Report on key design elements of auctions under Australia's Carbon Pollution Reduction Scheme

FINAL REPORT

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tradeslot

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Contents

Summary 3
1. Preamble 6
2. Report objectives 7
3. Decision framework for the auction design process 8
4. Implementation risk 11
4.1. Price risk 11
4.1.1. Winner's curse 11
4.1.2. Price divergence 12
4.1.3. Unintended bids 14
4.2. Demand risk 14
4.2.1. Bidder boycott 14
4.2.2. Seller constrained demand 17
4.2.3. Bidder strategies to reduce demand 19
4.2.4. Collusive behaviour 19
4.3. Credit risk 20
4.4. Systems risk 22
5. Recommendations 25
5.1. Table 1: Summary of Tradeslot's recommendations for the auction design of Australia's CPRS. 32
6. From design to practice 34
6.1. Feedback from stakeholders on policy settings 34
6.2. Feedback from stakeholders on auction platform usability 34
6.3. Early tender for auction platform provider 37
6.4. Rules and policy documentation 37
6.5. Communication and training 37
6.6. Mock auctions 38
6.7. Bid simulator 38
6.8. Decision support tools 38
7. References 39
Appendix 1: Summary of international auction experiences 40
Appendix 2: Key auction format mechanisms Appendix 2: Key auction format mechanisms 45
Appendix 3: Bidder qualification process case study - Victorian Timber Auctions 52

Summary

The Department of Climate Change (DCC) commissioned Tradeslot Pty Ltd (Tradeslot) to provide a report on key design elements of auctions under Australia's Carbon Pollution Reduction Scheme (CPRS). Key areas to be addressed include advice on the:

- Auction type
- Advance auctioning of future vintages
- Auction timing and frequency
- Timing of payments for permits

Tradeslot has drawn upon both academic and practical examples to conduct this analysis and provide our recommendations. The analysis assumes some knowledge regarding auction design.

Throughout the consultation process with the DCC, it has become evident that the primary concern to address was that of implementation risk. Accordingly, we focus on implementation risk.

In order to answer the core questions posed by the Department for this report, we have developed a 'decision framework'. This framework (detailed in Chapter 3) is essential in guiding the thinking and (ultimately) the decision making process.

Chapter 4 applies the decision framework through an analysis of how the various policy decisions and auction design choices impact on implementation risk to the government.

The analysis framework considers implementation risk from four different perspectives.

1. Price risk—the risk that prices will diverge from market fundamentals due to auction design choices and policy decisions.
2. Demand risk—the risk that demand will be artificially lowered during the auction due to auction design choices and policy decisions.
3. Credit risk—the risk that successful bidders at the auction will not follow through with payment
4. Systems risk—the risk that auction participation is artificially reduced due to bidders having troubles using or accessing the system.

Main findings

1. **Sale of future vintages is a policy decision that should be informed by stakeholder preference.**
2. **If selling multiple substitutable products (vintages) use a Simultaneous Ascending Clock Auction (SACA) in preference to a Sealed Bid Tender (SBT) format, as the reduction in price risk and demand risk dominates a possible increase in system risk.**
3. **Defer payment of future vintages as the reduction in demand risk dominates the increase in credit risk.**
4. **Frequency of auctions (SBT or SACA) should be monthly or quarterly depending on stakeholder preference.**

These findings are derived from Chapter 4 and can be summarised in the following diagram.

	Price Risk	Demand Risk	Credit* Risk	System* Risk
Sealed Bid Tender (SBT)	High	High	Low	Low
Simultaneous Ascending Clock Auction (SACA)	Low	Low	Low	Low-Med

* The mitigation strategies for these risks are well understood and work well in practice

It is acknowledged that various policy settings will result in alternative recommendations. The most likely policy setting alternatives (and the alternative recommendations) are outlined in Chapter 5 and summarised in Table 1.

Additional findings

1. When selling multiple substitutable products, price risk and demand risk are the most difficult to mitigate and therefore are the most likely to cause implementation failures. On the other hand, credit risk and system risk can cause catastrophic failure but the mitigation strategies are well understood and are tried and tested in practice.

2. Pricing complexity is a more important risk issue than system usability complexity when multiple substitutable products are sold at the same time.

