Review of the proposed ETS permit auction design

A REPORT PREPARED FOR THE NATIONAL GENERATORS FORUM

August 2008

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INTRODUCTION

This report, prepared by Frontier Economics (Frontier) for the National Generators Forum (NGF), provides a high-level qualitative review of the proposed permit auction design contained within Chapter 7 of the Commonwealth Government's Carbon Pollution Reduction Scheme Green Paper (the Green Paper). This review was to primarily identify areas of concern or support for the proposed auction design, and areas where further analysis is required.

In addition to considering market efficiency, participant risk management and the effectiveness of a double-sided auction, this report was also to advise on any other potential issues with the proposed permit auction design, whether any alternative and appropriate auction designs better meet the NGF's objectives, and to identify further work required to refine the proposed design going forward.

As a preliminary statement, we note that in conducting this review Frontier has abstracted, to as large an extent as possible, from discussions regarding the process by which permits should (at least initially) be allocated. Thus we have proceeded under the assumption that the auctioning of permits will occur at some point in the future – the extent to which this occurs, and when, is at this stage uncertain.

On the whole, Frontier's impression is that the Government's proposed permit auction design as outlined in Chapter 7 of the Green Paper has been well considered and presented. While none of the key design elements outlined in the Government's proposal appear seriously flawed, we do have several criticisms of Chapter 7. These criticisms mainly relate to the depth of arguments concerning certain design features and the lack of detail provided about others. A summary of our positions regarding the key auction design elements is outlined below.

SUMMARY OF REMARKS

Remark 1: Ascending-clock format

Having considered the options, we tend to favour the ascending-clock design for its open and transparent process and price discovery characteristics. We consider that careful management of revealed information and other measures designed to curtail collusion would adequately prevent such behaviour. To make a more informed decision, we support Evans & Peck (2007) in recommending experimental investigations of the various proposed formats.

Remark 2: Uniform pricing

Uniform pricing is relatively simple and ensures that all participants pay a single price for all permits. Based on the (virtual) universal acceptance of uniform pricing in the carbon permit auction design debate both within Australia and abroad, we support the notion of uniform pricing.

Remark 3: Simultaneous auctions for different vintages

The substitutability characteristics between permit vintages are likely to outweigh any potential complementary characteristics. As such, we support the simultaneous auctioning of different vintages should an ascending-clock format be adopted. If a sealed-bid format is adopted, we prefer sequential auctioning of different vintages, as this process provides more information than simultaneous auctioning in the sealed-bid case.

Remark 4: Double-sided auction

We support a double-sided auction that will allow participants with grandfathered permits to participate in the permit auction process. A double-sided auction has the potential to improve auction efficiency and the accuracy of the final permit price due to the ability for a larger number of buyers and sellers to compete.

Remark 5: Reserve price

Both Holt et al (2007) and Evans & Peck (2007) argue that a reserve price should be set so as to reduce the incentives for collusion. While this result flows from the theoretical literature, further investigation is warranted in the present context as to whether this is a concern, given that the proposed level of information revelation should limit collusive opportunities.

Chapter 7 of the Green Paper provides no detail regarding at what level the reserve price is to be set, how it will be set, or indeed whether reserve prices will be made public *ex ante* auctions. Holt et al's (2007) argument in favour of publicly disclosing reserve prices at the beginning of each auction in the event they are set is convincing.

Remark 6: Auction frequency

On balance, we believe there is a case for more frequent auctions than presented in the Green Paper. Thus, we consider that there may be a case for monthly auctions due to the cash-flow benefits for participants (which flow through to the liquidity of the electricity derivative market) and the likelihood of little drop-off in participation. Weekly auctions could be considered as an alternative if they did not lead to a significant reduction in auction participation and competition or undermining of a secondary market. If weekly auctions were adopted, it may be worth considering sealed-bid sequential auctions as opposed to ascending-clock simultaneous auctions to minimise the expenditure of participant resources and to maximise information revelation.

Remark 7: Advance auction of future vintages

The Green Paper's proposal for auctioning three-eighths of permits in advance seems to be a reasonable lower bound in light of NEM participants' preference to be highly contracted. So long as any cash-flow issues surrounding advanced auctions can be addressed without excessively limiting participation, it may be appropriate to auction 50% or more permits in advance. Such a high proportion of permits auctioned in advance would tend to undermine the case for very frequent (say, weekly) auctions.

Remark 8: Participation and settlement

In general, we agree with the Green Paper's proposal to not limit participation in permit auctions beyond compliance with prudential requirements. Some form of financial assurance should be applied to ensure participants treat auction transactions as binding commitments rather than options.

Remark 9: Proxy bidding

The addition of proxy bidding adds additional flexibility to the ascending-clock format and allows bidders who wish to treat the auction as a sealed-bid format, or those who wish to be absent from the auction, to do so. We support the inclusion of proxy bidding should an ascending-clock format be adopted.

Remark 10: Auction platform

We support the administration of permit auctions via an internet platform. The low administrative and participation costs of running an online auction have the potential to encourage entry and hence improve auction efficiency.

Remark 11: Lot sizes and treatment of unsold lots

The Green Paper provides no cohesive argument as to why a maximum lot size should be set. We question the need to set a maximum lot size in the absence of any convincing reasons to do so.

Any unsold lots should be auctioned in the future according to a specific schedule and are not arbitrarily sold. This will reduce the political risk faced by auction participants as well as reduce the uncertainty regarding future expected permit supply.

1 Introduction

1.1 BACKGROUND AND SCOPE

This report, prepared by Frontier Economics (Frontier) for the National Generators Forum (the NGF), provides a high-level qualitative review of the proposed permit auction design contained within Chapter 7 of the Commonwealth Government's Carbon Pollution Reduction Scheme Green Paper[1] (the Green Paper). This review is intended to assist the NGF in formulating a response to the Government's proposed permit auction design, which will be part of a wider response by the NGF to the Government regarding its positions as outlined in the Green Paper.

The key auction design elements detailed in Chapter 7 of the Green Paper include:

- Permit allocations would over the longer term progressively move towards 100% auctioning as the scheme matures;
- Four auctions would be held each financial year, one in each quarter;
- At least one auction of the relevant year's vintage would be held after the end of the financial year in the lead-up to the relevant surrender date – A suggested end date would be within one month prior to the acquittal date;
- The first auction would take place early in 2010 prior to the start of the scheme;
- Four vintages would be auctioned each year, and the advance auction of future year vintages would occur once each year;
- "Ascending-clock" auctions would be used for single vintage auctions and simultaneous ascending-clock auctions would be used for multiple vintage auctions; and
- Double-sided auctions are only available to those entities that receive free permit allocations.

In the agreed Terms of Reference for this review, the NGF outlined its desire to understand the impacts for the generating sector of the proposed auction design and frequency proposals. In addition, the NGF stated that it considers the overarching objective of any permit auction is to deliver efficiently priced permits and to provide clear price signals to facilitate the development of the secondary permit market, while minimising the overall level of market risk.

In providing its high-level review, Frontier was instructed to primarily identify areas of concern or support for the proposed auction design, and areas where further analysis is required.

[1] Commonwealth Government (2008). *Carbon Pollution Reduction Scheme (Green paper)*, July 2008.

This review was to take into account:

- Market efficiency – which includes such considerations as; predictability, price discovery, simplicity, transparency, market depth and the development of the secondary market;
- Participant risk management – which includes such considerations as broad cash-flow management issues, prudential requirements and transaction costs; and
- The effectiveness of a double-sided auction as a mechanism to allow generators as potential holders of 'grandfathered' permits to access the market.

The theoretical literature assesses auctions across two dimensions – efficiency and revenue. Auction *efficiency* is defined by the extent to which an auction allocates object(s) to those that value them most, *ex post*. Auction *revenue* refers to the expected selling price an auction fetches for the object(s) being sold. As Krishna (2002) argues, private sellers naturally focus more on an auction's revenue performance than its efficiency performance. From the perspective of society, the converse is the case, as an auction's revenue performance is simply a wealth transfer, while its efficiency performance has real welfare implications.

While in theory a benevolent central-planner would choose an auction selling 'public' assets, such as radio and television spectrums or carbon permits purely on the basis of efficiency, in practice the design choice of 'public' auctions gives consideration to both efficiency and revenue. The oft-cited 'double dividend' effect[2] – using more 'efficiently' raised revenue from an auction to offset 'less efficient' taxation, thereby achieving both the initial environmental goal and alleviating a taxation distortion – is commonly used as justification for such a position.

In addition to considering market efficiency, participant risk management, and the effectiveness of a double-auction, the report was also to advise on any other potential issues with the proposed permit auction design, whether any alternative, appropriate auction designs better meet the NGF's objectives, and to identify further work required to refine the proposed design going forward.

As a preliminary statement, we note that in conducting this review Frontier has abstracted, to as large an extent as possible, from discussions regarding the process by which permits should (at least initially) be allocated, and have intentionally left discussions regarding the relative merits of grandfathering versus auctioning of permits to other forums. Thus we have proceeded under the assumption that the auctioning of permits will occur at some point in the future – the extent to which this occurs, and when, is at this stage uncertain.

[2] Cramton & Kerr (2002), p. 339.

To provide a contextual background, much of the proposed permit auction design contained within Chapter 7 flows from an expert report[3], prepared by Evans & Peck, which was commissioned by the National Emissions Trading Taskforce (NETT) prior to the Department of Climate Change assuming responsibility for a national ETS. In this report, Evans & Peck were asked to inform the further definition of the auction proposal made by the NETT in their 2006 discussion paper.[4] The Evans & Peck report does not itself represent original research, although it does provide a useful summary of both the theoretical auction literature and practical experiences to date, drawing heavily on the work of auction theorists who have considered permit auction design, such as, *inter alia*, Peter Cramton and Suzi Kerr.[5]

1.2 STRUCTURE OF THE REPORT

This report is structured as follows:

- Section 2 briefly outlines the key auction types and describes the proposed permit auction design across two dimensions – its mechanism design and operational design features;
- Section 3 reviews these key design elements and compares and contrasts the proposed design with the theoretical literature and other proposed permit auction designs. Frontier's position regarding the main design elements are summarised by Remarks 1-10; and
- Section 4 concludes.

