AAUs.
- Germany: 8.8% of total allocation will be auctioned.
- Hungary: 4.3% of total allocation will be auctioned.
- Ireland: Allowances will be made available for purchase maybe through an auction, up to 0.5% of the total allowances. Revenue from sales of allowances will be used by the EPA to defray the administrative costs of the scheme.
- Lithuania: 2.7% of total allocation will be auctioned.
- Netherlands: 4 % of total allocation will be auctioned.
- United Kingdom: 7% of total allocation plus any surplus from the NER will be auctioned.

Five countries have decided to use auctioning to sell unclaimed NER allowances or allowances from closures:

- Denmark: Only surplus from the new entrants reserve will be auctioned, 0-2% of total allocation.
- Greece: The annual unused allowances of the new entrants reserve will possible be auctioned, up to the 10% of the total allowances.
- Italy: no auction is planned but 5.7% or 12Mt/a will be sold at a fixed price.
- Poland: About 10% deducted from allowances allocated to incumbents will be auctioned.
- Spain: Only allowances from the reserve that have not been used by June 30, 2012 could be auctioned.

Conclusions

It may be concluded from table 4. that the auction design for carbon permits in all auctioning countries was the sealed-bid uniform-price auction. They all had a minimum price; they were open to all registry owners in the Community Independent Transaction Log; and had undisclosed reserve prices. The issue of setting and publicly announce reserve prices is rather controversial. On one hand announcing the reserve price can increase transparency and protect the auction from unforeseen events, on the other hand keeping it secret can prevent coordination at this price with the intention to increase robustness of the carbon signal.

Denmark had a different experience from the other three states; they sold their allowances through a broker. The actual weighted average selling price of the Danish allowances had been higher than the average market price; it appears that the chosen method with sales using professional agents was clearly better than selling at a flat rate, in effect selling at the average market price. In this sense, it was a success. However, in the wisdom of hindsight, confirmed Mr. Pedersen, they contracted too late with the brokers.

The operation of auctioning in the other three Member States who all used the same design and implementation, it may be concluded that auctioning in the first phase was certainly a learning-by-doing process. Based on auction theory and experiences several recommendations may be formulated. Uniform-price auction format is simple, transparent; simplicity of the design facilitates participation, and avoids lock in. Single-round, sealed-bid format has proven to be efficient in promoting price discovery, and impeding collusion. Carbon permits need to be auctioned frequently, preferably on a quarterly basis; this provides the benefit of periodic price discovery and enhanced liquidity. Using lot sizes varied between 500 and 1000 allowances; this is advisable for the next phase as well. Greater lot size reduces administrative costs but can also exclude smaller participants. Auctions were open which enhanced competition and limited collusion.

Comparing auction clearing prices to daily market prices on the day of auctions (see table 6.) shows that CO₂ allowances are not unique goods isolated from the market, but identical and readily available goods, which can be purchased on a liquid market.

(€/per tonne)	January 27, 2006	December 2006	March 27, 2007	September 10, 2007
clearing price	26.32	6.87 for Ireland 7.42 for Hungary	0.88	0.06
Daily market price ⁸	26.10	7.10	0.98	0.06

Table 5. Comparing clearing and market prices

Timing seemed to be the most relevant issue for the success of auctions, in terms of revenue generation. Ireland made the most of the opportunity because they were the first to auction in January 2006 when the allowance price was clearly higher than in periods during which other Member States auctioned. Of course at the time of scheduling the auctions no one could foresee the price collapse, so an evenly distributed selling strategy may have seemed optimal.

⁸ Daily prices from Vertis Ltd.

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