   When selling multiple substitutable products simultaneously, the SACA allows iterative price discovery (of aggregate demand) and efficient demand substitution. This reduces the complexity that bidders face in making their individual pricing decisions.

3. If the products have characteristics that make them either substitutes or compliments then, where possible, they should be sold at the same time (simultaneously) to reduce the pricing complexity for the bidders.

4. Policy decisions (such as banking and borrowing rules and payment terms) do impact on the degree of substitutability of the products.

5. The number of products being sold does not increase pricing complexity; instead the pricing relationship (substitutability) between the products increases the complexity.

6. A potential risk in using a SACA format is credit risk, as all bidders rely on price signals created by the submitted bids during the auction to inform their bidding strategy. The government can mitigate this potential risk by ensuring that all bidders with access to the platform are thoroughly credit checked and certified and that all bidders understand that each bid is a legally binding contract. This is especially relevant where payments are deferred.

7. Deferring payment for later vintages should make these products more desirable and result in increased demand and higher prices. The trade-off is an increase in credit risk which can be mitigated by not transferring ownership until the permit is paid for, and by careful credit checking.

8. Initially bidders may be anxious about being involved in a clock auction because of a lack of experience with the format. Thorough bidder preparation is therefore critical.

9. The frequency of the auctions should be based on stakeholder preference, as the marginal costs of running additional web based auctions are minimal.

The report concludes by acknowledging that this analysis is just the beginning of the auction design and implementation process. Several key tasks follow and Chapter 6 provides a starting list of things to consider when moving from design to practice.

1. Preamble

The Department of Climate Change (DCC) commissioned Tradeslot Pty Ltd (Tradeslot) to provide a report on key design elements of auctions under Australia's Carbon Pollution Reduction Scheme (CPRS). Key areas to be addressed include advice on the:

- Auction type
- Advance auctioning of future vintages
- Auction timing and frequency
- Timing of payments for permits

Although these areas of auction design can be considered independently, we strongly recommend viewing them as part of a 'policy and auction environment'. Policy decisions made in one area almost invariably have impacts on auction design and vice-versa. In order to make this system of interacting decisions and design features manageable, we will apply a Decision Framework (explained in detail in the following chapter).

The DCC has indicated that reference to both academic and practical examples is paramount. Tradeslot has drawn upon:

- Experiences from existing auction systems that allocate goods with economic qualities similar to carbon (divisible and homogenous),
- Policy settings and experiences from other carbon markets,
- The expertise of our advisory board member Professor Peter Cramton (University of Maryland, USA), and
- Tradeslot's experiences with the development and delivery of private electronic market allocation systems (e.g. timber auctions for the Victorian Government).

In further consultation with the DCC throughout the development of this report, it was indicated that several additional issues would be valuable to address. They include:

- The role of speculators in the market,
- Optimal bidder preparation timelines,
- The setting of volume caps and reserve prices,
- Detail surrounding the credit checking process,
- The role of the regulator, and
- How to set optimal reserve prices.

While the first four items in this list are covered (in differing degrees of detail) throughout the report, the final two were beyond the scope here and could be the subject of further study.

2. Report objectives

In this report, Tradeslot aims to address the market design elements within the parameters provided by the DCC. This will be achieved by:

- Providing a decision framework by which to view the auction design process (taking into account policy inputs).
- Identifying the implementation risk (in its various interrelated dimensions) associated with two key auction format options
    - Sealed Bid Tender (SBT) format
    - Simultaneous Ascending Clock Auction (SACA) format
- Providing recommendations for auction design for the DCC to consider.

Auction design is in many respects a response to inputs such as policy decisions. Our report aims to enable the Department of Climate Change to understand the relationships between policy settings and design and how they may lead to the auction design most appropriate in light of given inputs and policy decisions.

3. Decision framework for the auction design process

In order to answer the core questions posed by the DCC for this report, we have developed and discussed with the DCC team a 'decision framework'. This framework is essential in guiding the thinking and ultimately the decision making process. The main advantages of the decision framework are:

- It enables the team to distinguish between inputs that are driven by factors outside the auction design (such as policy decisions) and outputs (reactions to policy settings and desired outcomes),
- The framework is flexible in that it is still valid if policy inputs change over time and
- It illustrates that the core questions addressed in this report are not independent but are interrelated in terms of hierarchy and flow.