[3] Evans & Peck (2007). *Possible Design for a Greenhouse Gas Emissions Trading System: Further Definition of the Auction Proposal in the NETT Discussion Paper*, prepared for: National Emissions Trading Taskforce, August 2007.

[4] NETT (2006). *Possible Design for a National Greenhouse Gas Emissions Trading Scheme: A Discussion Paper prepared by the National Emissions Trading Taskforce*, August 2006.

[5] Both Cramton and Kerr provided peer-review assistance to the Evans & Peck report. Much of the technical basis of the Evans & Peck report is covered in: Cramton, P and Kerr, S. (2002). Tradable Carbon Permit Auctions – How and Why to Auction not Grandfather. *Energy Policy*, 30(1), pp. 333-345.

2 The proposed permit auction design

In this Section we briefly outline the proposed permit auction design, as outlined in Chapter 7 of the Green Paper.

2.1 INTRODUCTION

It is at this stage useful to define the key design elements of the proposed permit auction across two categories – mechanism design issues and operational design issues. We will use this structure in reviewing the key design elements of the proposed auction design in Section 3 below.

Mechanism design issues relate to the choice of auction mechanism. Mechanism features are primarily concerned with providing the correct incentives to bidders to ensure an auction's objectives are met. Examples of mechanism design issues include:

- The type of auction – ascending, descending, first-price sealed-bid, second-price sealed-bid;
- The form of pricing when multiple units of the same object are sold in a single auction – uniform pricing or discriminatory pricing;
- The timing and interdependence of auctions – simultaneous, sequential or combinatorial when multiple different objects are being auctioned (e.g. different permit vintages);
- Whether a one-sided or double-sided auction is used – is the only seller of permits the government, or can participants in possession of grandfathered permits also participate as sellers?;
- Bidding rules, designed to curtail or encourage certain behaviour;
- Reserve prices – whether a reserve price should be set, and if so to what level; and
- Information revelation – where applicable, how much information the auctioneer discloses to participants and/or the market both pre, during and post auction.

The choice of mechanism design features will depend on several criteria:

- The objectives of the auction (the efficient allocation of resources, revenue maximisation, etc);
- Characteristics of the object being auctioned (independent private value, common value, or a combination of both); and
- Characteristics of the auction participants (number and strength of bidders, level of sophistication of bidders, potential for collusive behaviour amongst bidders).

Operational design issues relate to the manner in which a given mechanism design is implemented and administered. Operational features generally influence

the effectiveness of an auction in achieving its objectives, and may also influence bidder strategies and behaviour. Such operational design features can include:

- Auction frequency – for example weekly, monthly, quarterly or annually;
- Auction timing – when the auction should begin and the extent to which permits are auctioned in advance;
- Participation and settlement – who is eligible to participate, what requirements and/or financial pre-qualifications must participants meet;
- Proxy bidding – whether bidding in advanced through bidding rules is permitted, and if so how;
- Auction platform – in person, mail, phone, internet; and
- Lot size and the treatment of unsold lots – whether minimum and/or maximum restrictions on the quantity a given party can buy/sell are set, and if so to what level such quantities should be set. In addition, how unsold lots are treated.

While the list of both mechanism and operational design issues is long, many of these issues are readily resolvable. Some mechanism design issues can be resolved using the auctioneer's objectives and the body of auction theory currently available. More complex mechanism design issues can be resolved by looking at the experiences of similar, past auctions and using experimental studies to guide the proposed design. Most of the operational design issues can be resolved using a combination of economic theory, past experience and participant consultation.

2.2 BRIEF OVERVIEW OF AUCTION TYPES

2.2.1 Introduction

The field of auction theory is vast and considerably technical. What follows is a brief overview of the main types of auctions and is by no means exhaustive. A more thorough but equally accessible review is provided in Evans & Peck (2007). For the inquisitive and determined reader, excellent collections of the auction theory literature to date include Klemperer (2004)[6] and Krishna (2002)[7].

2.2.2 Single-unit auctions

Auctions are generally classified broadly as single- or multi-unit auctions. We first consider a normal[8] single-unit auction, where multiple buyers compete to buy a single object from a single seller, the auctioneer. The four most common forms of single-unit auctions can further be classified into 'open-bid' auctions (ascending auctions and descending auctions, often called 'English' and 'Dutch'

[6] Klemperer, P. (2004). *Auctions: Theory and Practice*. Princeton, US: Princeton University Press.

[7] Krishna, V. (2002). *Auction Theory*. San Diego, US: Academic Press.

[8] 'Normal' implies that there is only one seller, and that this seller is the auctioneer. Procurement auctions, where the auctioneer is a buyer, do not change the standard results. Double-sided auctions, where multiple sellers exist, are discussed in Section 3.1.4.

auctions, respectively) and 'sealed-bid' auctions (first-price sealed-bid auctions and second-price sealed-bid auctions). The proposed permit auction design in the Green Paper, an ascending-clock auction, is a form of open-bid auction.

In an ascending auction, the price is successively raised until only a single bidder remains, and that bidder wins the object for the final price. Alternatively, in a descending auction, the price initially starts high and is successively lowered until the first bidder to call out wins the object for their nominated price.

In a first-price sealed-bid auction, each bidder independently submits sealed bids with no knowledge of other bidders' bids. The bidder with the highest bid wins the auction and pays its bid price. In a second-price sealed-bid auction, the same process is followed and the bidder with the highest bid wins the auction, however the winner is only required to pay the price of the *second* highest bid (alternative known as the highest *rejected* bid).

In the single-unit case, a descending auction and a first-price sealed-bid auction are 'strategically equivalent', and thus can be commonly referred to as 'first-price' auctions. Likewise, an ascending auction and a second-price sealed-bid auction share many of the same characteristics, assuming that bidders have 'private values'[9], and thus can be commonly referred to as 'second-price' auctions.

Under the standard theoretical assumptions, which include risk aversion, no budget constraints and private, independent 'signals' drawn from a common, strictly increasing, continuous distribution, these four auctions are equivalently efficient and raise the same expected revenue – this is the celebrated *Revenue Equivalence Theorem*.

2.2.3 Multi-unit auctions

In contrast to single-unit auctions, multi-unit auctions involve multiple bidders competing in auction(s) for multiple units. These units may be homogenous or heterogeneous, and thus may be substitutes or complements.[10] This form of auction is more realistic when thinking about permits auctions, since any permit auction will involve the sale of multiple – as opposed to individual – permits. We will initially review the auction formats used in selling multiple units in a *single* auction, and following this discuss the auction arrangements used to sell multiple units in *multiple* auctions.

As was the case with single-unit auctions, the choice of open-bid or sealed-bid also applies to multi-unit auctions. Thus, as before, open-bid auctions include ascending and descending auctions, while sealed-bid auctions include auctions analogous to the first-price and second-price sealed-bid auctions outlined above.

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[9] The *private-value* model assumes that each bidder knows how much she values the object(s) for sale, but this value is private information to himself. Alternatively, the *pure common-value* model assumes the actual value of the object is the same for each bidder, but bidders have different private information about what that value is. Finally, the *almost common-value* model assumes some combination of both.

[10] Two objects are said to be substitutes if the demand for the first object decreases (increases) with a decrease (increase) in the price of the second object. Two objects are said to be complements if the demand for the first object decreases (increases) with an increase (decrease) in the price of the second object.

Single, multi-unit auctions

In a single, multi-unit auction, multiple bidders compete in a single auction where multiple objects are up for sale. These objects may be homogenous or heterogeneous. In the homogenous case, bidders bid for different quantities of the same object, while in the heterogeneous[11] case, bidders bid for different quantities of the different objects. Restricting our attention to the homogenous object case, an important distinction between single-unit and multi-unit auctions is the price that is charged per unit in the multi-unit setting. Two options are available in this regard – a uniform price auction and a discriminatory[12] price auction.

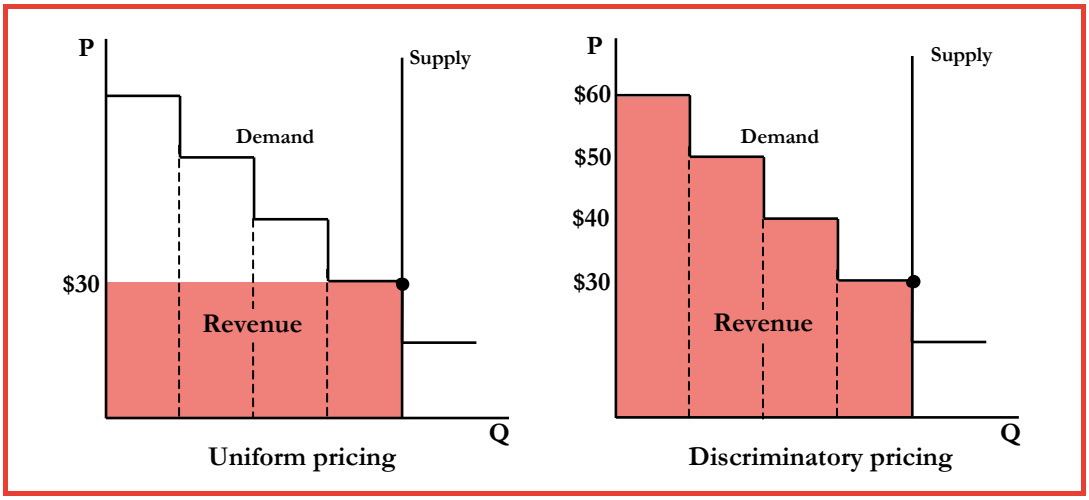

Figure 1: Uniform vs. discriminatory pricing

Source: Frontier Economics

In a uniform price auction, all units are sold at the market-clearing price, which equates demand and supply. Thus, the uniform-price, multi-unit auction is analogous[13] to the second-price, single-unit auctions outlined above. In a discriminatory auction, the price a bidder pays for each is exactly its bid price for that unit – thus the price paid by different bidders, and indeed by the same bidder but for different units of the same object, can differ. The discriminatory, multi-unit auction is analogous[13] to the first-price, single-unit auctions described above.

A graphical illustration of both uniform and discriminatory pricing is presented in **Error! Reference source not found.**. In this example, the market clears at four units. In the uniform price case, this results in a market-clearing price of $30, which applies to all four units. In the discriminatory price case, the price paid per

[11] Such auctions are sometimes referred to as *multi-item* auctions – thus the term *multi-unit* auctions is reserved for multi-unit auctions involving homogenous objects, while *multi-item* auctions refer to multi-unit auctions involving heterogeneous objects.