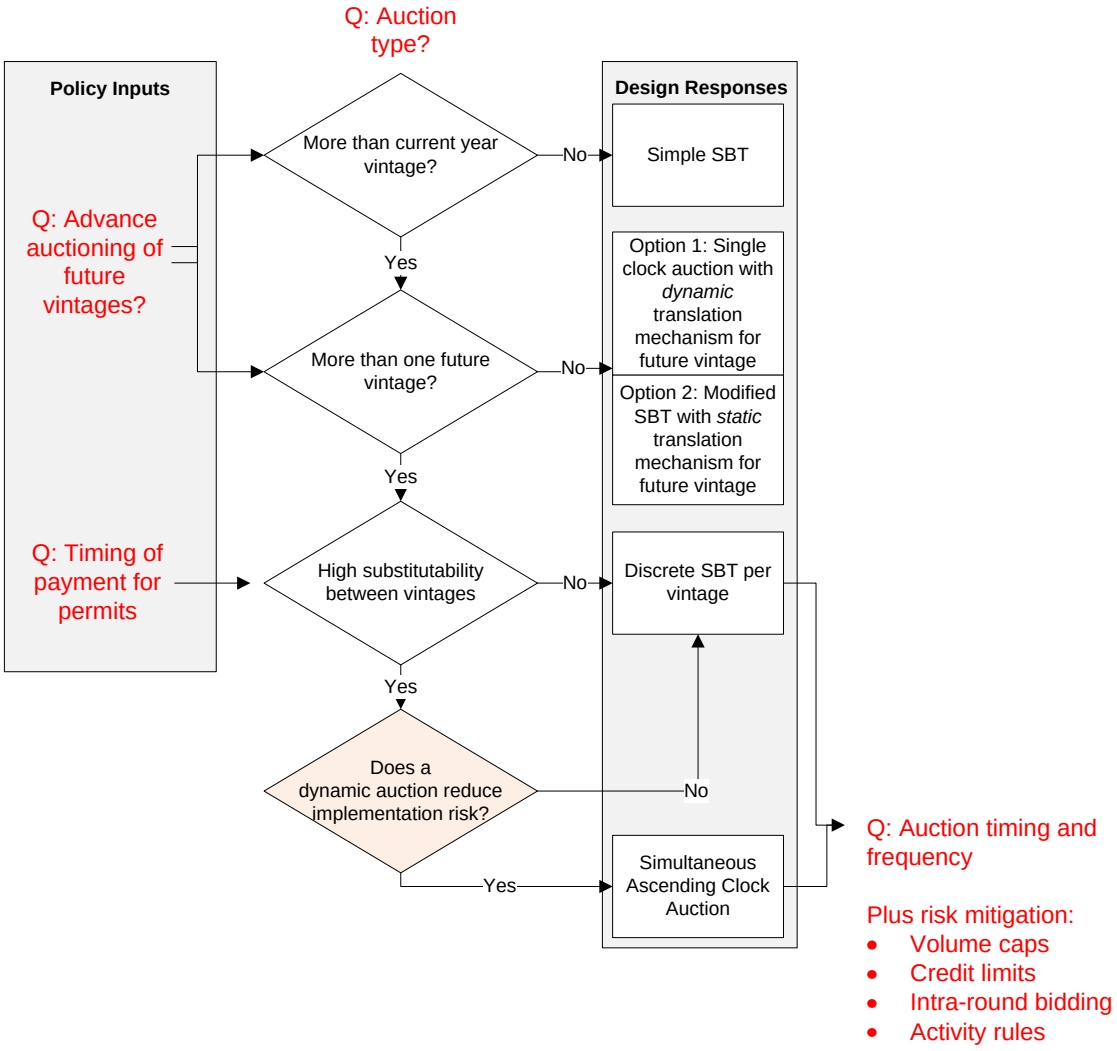

Figure 1 - Decision Framework

The starting point of the decision framework is whether or not to allow **'advance auctioning of future vintages?'** As such, this consideration is less an auction design question than one of political

intent as well as stakeholder preference. However, the model illustrates that the policy setting of the number of vintages to be sold becomes a main driver for **'auction type'**.