[12] Also called 'pay-your-bid' auctions.

[13] These analogies are used purely to aid explanation – importantly, the results derived in single-unit settings do not (necessarily) hold in more complex multi-unit cases.

unit depends on the bid submitted for each unit – the first unit has a price of $60, the second unit a price of $50, and so on.

Multiple, multi-unit auctions

Multiple, multi-unit auctions are generally used when the auctioneer wants to sell multiple units of different objects – that is, multiple units of several heterogeneous objects. Assuming multiple vintages of permits are auctioned under the Government's proposed design, this is the most relevant auction format to consider.

The options available to administer multiple, multi-unit auctions are largely the same as the single, multi-unit case. This means that the choice over auction format (open-bid or sealed-bid) and pricing (uniform versus discriminatory) for each auction must first be made. However, in addition, the *timing* of the multiple auctions must be considered. Again there are two options in this regard:

- Simultaneous auctions involve the simultaneous running of the multiple auctions – thus bidders can participate in both auctions concurrently; or
- Sequential auctions involve the running of the various auctions in sequence – thus a series of single, multi-unit auctions for each type of object, where the succeeding auction starts only after the preceding auction has finished.

In some cases, allowing bidders to make package or conditional bids may be desired. In particular, if the objects being auctioned are heterogeneous and strongly complementary, bidders may only wish to place a bid for one object contingent on obtaining other object(s). These auctions, known as 'combinatorial auctions', are best defined as a sub-category of simultaneous auctions, where bidders make package or contingent bids across the multiple auctions.

In summary, for the purposes of any potential permit auction design, the following auction design features are relevant:

- Assuming that only *current* vintages are auctioned, we are concerned with a **single, multi-unit auction** involving homogenous objects, since all permits of the current year vintage are assumed equivalent;
- Assuming that both *current* and *future* vintages are auctioned, we must now consider two options for the auctioning of multiple permits within each category of vintage, since current and future vintages are not assumed to be equivalent. These options include:
  - **Multiple, simultaneous auctions** – where in one auction, multiple units of current vintages are sold, while in other auctions, multiple units of different future vintages are sold. These auctions are run simultaneously. Additionally, a **combinatorial auction** can be run in this setting, where bidders can submit package or contingent bids across the various auctions; and
  - **Multiple, sequential auctions** – where, say, in the first auction, multiple units of the current vintage are sold, while in subsequent auctions,

multiple units of different future vintages are auctioned. Importantly, each successive auction occurs only once the preceding auction has finished.

2.3 THE PROPOSED PERMIT AUCTION DESIGN

In light of the above main single- and multi-unit auction formats, we now proceed with a brief outline of the Government's proposed permit auction design. Once again, it is convenient to define the proposed auction design on the basis of both its mechanism and operational design features.

2.3.1 Proposed mechanism design

The proposed mechanism design outlined in Chapter 7 of the Green Paper is an open-bid, ascending, uniform price, multi-unit auction. It is proposed to operate this format in respect of both single vintage and multiple vintage auctions, with multiple vintage auctions being conducted simultaneously. In addition, a double-sided auction has been proposed to allow participants who receive grandfathered permits to participate. In all cases, a reserve price is to be set and only the information regarding aggregate demand for permits will be revealed at the end of each auction round. Each of these key mechanism design issues is further explained below.

Ascending-clock format

The 'ascending-clock' auction is a form of English auction. Unlike a traditional open-outcry English auction, in the ascending-clock auction the auctioneer uses a clock to control the pace of the auction and to notify all participating bidders of the current price. Over successive rounds, the auctioneer announces a current price, which he increases from round to round. Bidders bid their desired quantity of permits at the given round's price, with only aggregate demand for permits being revealed to bidders at the end of each round. This process continues, with bidders dropping out as the rounds progress. Once a bidder has dropped out of the auction they are not allowed to re-enter. The auction finishes in the round where total demand is less than or equal to total supply. By definition, a standard ascending-clock auction has a uniform price – that is, the price paid by the winning bidders on their respective units is equal to the price at which excess demand is zero, which is common to all winning bidders.[14]

Uniform pricing

As mentioned above, the nature of the proposed auction format (i.e. an ascending-clock) implies that the multi-unit auctions conducted in this manner will generate a uniform price to be paid by all winning bidders for their respective quantities.

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[14] The actual price paid depends on what round demand no longer *exceeds* supply – if demand exactly equals supply in the final round, then this final round price is the final auction price. If supply exceeds demand in the final round (this can occur due to the discontinuous nature of bid increments) then the price from the previous round is used, and the excess supply at this price is allocated to bidders according to their penultimate-round bids. See Evans & Peck (2004), p.10, for details.

Simultaneous auctions for different vintages

The proposed permit auction design highlights that, in those cases where multiple vintages are to be auctioned, different vintages of permits will be auctioned simultaneously. Thus, multiple, multi-unit auctions will run simultaneously, selling multiple units of the differing vintages being offered.

Double-sided auction

The Green Paper tentatively proposes that participants who initially receive grandfathered permits will be allowed to participate in permit auctions in the early stages of the scheme – thus the auctions may be double-sided. This implies that more than one seller, the auctioneer, will exist. Preferred position 7.10 of the Green Paper does not guarantee that a double-sided auction format will be adopted, but rather implies that *if* double-sided auctions are adopted, only those recipients of grandfathered permits will be eligible to participate as additional sellers. Details of the proposed double-sided auction process can be found in Evans & Peck (2007), p.13.

Reserve price

The proposed permit auction design states that permits in any eventual auction will have a reserve price. Unsold permits (i.e. permits for which the price does not exceed the reserve price) would be sold in future auctions. No guidance as to what the reserve price will be, or how it will be set, is provided.

2.3.2 Proposed operational design

The proposed operational design is outlined in several Sections within Chapter 7 of the Green Paper. We note that, in addition to the 'Auction Operational Features' contained in Box 7.8 (some of which we feel are more appropriately classified as mechanism design issues), the Green Paper discusses several other operational design issues in Section 7.5.

Auction frequency

The proposed operational design calls for four auctions per year, with one auction falling in each quarter.

Auction timing

The proposed operational design indicates that at least one auction of the relevant year's vintage will be held *after* the end of the financial year in the lead up to the relevant surrender date. The suggested date of this auction is one month prior to the surrender date. The first permit auction would be held as soon as feasible in 2010, and by definition must occur prior to the start of the ETS. The proposed auction schedule also includes a transitional period up to the end of June 2010.

Advanced auctioning of future vintages

The proposed design calls for the auction of four vintages once in each year – the current year's vintage plus an advanced auction of three future vintages. However, during the 2009-10 transitional period, permits for future vintages may be auctioned on more than one occasion.

Participation and settlement

The proposed operational design indicates that universal participation would be permitted at auctions. Therefore, no requirements that bidders be participants in certain markets (e.g. participants in the wholesale electricity market) are mentioned. Preferred position 7.8 indicates that the lodgement of a security deposit may be a bidding prerequisite.

Proxy bidding

The proposed operational design allows proxy bidding by letting bidders submit demand schedules or 'bidding rules' in advanced. Proxy bidding will allow participants to be absent from part, or all, of the auction. It may also reduce the costliness of participation to less sophisticated bidders who may not wish to actively participate in each round.

Auction platform

Using an internet platform to administer the permit auctions is suggested in the proposed operational design. Using an internet platform is expected to encourage participation and hence competition due to the relatively low costs of entry, and will also likely be relatively cost-effective for the government to run.

Lot sizes and treatment of unsold lots

The proposed operational design indicates that both minimum and maximum lot sizes may be enforced. Minimum lot sizes may apply for the sake of administrative simplicity. Since a reserve price is to be set, the potential for supply to exceed demand at the reserve price, and hence for permits to go unsold, exists. The proposed operational design indicates that unsold permits will need to be sold in future auctions.

3 Review of key design elements

In this Section, we review and discuss the proposed permit auction design elements of Chapter 7 across the same two dimensions used in Section 2 – mechanism and operational designs. In reviewing and discussing each, we draw heavily on two main resources in addition to Evans & Peck (2007). The first is a final report[15] prepared by a panel of experts advising the RGGI[16] member States on their own potential permit auction design. The second is a response[17] by Peter Cramton to this proposed design. Given Cramton's involvement with the Evans & Peck (2007) report (and by extension Chapter 7 of the Green Paper), both the views expressed in Cramton (2007) and Holt et al (2007) are valuable resources in evaluating the proposed permit auction design.

Where applicable, we have considered results, conclusions and lessons learned from the theoretical literature in assessing the various design elements of the proposed permit auction. However, as Krishna (2002) observes, the analytical assessment of multi-unit auctions with interdependent valuations "makes the attendant difficulties [of multi-unit, private value auctions] more acute, even insurmountable". Krishna observes that in such settings we have, in many ways, reached the limits of what auctions can achieve as mechanisms for efficiently allocating objects. In such cases, decisions on auction design must increasingly be based on experimental evidence and/or past experiences, given the virtual impossibility of making sound *a priori* judgements and recommendations.

3.1 MECHANISM DESIGN ISSUES

3.1.1 Ascending-clock format

Terminology and general results

At this stage it is instructive to review two broad classifications of auctions – the *common-value* and *private-value* auction. In a common-value auction, all bidders have the same value for the object, and each has private information about this uncertain value – this scenario often arises when the object being auctioned is purchased for resale.[18] In a private-value auction, each bidder's value does not depend on information held by others, but depends on the bidder's particular situation – this scenario often arises when the object being auctioned has subjective value (such as art) or when the object is bought for consumption.

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[15] Holt, C., Shobe, W., Burtraw, D., Palmer, K. and Goree, J. (2007). *Auction Design for Selling CO_2 Emissions Allowances Under the Regional Greenhouse Gas Initiative: Final Report*; prepared for: RGGI Board, October 2007.

[16] The Regional Greenhouse Gas Initiative is a cooperative effort of several Northeast and Mid-Atlantic states in the US for a proposed regional cap-and-trade program, initially covering CO_2 emissions from power plants.

[17] Cramton, P. (2007). *Comments on the RGGI Market Design*, prepared for: New York Independent System Operator, November 2007.

[18] The resale price thus determines the realised 'common value'.