The auction design response to a single vintage option is an online Sealed Bid Tender with immediate payment. Chapter 4 will discuss this option and Appendix 1 shows examples of auctions where policy makers decided to sell current vintage only and accordingly opted for the Sealed Bid Tender format.

If the intention is to create price certainty beyond the spot year (a requirement regularly pushed by companies that will have to obtain permits as a liable party), the Government could decide to offer future vintages as well as the current year (spot) vintage. The corresponding auction design becomes more complex. If the decision was made to offer the spot vintage and future vintage(s), the question of substitutability of vintages comes into play. The Department has stated to date that banking and borrowing rules apply which creates a relatively high degree of substitutability. The auction design response would be to sell both vintages simultaneously. Selling current and one future substitutable vintages separately would create a 'pricing puzzle' for bidders: 'How can I have confidence in my bid for one vintage, if a substitutable vintage could sell at a much cheaper price in a subsequent event?'

Despite the fact that bidders might switch from one vintage to the other depending on market price, the Sealed Bid Tender (SBT) format can still be applied in this situation. As has been shown in related auction formats (see Chapter 4), the relationship between the value of spot and future can be expressed as a fixed ratio or absolute value. In other words, the bidder can clearly express, at what price differential they would switch to the alternative vintage.

Alternatively, the relationship between the value of spot and future vintages can be expressed in a dynamic auction format, using a single clock. Chapter 4 and Appendix 2 provide more detail.

If the feedback from liable parties and other stakeholders indicates that more than just one future vintage is strongly preferred, the design choice becomes more obvious. Fixed ratios between more than two vintages are unworkable for bidders and the auction design would have to include both feedback mechanisms and the ability for bidders to respond as the market unfolds. The most common auction format allowing for more than two *substitutable* alternatives is the SACA. As we will show in Chapter 4, substitutability is not just driven by banking and borrowing rules but also the seemingly less related question the **'timing of payment for permits'**.

While the design response to a 'spot plus multiple future vintages' policy input favours the SACA format, there are several caveats. Some participants perceive the SACA to be more complex than more traditional formats such as the SBT. Our experience, however, is that this initial reaction typically turns to an understanding, following training, that the clock auction actually simplifies bidding. The DCC has expressed that implementation risk is the most important issue to be addressed. Accordingly, this report will provide detailed analysis of the implementation risks, benefits and risk mitigation options for the SACA format. In particular, we will address options around volume caps, credit limits, intra-round bidding and activity rules.

Somewhat outside the decision making framework lies the question of **'auction timing and frequency**'. While there are logical upper and lower limits for frequency (not more frequent than where the number of permits on offer becomes too small, but at least once a year), there is no

'right' or 'wrong' decision in monthly, bi-monthly, quarterly or half-yearly auctions. In addition to our analysis of implementation risk, we will refer to international practice and also suggest to the DCC where to seek feedback from stakeholders (see chapter 'Recommendations').

4. Implementation risk

This analysis focuses on how the key policy decisions and auction design choices impact on implementation risk.

This analysis framework has been used in a range of industries for various commodities. The analysis framework considers implementation risk in four different dimensions:

1. Price risk,
2. Demand risk,
3. Credit risk and
4. Systems risk.

The chapter concludes with a summary of the analysis and an overall assessment of implementation risk given the various policy choices.

4.1. Price risk

Price risk is the risk that prices will diverge from market fundamentals because of auction design choices and policy decisions. From practical experience, price risk manifests in three ways:

- Winner's curse
- Price divergence (in multi product events)
- Unintended bids

Price failure can result in bidder grievances, negative publicity, payment defaults and in some cases, legal action.

4.1.1. Winner's curse

The winner's curse occurs when a bidder has been successful at the auction but has paid significantly more than what the product is worth.

The risk of 'winner's curse' can be mitigated in a number of ways:

1. Uniform pricing – ensures bidders pay no more than one increment above the highest losing bidder. Very high bids will be reduced in line with the allocation cut-off point where supply and demand intersect.
2. Price discovery – allows bidders to learn from other bidders and price accordingly. Both private and public values can then be used by each bidder to make informed pricing decisions and reduce the likelihood of overpaying during the auction.

Key design decision: Which auction type minimises the risk of the 'winner's curse'?