The distinction between common-value and private-value auctions is important in the context of designing carbon permit auctions, since the bidding behaviour of participants, and hence expected results, vary quite considerably across each of these auction types. As a further complication, carbon permits are likely to possess both private- and common-value characteristics. This is because permits will have a common value, set by the price in the secondary market, but will also be bought by participants for 'consumption', or to allow them to emit CO_2, and hence will also have a private-value component.

At this stage it is worth briefly reviewing some of the key results from the auction theory literature. While most of these results apply exclusively to the single-unit case and are based on somewhat restrictive assumptions, we discuss them for completeness:

- First, in the single-unit case with private-values and under standard assumptions, the Revenue Equivalence Principle implies that all standard auctions are equally efficient and will generate the same expected revenue (Klemperer, 2004);
- Second, also in the single-unit case with private values and under the standard assumptions but allowing for risk-aversion, first-price auctions generate more revenue on average than second-price auctions (Klemperer, 2004). This is because first-price auctions encourage bidders to bid more aggressively (or closer to their true valuation) than do second-price auctions; and
- Third, in the single-unit case with common-values, an auction format that 'links' the price paid to individuals' private information regarding their beliefs of an objects value will generate greater expected revenues, since the eventual price paid is linked to the winner's information (Klemperer, 2004). This result, known as the *linkage principle*, implies that in the presence of common-values, ascending auctions will generate greater expected revenues than second-price, sealed-bid auctions, which in turn will generate greater expected revenues than first-price, sealed-bid auctions.

While these and numerous other fundamental results hold in the single-unit case, multi-unit auctions are considerably more complex. Consequently, the theoretical predictions of single-unit auctions do not necessarily follow for multi-unit auctions. Indeed, Klemperer (2004) notes that the achievement of efficiency in multi-unit auctions is difficult, while Krishna (2002) observes that multi-unit auctions are generally inefficient.

In the uniform pricing case, this inefficiency arises since bidders have incentives to 'shade' their bids (i.e. reduce them below their true valuation), or practice what is known as 'demand reduction'. Demand reduction is a profitable strategy in a multi-unit auction with uniform pricing. This is because, by reducing demand and hence bids on early units, bidders benefit from the lower eventual (uniform) price paid on all units which are won. Thus, a bidder may find it profitable to buy fewer units than it actually wants, as doing so keeps the price paid for these units lower than if the actual desired number of units were purchased. As Klemperer (2004) observes, demand reduction is of most concern where there is a small number of large bidders – in such cases a natural analogy for demand reduction

behaviour in auctions is oligopsonistic behaviour in other naturally occurring markets.

The inefficiency of multi-unit auctions is not confined to uniform price auctions; discriminatory price auctions can also result in an inefficient allocation of objects. While the reasons as to why this occurs are somewhat more complex, the essence of the problem is that even symmetric bidders value different units of the same object differently (Krishna, 2002). Since different units of the same object in a multi-unit auction are valued in a non-symmetric fashion, bidding behaviour across units changes, and hence because the fundamental assumption of bidder symmetry is violated, discriminatory price auctions are inefficient.

'Open' versus 'sealed' bidding

Having briefly reviewed some key theoretical findings, we now consider the fundamental differences between the proposed open-bid, ascending-clock auction and an alternative format: a sealed-bid, uniform price auction advocated by Holt et al (2007).[19] The key difference between the open- and sealed-bid formats is that the former is a multiple-round auction while the latter involves only a single round of bidding. The multiple-round nature of open-bid auctions vis-à-vis sealed-bid auctions has three main implications which all stem from the issue of information revelation.

First, multiple-round auctions allow a process of price discovery, whereby bidders gain information in each round about the common-value component of a given object. This process of price discovery leads, in theory, to a more accurate and efficient final price since all participants (and the greater market if auction results are released) learn, across multiple rounds, the relative value to all bidders of the object being auctioned (Cramton & Kerr, 2002). This process of price discovery can be particularly influential in fostering the development of liquid, efficient secondary markets since the price discovery process during auctions informs the secondary market of the object's true value. While a sealed-bid auction will also determine a market price, the process by which this price is set is less transparent and importantly does not reveal to all bidders any information regarding relative differences between bidder valuations. Price discovery generally improves the efficiency of an auction's outcome by ensuring that both auction participants and any potential secondary markets receive accurate signals regarding the true valuation of the object in question.

Second, the price discovery and greater information revelation characterises of open-bid auctions helps to alleviate the 'winner's curse'. The winners curse is a strategic mistake on behalf of bidders in common-value auctions, where the winning bidder ends up over-paying for the object in question. Information revelation through multiple bidding rounds helps to better inform bidders of the 'common value' of the object in question, and hence links bidders' information

[19] Evans & Peck (2007) states: "It is relevant to note that the RGGI proposes to adopt an ascending-clock auction format" (p.9). This statement was based on a preliminary report prepared by Holt et al for the RGGI. In their final report, Holt et al dismissed the ascending-clock format they had earlier proposed in favour of a standard, sealed-bid auction.

to the price that is paid – this is the linkage principle. Thus, information revelation across repeated rounds encourages bidders to bid more aggressively without the fear of learning they have over-paid for an object (relative to other bidders) once it is too late. Alleviating the winner's curse is both an efficiency and revenue consideration – by providing greater information throughout the auction, bidders can be expected to bid more aggressively (i.e. closer to their true values) and hence auction efficiency and revenue is generally improved.

Third, open-bid auctions tend to be more susceptible to tacit collusion between bidders (Klemperer, 2004). While the first two issues generally support open-bid in favour of seal-bid formats, information revelation through multiple bidding rounds can be a double-edged sword. Open-bid auctions can lead to collusion in several ways. First, over repeated rounds, bidders have the ability to communicate with one another. This can be done implicitly by 'signalling' through bidding patterns or explicitly by passing information to rival bidders through some form of code.[20] Second, the greater level of information revealed to bidders in multiple-round auctions can aid collusion. For instance, if bidders know at the end of each round how many rival bidders are remaining, the potential for collusion will be greater. This is because collusion is easier to sustain with lower numbers of bidders – as the number of bidders decreases, the remaining bidders will face greater incentives to attempt to form a collusive buyers cartel, given that such a cartel is more likely to succeed.

It therefore seems apparent that when objects possess common-value characteristics, the open- and sealed-bid formats have opposing strengths and weaknesses. The open-bid format may potentially improve efficiency and/or revenue performance though reliable price discovery *vis-à-vis* sealed-bid formats. However, this potential is partially undermined by the greater scope for collusive outcomes. Likewise, while the sealed-bid format may under-perform relative to the open-bid format due to a lack of information revelation and the winner's curse, the lower probability for collusion potentially offsets this downside.

As Evans & Peck (2007) note, the potential for collusion under the ascending-clock format can, to some degree, be controlled through the level of information revelation at the end of each bidding round. Thus, the potential for collusion varies across a continuum of information revelation – collusion is more likely if each individual bid is published each round than if only aggregate demand at a given price is revealed each round. As Chapter 7 of the Green Paper proposes to reveal only aggregate demand at the end of each round – this should limit the potential for collusion while still providing adequate information to bidders regarding other participants' valuations.

Unfortunately, the theoretical literature provides no guidance as to which of the above effects is likely to dominate – in other words, whether an open-bid or sealed-bid format is preferred overall. This suggests that the choice between

[20] This was the case in the FCC spectrum DEF auctions, where rival bidders managed to communicate their desire to win certain spectrums by 'code bidding' – for instance, bidding \$3**1** could indicate your interest in Spectrum **1**, bidding \$4**2** could indicate your interest in Spectrum **2**, bidding \$5**3** could indicate your interest in Spectrum **3**, etc. See Cramton & Schwartz (2002) for details.

open- or sealed-bid formats is likely to be best made on the grounds of experimental evidence and/or past experiences.

Holt et al (2007) experimentally test several auction formats, including both an open-bid, ascending-clock and a standard, sealed-bid auction. Holt et al find no evidence that the sealed-bid, uniform price format out-performs the open-bid format on either efficiency or revenue performance measures. In addition, Holt et al (2007) find no evidence that collusion substantially affects one format more than the other.

In response to Holt et al (2007), Cramton (2007) notes that Holt et al's criticism of the ascending-clock auction on the basis of collusive concerns is unsubstantiated by their own experimental evidence. In addition, Cramton argues that Holt et al's use of a non-standard ascending-clock design negatively biases their results. Specifically, Cramton notes that the ascending-clock design used in Holt et al's experiments;

(i) did not reveal excess demand at the end of each round; and

(ii) did not allow intra-round bidding;

both of which would be likely to improve auction revenues and efficiency if they were included (Cramton, 2007).

Activity rules

The Green Paper makes references to the need for an appropriate set of 'auction rules' but provides no further details on the topic. More so than with sealed-bid auctions, open-bid auctions such as the proposed ascending-clock auction require activity rules to prevent 'disorderly bidding' and gaming.

Evans & Peck (2007) highlight three activity rules required under an ascending-clock format. These rules are 'plain vanilla' rules for such auctions, and are more completely described in both Holt et al (2007) and Cramton (2007):

(i) A bidder's total demand for a particular object cannot exceed its eligibility for that object, if such restrictions are enforced;

(ii) As prices rise, a bidder can only maintain or decrease its bid quantity – thus a bidder's total demand may never increase from round to round;[21] and

(iii) In the simultaneous ascending-clock case, if a clock does not tick to the next price between rounds (since demand is less than or equal to supply), any bidder that submitted a positive bid in the previous round must submit at least that same bid in the next round.[22]

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[21] This rule prevents last-minute 'sniping' and forces bidders to bid actively from the outset.

[22] This could occur if bidding stops on, say, a future vintage clock at a certain price, but continues on a current vintage clock. This rule implies that the final bid on the future vintage clock cannot be reduced as bidding continues on the current vintage clock.