The risk of the 'winner's curse' is greater in a SBT environment where bidders have no price guidance from the market. However, this risk is reduced considerably by using a uniform pricing approach.

4.1.2. Price divergence

Price divergence occurs where bidders have overly complex pricing tradeoffs to make between substitutable products during the auction. Their inability to solve this 'pricing puzzle' results in final price outcomes that are not representative of the intrinsic value of the different products.

It is often perceived that the bidder's greatest challenge in participating in an auction has to do with using the system itself (submitting bids), whereas it is more often the case that this pricing complexity issue (knowing what to bid) is a far greater challenge.

Pricing complexity increases as:

- More substitutable products (in this case vintages) are offered simultaneously,
- Products are closer substitutes or compliments,
- Insufficient secondary market information exists to guide price tradeoffs between the products.

Examples of price failures are:

- Significantly lower prices result for products which are generally more highly valued (spot vintages) than others (future vintages)[1], and
- Price spikes, which may occur when some products (such as bankable spot vintages) may attract much higher prices than close substitutes (future vintages).

Key design decision: Which auction type minimises the risk of price failure?

Where just one product (the spot vintage) is auctioned, the SBT format poses little price risk.

Should two substitutable products be auctioned simultaneously, a SACA format poses less price risk than a SBT format[2, 3]. In this situation a single clock can be used with a demand substitution price setting that automatically switches demand between the spot and future vintage as the price point is reached.

If more than two substitutable products are auctioned simultaneously, a SBT format poses much greater pricing complexity than a SACA.

The chief advantage of the SACA approach is price discovery: bidders can learn about the demand of other bidders from the bidding process and condition their bids on this information. If the auction system does not provide adequate price discovery and allows bidders to act only on private values, there is a risk that their values may be out of line with the collective intelligence of the market and may cause them to do 'crazy things[4]' in terms of their bidding behaviour (bid far too high or too low).

While price discovery is a valuable mitigation strategy for price risk, by itself it is not enough. The auction mechanism must be designed to allow buyers to respond to their new found pricing

[1] Cramton (2007a) p7

[2] If substitutability of vintages is desired, the SBT format could allow bids for the future vintage to specify the premium, if any, which they would pay to receive the current vintage product. See Appendix 2 for more detail.

[3] Giberson (2007)

[4] Cramton (2008b)

intelligence. A multi-round format (such as a SACA) allows bidders to respond by shifting demand[5], as opposed to the 'one-shot' single round SBT, where bidders need to wait until the next auction, rather than the next round, to respond to market information.

When selling multiple substitutable products simultaneously, a SACA format reduces the risk of price failure, by providing excellent price discovery and substitutability opportunities[6]. The clock auction allows bidders to substitute freely between spot and forward products, so that any price separation is a true reflection of the difference in value of the two products.

Key policy decision: How many vintages can be offered in a single auction without increasing the likelihood of price failure?

An important point is that price complexity is not a function of the number of products sold simultaneously, but rather the degree to which the products being sold are related i.e. the products are substitutes or compliments.

The SACA approach has been used successfully in a range of auction settings (spectrum, electricity generation capacity) where many products are sold simultaneously[7]. A simultaneous auction with a spot plus up to five future vintages would not increase the risk of price failure in a SACA format.

Key policy decision: Does the sequential sale of future vintages increase the price risk compared to the simultaneous sale of future vintages?

Selling multiple substitutable products sequentially (auction 1: spot + v1, auction 2: spot + v2 etc.) increases the pricing complexity as bidders effectively see four sequential auctions (of the future vintages) - they have to guess the likely price differential between the future vintages and which auction will provide them with the lowest price. Since the auctions are independent, there is nothing keeping the prices aligned.

If demand for allowances is easily batched, it is preferable (from a price discovery and demand substitution perspective) to auction all the spot plus future vintages simultaneously in each auction and spread the volume for each vintage over the four or twelve auctions.

"However, if demand arrives more as a flow and can't be batched easily then a sequential approach is recommended." ….. Peter Cramton[8]

Key policy decision: Does the timing of payments increase the risk of price failure

If buyers are required to make immediate payment for any future permits that are purchased in a current auction, then the permits become more substitutable and the pricing puzzle becomes more complex.