A further consideration is whether to restrict a bidder's total eligibility to a given number of permits. Holt et al (2007) argue that limiting the share of allowances that a single entity can purchase in an auction will raise the cost of using auctions to "corner the market" and hence should be enforced to encourage competition and efficiency. Holt et al propose a maximum entitlement per bidder of 33% of the total permits available in a given auction. Evans & Peck (2007) also discuss this issue, and argue that to limit the potential for market power abuse, each bidder's entitlement should be limited to 20% of all permits available in a given auction. In setting maximum bidding entitlements, preventing the ability for large players to corner the market must be weighed against the need to allow large participants to access their required amount of permits. To the extent such restrictions prevent permits going to the bidder that values them highest, efficiency will be compromised. Holt et al (2007) note that a 33% cap should not place "too stringent a restriction" on what quantity of permits large participants can purchase. Evans & Peck (2007) report that the 20% cap imposed in the UK ETS auctions only bound once, with one bidder out of 38 constrained in the 2005 auction.

Intra-round bidding

Both Evans & Peck (2007) and Cramton (2007) highlight the value of intra-round bidding within the ascending-clock format, an issue that is not discussed in the Green Paper. Intra-round bidding involves bidders submitting demand schedules for prices in between the bid increments determined by the ascending-clock process. For instance, bid increments may be $5, but bidders who wish to submit intra-round bids may submit price-quantity bids at $1 levels within this $5 increment.[23] The major advantage of intra-round bidding is that it speeds up the auction process by alleviating the need to have excessively 'fine' bid increments, while ensuring that the final price is both more accurate and thus potentially more efficient. This is evident if one considers a situation in which supply exceeds demand at the final clearing price range. This excess supply is generally allocated between winning bidders according to their previous round bids. Allocations based on previous round bids is likely to be inefficient, since units will not be efficiently allocated if the *relative* bids of participants between the penultimate and final rounds change.

A related issue to intra-round bidding is the size of bid increments. The Green Paper provides no details as to what the bid increments will be, how they will vary according to the progression of the auction, or how they will be calculated. Evans & Peck (2007) propose that bid increments narrow as the auction progresses, and note that if intra-round bidding is not adopted, bid increments need to be sufficiently fine – this is to ensure that the final clearing price is accurate both from an efficiency viewpoint and in informing the greater market about the true price of carbon abatement.

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[23] For example, if the bidding increment increased from $20 to $25, bidders who wished to submit intra-round bids may submit price-quantity bids for $21, $22, $23, $24 and $25, as opposed to just $25. See Evans & Peck (2007) and Cramton (2007) for details.

Cost and complexity considerations

A sealed-bid format is likely to have advantages over an open-bid format with regards to administrative and participation costs. On this issue, Holt et al (2007) observe:

> Past experience suggests that a significant proportion of the administrative cost of holding auctions is related to the initial set-up of the auction, including the development of auction rules, deploying auction software, and establishing the mechanisms for pre-qualifying bidders (discussed below) and that the incremental costs of repeating a particular auction type will be low in comparison to these initial costs (p. 36).

It thus appears that the majority of any auction costs will be incurred up-front, and that the incremental cost of additional auctions could be relatively quite low. Notwithstanding this, the choice of auction format is likely to determine what such incremental costs are likely to be. While Evans & Peck (2007) observe that the technological costs of participating in an ascending-clock auction should be quite low, since any computer connected to the internet would suffice, the time taken to complete such auctions is an important consideration.

The administrative costs of running a single-round auction are likely to be lower than those associated with a multiple-round auction, mainly due to the longer time demands placed in participants in multiple-round auctions. As Cramton (2007) notes:

> The only potential downside of a clock auction compared with a sealed-bid auction is the clock auction takes time to run, which entails some cost for both the market operator and the bidders (p. 8).

Cramton notes that an ascending-clock auction would generally take between half a day to a full day to complete, depending on how many rounds are used. While we have no indication as to the likely time required to prepare bid schedules for sealed-bid auctions, it is likely to be less time-consuming than participating in either a half- or full-day open-bid auction. In addition, while we have no indication as to the likely incremental cost of running a sealed-bid auction, Holt (2006) reports that the Virginia NO_X allowance auctions, which were sequential, ascending-clock auctions and which raised approximately $10.5m, cost approximately $200,000 to design and administer.[24]

Assessment

There appears to be little consensus within either the theoretical or experimental literature regarding the preferred choice between an ascending-clock auction as proposed in the Green Paper, and a sealed-bid auction as proposed by Holt et al (2007). Having considered the options, we tend to favour the ascending-clock design for its open and transparent process and price discovery characteristics. We consider that careful management of revealed information and other measures designed to curtail collusion would adequately prevent such behaviour. To make a more informed decision, we support Evans & Peck (2007) in recommending experimental investigations of the various proposed formats. We

[24] This figure included one-off R&D costs, and thus the true incremental cost of holding the auctions was likely less.

note that neither intra-round bidding nor the potential costs of an ascending-clock auction (relative to a sealed-bid format) are discussed in the Green Paper. Both of these issues warrant further attention and may affect the final choice of auction format, given the lack of clear theoretical or experimental evidence on the issue to date.

Remark 1

Having considered the options, we tend to favour the ascending-clock design for its open and transparent process and price discovery characteristics. We consider that careful management of revealed information and other measures designed to curtail collusion would adequately prevent such behaviour. To make a more informed decision, we support Evans & Peck (2007) in recommending experimental investigations of the various proposed formats.

3.1.2 Uniform pricing

In addition to the auction *format* (ascending-clock versus sealed-bid), a second crucial decision unique to multi-unit auctions is the choice of *pricing*. As mentioned before, the two options are uniform and discriminatory pricing.

There is a general consensus between Chapter 7 of the Green Paper, Evans & Peck (2007), Holt et al (2007) and Cramton (2007) that a uniform price auction is preferable to a discriminatory price auction. As noted above, the theoretical revenue and efficiency performance of uniform versus discriminatory price auctions in the multi-unit setting is ambiguous. In both cases, auction outcomes can be inefficient – in the uniform-price case due to demand reduction and in the discriminatory-price case due to a violation of symmetry (Krishna, 2002).

The relative complexity of a discriminatory price design and the potentially undesirable feature that the price paid by different bidders (and indeed by the same bidder but for different units of the same object) can differ are universally used as justification for favouring uniform pricing over discriminatory pricing. Cramton & Kerr (2002) also suggests that uniform pricing may encourage participation by smaller bidders, since uniform price auctions are relatively strategically simple and smaller bidders tend to benefit from demand-reduction by larger bidders.

Remark 2

Uniform pricing is relatively simple and ensures that all participants pay a single price for all permits. Based on the (virtual) universal acceptance of uniform pricing in the carbon permit auction design debate both within Australia and abroad, we support the notion of uniform pricing.

3.1.3 Simultaneous auctions for different vintages

Assuming future vintages are auctioned, the decision regarding how auctions for different vintages are conducted (simultaneous, sequential or combinatorial) is contingent on two factors:

(i) Whether an open-bid or sealed-bid auction format is adopted; and

(ii) Whether different vintages are viewed as complements or substitutes.

We consider the decision of how to auction multiple vintages, contingent on each of these factors, below.

Open-bid versus sealed-bid

Under an open-bid format, two options exist for auctioning vintages of different years. These are, as highlighted in Section 2.2.3, multiple, simultaneous auctions or multiple, sequential auctions. Under a sealed-bid format, one likely option exists: multiple, sequential auctions. Running multiple, simultaneous auctions under a sealed-bid format is less desirable than running multiple, sequential auctions, since simultaneous auctions provide no potential for information from one auction to inform and impact behaviour in subsequent auctions.[25]

Cramton (2007) highlights the advantages of open-bid, simultaneous auctions, namely the ability for bidders to efficiently substitute between different vintages concurrently. This allows information and prices from one auction to influence bids in the other and vice versa. Crampton (1998) and Ausubel & Crampton (2004) discuss the benefits of substitution between simultaneous auctions in detail. In essence, this approach facilitates price discovery since bidders learn from the bidding process and condition their future bids on this information. By contrast, one possible issue with the sealed-bid approach, where iterative substitution between simultaneous auctions is not possible, is that the prices achieved in each vintage auction may not reflect bidders' preferences. This can result in inefficient outcomes. An extreme example of this would be if the price of a current year vintage were to fall below the price of future year vintages (assuming the cost of abatement was constant over the period). This situation is implausible, since a current year vintage is a perfect substitute for future year vintages (due to unlimited banking) but due to the cost of carry must be worth more today than in the future. Such a scenario is possible in a sequential auction if bidders make decisions based on imperfect information or make mistakes. But it is far more unlikely in a simultaneous auction, since this price difference would be immediately obvious to bidders, who would likely bid more aggressively for the current year vintage given the apparent mis-pricing.

An additional issue that arises in sequential auctions is a phenomenon known as the 'declining price anomaly'. This anomaly is described by a common observation: prices tend to *decline* with repetition over multiple, sequential

[25] On this point, Cramton (2007) notes that the potential for mis-pricing between different vintages, due to a lack of information, is somewhat mitigated when sequential versus simultaneous sealed-bid auctions are used.

auctions that sell homogenous objects exhibiting common-values. The declining price anomaly is counter-intuitive since the information revealed over multiple auctions should help to alleviate the winner's curse, and hence, due to the linkage principle lead to an upward drift in prices (Klemperer, 2004). The declining price anomaly is discussed in Ashenfelter (1989) and Milgrom & Weber (2000), amongst others.

The declining price anomaly is generally evident when homogenous objects are auctioned sequentially. For the purposes of carbon permit auctions, separate vintages (not assumed homogenous) might be sequentially auctioned. The extent to which the declining price anomaly may affect sequentially auctioned heterogeneous objects is uncertain. Certainly, any price drift downwards due to the declining price anomaly would be difficult to separate from the natural tendency of older vintages to sell at a discount due to the substitutability between permit vintages, and the cost of carry associated with holding younger permits for use later.[26]

Complements versus substitutes

If different vintages are viewed as complements, a simultaneous, combinatorial auction, in which package or contingent bids can be made, is likely to be more appropriate than simultaneous, non-combinatorial or sequential auctions. This is because the value of complementary vintages is contingent on obtaining other available vintages – obtaining only some of those vintages would detract from the overall package value. A simple example would be if two car park spaces are to be auctioned, and a potential bidder seeks both in order to park both her car and her boat. The value of both car parks to the individual as a 'package' far exceeds the value of winning just one of the car parks. Thus, the ability to make package or contingent bids when the objects in question are complementary (i.e. a car and boat car park) results in stronger bidding, increased participation and more efficient outcomes.

Conversely, if different vintages are viewed as substitutes, simultaneous auctions, where bidders can actively substitute between vintages of different years, are to be preferred (see Evans & Peck, 2007). A simple example was provided above regarding different permit vintages: if banking of permits is allowed, current year vintages are close to perfect substitutes for future year vintages, since one tonne of CO_2 can be emitted in 2010 by (i) purchasing a year-2010 permit today or (ii) purchasing a year 2008 permit today, and banking it for use in 2010. As a second-best solution when a sealed-bid format is used, sequential auctions are preferred, given that more information is available through sequential auctions than simultaneous auctions in the sealed-bid case. Thus, while real-time substitution is not possible in sequential auctions, it is nevertheless possible to base decisions on later auctions with information obtained from earlier auctions.

The extent to which permits of different vintages reflect substitutable or complementary objects is perhaps best judged by market participants. While it

[26] This assumes the cost of abatement remains constant across time.

appears *prima facie* that permit vintages exhibit stronger substitute characteristics, thus indicating that combinatorial auctions may be ineffective, a recent paper by Porter et al (2007) reports experimental results showing that a combinatorial ascending-clock auction outperformed both a combinatorial sealed-bid and a sequential ascending-clock auction when selling different vintages of $N0_x$ allowances.

Remark 3

The substitutability characteristics between permit vintages are likely to outweigh any potential complementary characteristics. As such, we support the simultaneous auctioning of different vintages should an ascending-clock format be adopted. If a sealed-bid format is adopted, we prefer sequential auctioning of different vintages, as this process provides more information than simultaneous auctioning in the sealed-bid case.

3.1.4 Double-sided auction

The issue as to whether the proposed permit auction design should be a single- or double-sided auction is particularly pertinent for those market participants who can expect to receive grandfathered permits in the early stages of the scheme. A double-sided auction would allow such participants to sell permits in the primary market, by participating as additional sellers, as opposed to relying on the secondary market.

The theoretical efficiency of double-sided auctions was first considered by Wilson (1985) who formulates a generalised, multi-buyer, multi-seller auction where each agent trades at most one indivisible unit. Subject to various assumptions, Wilson demonstrated that with sufficiently many buyers and sellers the double-sided auction is efficient in this setting.

Milgrom (2004) also notes that, provided individual buyers and sellers represent small proportions of total demand and supply respectively, double-sided auctions generally involve larger numbers of buyers and sellers, and thus incentives to bid-shade are reduced – thus double-auctions have the potential to improve efficiency and expected revenues.

Evans & Peck (2007) observe that adopting a double-sided auction may improve the accuracy of auction prices, and hence efficiency, since participation by all market participants in the primary market (permit auction) will result in better price signals than if some participants participate in the primary market and others (namely those participants who receive grandfathered permits and who wish to sell these permits) participate in the secondary market. Thus a single-sided auction may introduce some form of 'bias' in determining the final permit price, since only those firms with relatively high abatement costs (i.e. buyers of permits) will participate in the auction.

A final benefit of the double-sided auction is that is allows participants with grandfathered permits to access a liquid, transparent and relatively low-cost trading environment to sell their permits. If a single-sided auction is adopted,

these participants will need to trade in the secondary market, which at least initially may prove to be 'thin' and thus more costly in terms of search and transaction costs.

Remark 4

We support a double-sided auction that will allow participants with grandfathered permits to participate in the permit auction process. A double-sided auction has the potential to improve auction efficiency and the accuracy of the final permit price due to the ability for a larger number of buyers and sellers to compete.

3.1.5 Reserve price

Both Crampton (2007) and Holt et al (2007) highlight the benefits of setting a reserve price. Setting an appropriate reserve price is important from an efficiency perspective, since if the market-clearing price at which a bidder wins an object falls below the seller's valuation and no reserve price is set, efficiency will be harmed when the seller parts with the object for a price less than her valuation. However, a reserve price that is set too high can also harm efficiency – if a reserve price is set in excess of a seller's valuation, and a bidder has a valuation that is above the seller's valuation but below the reserve price, efficiency will be harmed since the bidder values the object more than the seller but the object is not traded.

Reserve prices can also play a role in determining an auctions revenue performance. In the single-unit case with symmetrically distributed, independent private values, it is always profitable for a revenue-maximising seller to set a reserve price that *exceeds* his or her value. This result, known as the *exclusion principle*, implies that it is optimal for a seller to exclude bidders whose values fall below a set reserve price, even if these values exceed the seller's valuation of the object (Krishna, 2002). Relaxing the assumption of independent private values and allowing for interdependent values and affiliated signals (i.e. common-values) invalidates the exclusion principle (Krishna, 2002). This result implies that in the single-unit case, reserve prices in common-value auctions should be set lower than those in independent, private-value auctions.

Reserve prices are also important in reducing the likelihood of collusion, since reserve prices reduce the profitability of collusion (Holt et al, 2007). This is because a reserve price reduces the potential collusive surplus that bidders acting in collusion can generate, thus making collusion harder to sustain and hence less likely to occur. The importance of reserve prices in limiting collusion is strongly supported in both the theoretical and empirical literature (Holt et al, 2007). Should a sealed-bid format be adopted as the preferred permit auction design, the importance of a reserve price as a mechanism to limit collusion could be somewhat diminished, since sealed-bid auctions are less susceptible to collusion than ascending-clock auctions by nature. In such cases, from an efficiency point of view, the reserve price should be set to broadly reflect the value the government places on such permits.

One final consideration regarding the appropriate level of reserve prices is their role in stabilising permit prices across auctions. By preventing the clearing price from auction to auction fluctuating significantly (at least on the down-side), reserve prices can help strengthen the pricing signals emanating from the auction process, and thus may provided broader market efficiency benefits.

The proposed permit auction design outlined in the Green Paper states that a reserve price will be set, but provides no details as to what this price might be, or how it will be calculated. Cramton (2007) outlines a simple formula for determining the reserve price, based on the history of prior auctions. Cramton's reserve price formula initially sets the reserve price to 10% of the expected clearing price of the first auction, and progressively increases this reserve price to 50% of the expected clearing price after 8 quarterly auctions. Thus the reserve price is determined using past auction prices (expectations are myopic) and ensures that reserve prices start low and progressively increase to a maximum of 50% of the expected closing price. Evans & Peck (2007) propose an initial starting reserve price of 33% of the lowest estimate of future permit prices, or alternatively 33% of the price of a comparable permit traded under another ETS, such as in Europe or under the RGGI scheme. The RGGI recently announced a reserve price of USD$1.86 per allowance for the first round of auctions, due to start in September of this year.[27]

In addition to questions regarding what the reserve price should be, and how it should be set, the decision regarding whether the reserve price is made public also needs to be considered. Holt et al (2007) note that undisclosed reserve prices have been used in ascending-clock auctions selling wine and art, as well as in auctions selling publicly owned assets. Holt et al argue in favour of publicly disclosing the reserve price prior to any auction on the grounds that, on repeated participation in carbon permit auctions, some participants are likely to learn how reserve prices are set, and hence act as though this reserve price is public information even though the government may assume this information is private. Predicting this potential information-seeking behaviour, it may be best to publicly disclose reserve prices at the outset.

Remark 5

Both Holt et al (2007) and Evans & Peck (2007) argue that a reserve price should be set so as to reduce the incentives for collusion. While this result flows from the theoretical literature, further investigation is warranted in the present context as to whether this is a concern, given that the proposed level of information revelation should limit collusive opportunities.

Chapter 7 of the Green Paper provides no detail regarding at what level the reserve price is to be set, how it will be set, or indeed whether reserve prices will be made public *ex ante* auctions. Holt et al's (2007) argument in favour of publicly disclosing reserve prices at the beginning of each auction in the event they are set is convincing.

[27] http://www.co2-handel.de/article187_8274.html

3.2 OPERATIONAL DESIGN ISSUES

3.2.1 Auction frequency

As noted in the Green Paper, there is an inverse relationship between the frequency of auctions and the average number of permits allocated through each auction. The Green Paper also makes the case that the use of more frequent and smaller auctions has implications for a variety of criteria, such as:

- Reliability of price information;
- Timeliness of price information;
- Cash-flows of liable entities; and
- Administrative costs to government and businesses.

The issue of "absorptive capacity" raised in the Green Paper seems to be encompassed by other criteria such as the reliability of price information and cash-flow impacts on participants.

Generally speaking, we consider that the Green Paper provides a fair description of the types of factors that ought to be taken into account in determining auction frequency and the trade-offs between them.

However, there are several areas where the Green Paper could potentially provide an incomplete picture of the magnitude or nature of the trade-offs involved between the criteria. On the whole, most (but not all) of these areas of incompleteness lead to a preference for less frequent as opposed to more frequent auctions.

This Section proceeds by discussing the areas where the Green Paper could have acknowledged a stronger case for more frequent auctions. This is followed by a discussion of the counter-arguments the Green Paper could have made in favour of less frequent auctions. On balance, we believe that the case for more frequent auctions is stronger than provided by the Green Paper.

Case for more frequent auctions than stated in the Green Paper

In general, the Green Paper appears to understate the importance of cash-flow and risk management for NEM participants. NEM participants are settled on wholesale purchases and sales of electricity approximately four weeks after the end of the relevant 7-day billing period. Many participants are presently financed in a manner that allows little spare cash-flow or the ability to borrow in order to finance the acquisition of permits for later use. In this context, if such participants are required to pay for permits immediately following an auction, it may leave many in a position where they are simply not capable of acquiring permits in advance of the period to which the permits relate, *even if the price of those permits fell significantly as a result of weak demand.* An inability to acquire permits at auction could subject those participants to significant contracting risk, as they would not be assured of acquiring a given number of permits prior to entering electricity derivative contracts that spanned the period to which the permits applied. The result could be an extension to the present "chilling" of the OTC derivative market, with negative implications for the efficiency of future

investment decisions in new generation plant and the competitiveness of retail energy markets.

In the longer term, it is probable (and desirable) that a liquid secondary market in permits would develop, in which intermediaries would buy and sell permits so as to effectively finance the acquisition of permits in advance of their application date in return for a higher future permit price. Such a market would enable cash-strapped market participants to enter into an agreement to take delivery of permits at the time they were required in exchange for a premium reflecting the cost of carry. This would allow participants to enter electricity derivative contracts with confidence. But such a secondary market is likely to take some time to develop. As discussed below, this issue of cash-flow timing is even more important to the auctioning of future vintages of permits due to the much longer timeframes involved.

Second, the Green Paper should have noted that the relationship between some of the criteria may not be directly proportionate. In other words, the *rate* at which one criterion needs to be traded-off to achieve another may vary. For example, a greater frequency of auctions does not *necessarily* mean that auctions will be less competitive and hence, that auction prices will be a less reliable indicator of the value of permits than less frequent auctions. After all, even if there are more frequent auctions of a smaller number of permits, the total number of permits auctioned over a finite period of time will not change. In fact, if all auction participants participate in all auctions, small frequent auctions may actually yield more competitive and stable prices than less frequent larger auctions. For small frequent auctions to yield less stable and reliable prices than infrequent large auctions, it must be the case that some bidders do not participate in all of the auctions. This may occur if auctions are held on an extremely frequent basis. For example, daily auctions will likely lead to some participants "sitting out" some proportion of auctions. However, if auctions are held quarterly or monthly (or even possibly weekly), it is quite possible that all active participants will bid in those auctions. If this occurs, it is likely that little if anything in the way of price reliability would be sacrificed in conducting auctions on a more frequent basis than quarterly. Consequently, it may be possible to secure the cash-flow benefits of more frequent auctions with little or no loss to price competitiveness and reliability.

Third, while the Green Paper acknowledged that it will be difficult to know how to set many auction variables in advance of experience, it did not mention that more frequent auctions allow greater scope for, and lower the costs of, minor changes to reflect initial experience. This point is not made to encourage fiddling by the auction administrator; rather, it is in recognition of the fact that some changes to the initial auction will almost inevitably be required in the initial phases of the scheme. Frequent smaller auctions limit the costs of early shortcomings while enabling them to be addressed quickly enough to avoid undermining confidence in the auction design.

Finally, the literature suggests that the incremental administrative costs of running frequent auctions can be low in the context of electronic internet-based platforms. As noted above, Holt et al (2007) note that the bulk of such auction

costs are once off and incurred at the set-up stage, whereas the incremental costs are relatively small and mainly incurred by agents in the process of participation.

Case for less frequent auctions than stated in the Green Paper

On the other hand, it may be the case that more frequent auctions will undermine the development of a liquid secondary market. To some extent this is inevitable, although we note that a combination of annual and monthly auctions of financial transmission rights in the Pennsylvania-New Jersey-Maryland (PJM) market in the United States has not prevented the formation of an internet-based secondary bilateral trading market.

Similarly, the Green Paper in our view possibly overstates the value of more timely price signals resulting from more frequent auctions. Cash-flow management issues aside, the efficiency of participants' investment or strategic decisions is unlikely to be improved by pricing signals emerging from weekly as opposed to monthly or even quarterly auctions.

Finally, given that ascending-clock auctions are likely to be more time-consuming for participants to engage in than sealed-bid auctions (see Section 3.1.1 above), it is worth noting that very frequent (say, daily or weekly) ascending-clock auctions could consume an excessive amount of participant time and trading resources. This suggests that if auctions were to be run on a weekly basis, it may be worth adopting sealed-bid auctions in place of ascending-clock auctions. This, in turn, would suggest the use of sequential auctions rather than simultaneous auctions.

Assessment

As noted in the Green Paper and above, a number of trade-offs need to be considered when coming to a view on the appropriate frequency of permit auctions. On balance, we consider that the case for more frequent auctions is stronger than that presented in the Green Paper due to the importance of smooth cash-flow to at least some NEM participants. Thus, monthly auctions could strike a better balance between smoothing participants' cash-flows and ensuring price reliability and stability than quarterly auctions.

Weekly auctions may also provide a viable alternative to quarterly and monthly auctions, but this would depend on: (i) the extent to which auction participants chose to "sit out" some or many of these auctions on the very account of their frequency; and (ii) the potential undermining impact on the development a secondary market. If participation levels were significantly lower for weekly auctions than monthly or quarterly auctions, this could mean that auction competition and price reliability would be compromised. This could more than offset any incremental cash-flow benefits brought about by weekly auctions. Similarly, to the extent that weekly auctions "crowded out" the development of a secondary market, efficiency could be compromised in the longer term. In addition, if weekly auctions were adopted, it may be worth considering sealed-bid sequential auctions as opposed to ascending-clock simultaneous auctions to minimise the expenditure of participant resources and to maximise information revelation.

Finally, it is important to note that the case for more frequent auctions to improve cash-flow management would be undermined if a large proportion of permits were auctioned in advance of the relevant financial year. This is discussed below in the context of auctions of future permit vintages.

Remark 6

On balance, we believe there is a case for more frequent auctions than presented in the Green Paper. Thus, we consider that there may be a case for monthly auctions due to the cash-flow benefits for participants (which flow through to the liquidity of the electricity derivative market) and the likelihood of little drop-off in participation. Weekly auctions could be considered as an alternative if they did not lead to a significant reduction in auction participation and competition or undermining of a secondary market. If weekly auctions were adopted, it may be worth considering sealed-bid sequential auctions as opposed to ascending-clock simultaneous auctions to minimise the expenditure of participant resources and to maximise information revelation.

3.2.2 Auction timing

Frontier considers that the Green Paper provides a reasonable assessment of the issues influencing the appropriate timing of permit auctions. In particular, we agree with the notion that the first auction should be held after participants have had time to develop informed opinions about overall demand and supply conditions – especially, the scheme cap, although we note that this will become informally public before its final announcement. On the basis of current information, we agree that it would make sense for the first auction to held some time in the first half of 2010. If possible, this should be after the formal announcement of the scheme cap.

Finally, the Green Paper proposes auctioning three-eighths of the permits for a given vintage in advance of the start of the relevant financial year. This issue is discussed in more detail below in the context of auctions of future vintages.

3.2.3 Advance auction of future vintages

As noted above, the Green Paper proposes auctioning three-eighths of the permits for a future vintage in advance of the start of the relevant financial year. It also restricts the proportion of permits sold *in any one* advanced auction to one-eighth of the total number of permits for that year. By way of comparison, Cramton (2007) proposes that 50% of available permits for a given year be sold as future vintages while 50% be reserved for sale within that year.

In principle, the auctioning of future financial year permit vintages seems sensible. We also accept the points made in the Green Paper regarding the trade-offs involved in deciding whether and how many future vintage permits should be auctioned in advance. As noted in Chapter 7 of the Green Paper, auctioning future vintages would provide market participants with the option of acquiring future vintage permits in advance of when they were required, thereby mitigating the risks of relying on acquisition at auctions closer to the financial year of the

relevant vintage. This should help support the electricity derivative market, as recognised in Cramton (2007, p.10). In this context, we understand that many NEM participants prefer to hedge at least two-thirds to three-quarters of their sales and purchases in advance. This suggests that more than half the permits relating to a particular vintage could usefully be auctioned in advance of the start of that financial year.

However, an important caveat to the adoption of this view is that participants' concerns about the timing of settlement for future years' vintages need to be considered. As noted above, some market participants may lack the cash-flow to pay for permits in advance of their use. If a significant number of potential bidders do not participate in auctions for future year vintages, it is likely that the efficiency of permit pricing that emerges from those auctions will suffer, with negative flow-on effects for the liquidity of the electricity derivatives market. While these efficiency problems could be resolved through an active secondary market, we would highlight again that this might take some time to develop. Further, relying on the secondary market to resolve inefficient permit allocations arising from auctions suggests that there is little value in careful design of the auctioning regime in the first place – a position that does not appear to be held by the DCC. Therefore, if cash-flow concerns are likely to significantly deter participation in auctions held in advance for future vintages, it may be wise to limit the proportion of future vintage permits sold in advance to minimise any inefficiency.

The problems created by immediate payment for future vintages of permits could be addressed by postponing the requirement to settle such purchases until closer to the time of their use. For example, payment for permits from the 2011-12 vintage that were auctioned in 2010 could be required at the commencement of the relevant month or quarter. This would help to align participants' payments for permits with their revenue stream through the spot and forward electricity markets. On the other hand, such a deferral of settlement could lead to higher rates of non-payment or default than would occur if settlement were required to immediately follow an auction. This issue is discussed further in the next Section.

To the extent that immediate settlement of auctions cannot be avoided, there is likely to be a trade-off between:

- Auctioning future vintages in advance to assist participants manage the risks of obtaining enough permits and promoting liquidity of the electricity derivatives market; and
- Auctioning future vintages closer to the time they are to be used in order to maximise bidding competition and the reliability of auction prices.

Finally, we would highlight that if a substantial proportion of permits were to be auctioned in advance, the case for much more frequent auctions would be undermined. After all, if the benefits of frequent auctions lie in improved cash-flow management, but most permits are auctioned in advance, it is difficult to see how those cash-flow benefits would be realised.

Assessment

In light of the strong historic preference of NEM participants to enter derivative contracts in respect of a large proportion of their purchases and sales in advance, we consider that the Green Paper's proposal for three-eighths of permits to be auctioned in advance appears reasonable as a minimum lower bound for consideration. So long as any cash-flow issues surrounding advanced auctions could be addressed without excessively limiting participation, it may be appropriate to auction 50% or more permits for future vintages in advance. However, such a high proportion of permits auctioned in advance would tend to undermine the case for very frequent (say, weekly) auctions.

Remark 7

The Green Paper's proposal for auctioning three-eighths of permits in advance seems to be a reasonable lower bound in light of NEM participants' preference to be highly contracted. So long as any cash-flow issues surrounding advanced auctions can be addressed without excessively limiting participation, it may be appropriate to auction 50% or more permits in advance. Such a high proportion of permits auctioned in advance would tend to undermine the case for very frequent (say, weekly) auctions.

3.2.4 Participation and settlement

Liable vs. all entities

Chapter 7 of the Green Paper raises the risk of speculation as the only real reason to limit participation in permit auctions to liable entities. We agree that, other things being equal, greater participation should mean more efficient auction outcomes and a more vibrant secondary market.

While speculation may occur if participation is not limited, it is not obvious that non-liable entities are likely to bid for permits in a more speculative manner than liable entities. If anything, liable entities may have stronger incentives to acquire and hoard larger numbers of permits than non-liable parties. While liable entities may hoard permits in order to deter new entry into the NEM, non-liable entities may be motivated to bid for permits solely to make profits from their subsequent sale. On the other hand, non-liable entities such as financial institutions may have "deeper pockets" than liable entities and be able to pay much higher prices. However, this does not imply that such parties are likely to be willing to pay more for permits than their efficient value.

Financial assurance

On the issue of the financial standing of participants, the Green Paper suggests that some form of financial guarantee would be required to ensure that bidders will be able to pay for the permits they buy at auction and to encourage only genuine bidders (p.269). The Green Paper goes on to say that the form of guarantee could be a cash deposit or some other form of security. Depending on

the auction outcome, the deposit would either be refunded in whole or part or be used to reduce the bidder's payment.

Frontier recognises that the administrative arrangements for auctions need to provide participants with a strong incentive to pay for permits. Evidence from auction processes for spectrum, nitrogen oxide (NO_X) and carbon dioxide (CO_2) in the United States and elsewhere suggests that weak eligibility rules can lead to parties defaulting on their bids (Holt et al (2007), p.41). The problem with mechanisms only requiring payment when a permit is needed is, as explained by Klemperer (2004), that they potentially provide the purchaser with an *option* as to whether to proceed: if the value of the right later turns out to be less than the price bid at auction, the purchaser may choose to renege on its purchase (p.176). This potentially undermines the integrity and efficiency of the auction process.

Potential forms of financial assurance mentioned in Holt et al (2007) include the posting of a bond, deposit or letter of credit that would cover a substantial fraction of the bidder's ultimate payment should it win (p.41). These could be combined with, or avoided by, the imposition of a penalty for participants that failed to settle permits by a specified date close to the applicable time period of the permits.

At the same time, we again highlight the cash-flow issues that can arise for NEM participants if they are required to pay or lodge a substantial proportion of the price of permits in advance of when those permits are used. Ideally, some form of financial assurance could be required that did not create barriers to the participation of NEM participants. This would be even more important for the auctioning of permits from future vintages, where cash-flow issues or of even greater importance.

Remark 8

In general, we agree with the Green Paper's proposal to not limit participation in permit auctions beyond compliance with prudential requirements. Some form of financial assurance should be applied to ensure participants treat auction transactions as binding commitments rather than options.

3.2.5 Proxy bidding

Evans & Peck (2007) and Crampton (2007) highlight the value of allowing proxy bidding under an ascending-clock auction format. Proxy bidding involves bidders submitting a demand schedule that specifies quantities demanded at various prices. Proxy bidding allows participants who wish to be absent from part or all of auction to be so. Both Evans & Peck (2007) and Cramton (2007) argue that proxy bidding may especially appeal to smaller bidders who do not wish to participate in each round (presumably due to the cost or complexity of dynamic bidding) but who still wish to participate in the auction. The addition of proxy bidding under the ascending-clock format allows those bidders who wish to treat the ascending-clock auction as a standard, sealed-bid, uniform price auction (and hence not take advantage of price discovery across rounds) to do so. Having said that, bidders who behave in such a way are likely to not do as well as if they took

account of the information revealed through each round of the ascending clock in their bids.

Remark 9

The addition of proxy bidding adds additional flexibility to the ascending-clock format and allows bidders who wish to treat the auction as a sealed-bid format, or those who wish to be absent from the auction, to do so. We support the inclusion of proxy bidding should an ascending-clock format be adopted.

3.2.6 Auction platform

The proposed operational design within Chapter 7 calls for permit auctions to be administered on an internet platform. The idea of an internet platform is supported by both Evans & Peck (2007) and Cramton (2007). Administering auctions on an internet platform is low cost for both the government (in terms of administration costs) and participants (in terms of participation costs). Low participation costs will encourage entry and hence has the potential to increase competition. Evans & Peck note that specialised software is available to operate such auctions, and that such software has been used in high-stakes auctions worldwide for several years. We support the recommendation that care be taken in designing the user interface of any online auction. Such design considerations could be tested experimentally, or else trialled thoroughly.

Remark 10

We support the administration of permit auctions via an internet platform. The low administrative and participation costs of running an online auction have the potential to encourage entry and hence improve auction efficiency.

3.2.7 Lot sizes and treatment of unsold lots

The proposed operational design within Chapter 7 states that both minimum and maximum lot sizes may be enforced in permit auctions. Minimum lot sizes are generally imposed to reduce administrative costs and speed up the auction process. The size of lots needs to be carefully considered, since lot sizes that are too small may discourage entry, while lot sizes that are too large may burden some bidders and impede their ability to obtain their desired (albeit relatively small) quantity of permits. The Green Paper states that maximum lot sizes may be imposed "to ensure credible auction results while still allowing legitimate bidders to participate at auction". This statement is vague on the issues and requires further detail. While Evans & Peck (2007) appear to propose lot sizes of "one tonne CO_2-e" (presumably implying that there is no minimum lot size, other than that permits must be sold in discrete units), both Cramton (2007) and Holt et al (2007) propose minimum lot sizes of 1,000 tonnes.

The setting of a reserve price allows for the potential situation where supply exceeds demand at the reserve price, and hence permits go unsold. While the Green Paper states that unsold lots would need to be sold at future auctions, the

process by which this is achieved is not discussed. Crampton (2007) highlights the advantage of auctioning unsold permits according to a specific schedule, rather than unsold permits being assigned to an actively managed contingency reserve account and sold in an arbitrary manner. Cramton argues that by committing to sell unsold permits according to a specific schedule, the political risk associated with the managing of a contingency reserve fund would be mitigated, thus reducing market uncertainty.

Assessment

The setting of a minimum lot size due to administrative costs is frequently cited. Given that any permit auction is likely to be conducted online and that bidders will need to meet certain pre-requisites before competing, we question the extent to which setting a minimum lot size will discourage entry and reduce the administrative burden of running the auctions. It does not seem *prima facie* that setting a minimum lot size is necessary or indeed desirable. The Green Paper provides no cohesive argument as to why a maximum lot size should be set. We question the need to set a maximum lot size in the absence of any convincing reasons to do so.

We support the recommendation made by Crampton (2007) in ensuring that any unsold lots are auctioned in the future according to a specific schedule and are not arbitrarily sold. This will reduce the political risk faced by auction participants as well as reduce the uncertainty regarding future expected permit supply.

Remark 11

The Green Paper provides no cohesive argument as to why a maximum lot size should be set. We question the need to set a maximum lot size in the absence of any convincing reasons to do so.

Any unsold lots should be auctioned in the future according to a specific schedule and are not arbitrarily sold. This will reduce the political risk faced by auction participants as well as reduce the uncertainty regarding future expected permit supply.

4 Conclusions

On the whole, our impression is that the Government's proposed permit auction design as outlined in Chapter 7 of the Green Paper has been well considered and presented. Through his indirect involvement with the Evans & Peck report, many of Peter Cramton's (a renowned auction theorist with extensive experience in designing and administering high-stakes auctions) recommendations have been adopted.

While none of the key design elements outlined in the Government's proposed auction design appear seriously flawed, we do have several criticisms of Chapter 7. These criticisms mainly relate to the depth of arguments concerning certain proposed design features and the lack of detail provided about others. While Remarks 1-11 outline our position on the key auction design elements contained in Chapter 7, we briefly outline our main concerns with both the mechanism and operational designs below.

Mechanism design issues

First, we note that while the Government's proposed ascending-clock format has its strengths and has been successfully used in other high-stakes auctions, it is not the only viable option. As Holt et al (2007) argue, a second option is a standard, sealed-bid, uniform price auction. While Chapter 7 does mention this auction form, we believe that the choice between these two formats deserves further attention. As outlined in Section 3.1.1, the ascending-clock and sealed-bid, uniform price auctions have different strengths and weaknesses – the former provides greater price discovery properties while the latter better guards against the potential for collusion. Neither the theoretical literature nor Holt et al's experimental results provide conclusive evidence as to which auction type is preferable overall.

While we tend to favour the ascending-clock format for its transparency, we support Evans & Peck's call for experimental research into which format performs best under conditions reflective of the Australian permit auction environment. Such experiments could also be used to hone other key design elements, such as a process for allowing intra-round bidding, the impact of different reserve prices, the impact of restricting certain combinations of current and future vintages, and the best form of user interface if online auctions are used.

Second, we note that several key mechanism design issues are not discussed in the Green Paper. These include the potential for intra-round bidding, the level and evolution of bid increments, the level and process for setting reserve prices, and whether reserve prices will be made public. While other less crucial details will likely be resolved with the passage of time, we consider that these issues require further consideration in the near term.

Operational design issues

One of the key operational design issues for participants is the frequency of auctions. Given that some auction participants face serious cash-flow constraints in participating in permit auctions, we contend that the case for more frequent auctioning of permits (perhaps monthly as opposed to quarterly) is stronger than the Green Paper suggests. In this context it is not necessarily the case that more frequent auctions will result in lower levels of participation and hence less competition – the inter-relationship between the frequency of auctions and their competitiveness is not as simple as the Green Paper assumes. Indeed, more frequent auctions may result in greater competition between bidders if either the number of bidders does not fall or if the bidders that do participate compete more fiercely for the smaller number of permits available as a result of more frequent auctions.

Closely inter-related to the choice of auction frequency are the issues of future vintages and settlement. In particular, many NEM participants are likely to favour a substantial proportion of future vintage permits being auctioned in advance to facilitate their entry into electricity derivative contracts. This raises the question of whether participants should be required to pay upfront a substantial proportion of the price of any future vintages bought in advance. While substantial upfront payment is likely to be necessary to prevent participants reneging on their obligations (should doing so be privately profitable), such a requirement may deter entry to auctions and hence harm competitiveness and efficiency. Thus the appropriate degree of auctioning in advance and the form of financial assurance needs to be determined carefully alongside the choice of auction frequency to ensure the right trade-offs are made. Finally, we observe that auctioning a large proportion of permits in advance undermines the case for much more frequent auctions to address participants' cash-flow concerns.

Finally, we question the Government's position in regard to minimum and maximum lot sizes on the basis of the evidence provided. While it is feasible that a minimum lot size may reduce the administrative burden of running these auctions, the extent to which this occurs when auctions are held via an online platform is uncertain. In addition we question the need for a maximum lot size, especially if (maximum) eligibility requirements are imposed, as was proposed by Evans & Peck. The Green Paper provides no compelling reasons as to why a maximum lot size would be necessary.

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