Any policy decision that makes the goods being sold more substitutable (banking and borrowing) will increase the complexity of the pricing tradeoffs for the bidders.

[5] Ausubel & Cramton (2006)
[6] Cramton (2007a)
[7] See Appendix 1 for more detail
[8] Cramton (2008c)

4.1.3. Unintended bids

Bidders that are unfamiliar with the auction system may become confused and make less than optimal decisions (known as 'dumb bidding'). These kinds of bids pose a similar risk as financially unviable bidders[9], in terms of how their bidding behaviour may influence the overall auction result and the credibility of the auction price signals.

Mitigation strategies to avoid this form of price risk are well understood and include:

1. Thorough bidder preparation, through training etc.
2. Systems checks put in place to require a number of confirmations from the bidder about their intent to submit a new bid. If the bid is outside of a pre-set volume range the bidder will be requested to re-enter the volume for confirmation that their bid is intended e.g. they have not missed a zero.
3. Bidder certification to ensure all bidders are at a minimum skill level.
4. An assurance that bidders understand the seriousness of making a bid i.e. every bid is a legally binding contract to buy.
5. A thorough understanding of the auction rules, including that no bid withdrawals can be allowed, even if the bidder claims it was unintended. The reason is that allowing bid withdrawals opens the system to gaming and other bidders might have already reacted to the unintended bid before it gets withdrawn.
6. Provision of a proxy bidding option, where some bidders (such as bidders requiring only small quantities) are permitted to only use this system[10].
7. Credit limits that act to reduce the likelihood of unintended bids way outside of the normal price range.

4.2. Demand risk

Demand risk relates to design choices and policy decisions that artificially lower demand during the auction, with the flow-on effect of lower prices and possibly grievances from disgruntled bidders. A key objective of any auction system is to maximise participation by qualified bidders.

Demand risk has three separate (but inter-related) dimensions:

1. Bidder boycott,
2. Artificially constrained demand, and
3. Demand shading and collusive behaviour.

4.2.1. Bidder boycott

The risk is that bidders will boycott the auction system which results in significantly lower demand and lower prices during the auction.

Bidder boycotts can manifest in grievances such as:

- "The system was too hard to use and we got confused."
- "The allocation was not transparent, we don't trust the result."

[9] Successful bidders that default on payment.

[10] The UK ETS rules dictate that 'non-competitive bidders' (those buying less than 10 000 permits) must use the proxy bidding option.

- "We could not use the system to express our bid preferences i.e. we were too constrained by the rules."
- "The system did not work in accordance with the rules i.e. there was a processing failure."
- "Other bidders were not bidding in accordance with the rules i.e. other bidders were gaming the system."
- "We were forced to overpay during the auction, because of a perception of artificial competition."
- "We got ourselves stuck in a position due to bad choices that we made earlier in the auction."

Thorough bidder preparation is critical to reducing the likelihood that bidders will boycott the system. Preparation should include:

- Face-to-face training session (with online access for each bidder) before the first auction and ongoing refresher training,
- Several mock auctions before the first auction and a mock auction before each subsequent auction,
- Online training tools,
- Bidding simulation tools that bidders can access at any time to test their bidding strategies and their understanding of how the rules work,
- Bid guidance tools to assist bidders during the auction in interpreting the auction progress and to inform their responses,
- User guides (both print and online video versions),
- Early release of rules for review and comment by the bidders,
- Expert help desk hotline available during the auction.

Key design decision: Which auction type minimises the risk of 'bidder boycott'?

The SBT is a simpler system (in terms of bidder preparation) as only one demand curve needs to be determined before the auction. Most bidders feel comfortable with this approach as they are accustomed to 'one-shot' Sealed Bid Tenders. The usual reaction is that bidders prefer this approach.

The interfaces (screens) used by SBT and SACA are very similar from a technical complexity perspective i.e. the user interface is very similar and very simple to use for both formats. Chapter 6.2 provides some examples of both SBT and SACA user interfaces.

"Anyone that can use a cash machine or a cell phone can bid in one of these auctions (SACA). It is simpler for the bidders because the price discovery reduces the strategic complexity relative to sealed bid."... Peter Cramton[11]

Both systems will be web based, highly secure (password protected and encrypted), highly redundant (securely backed-up) and highly scalable so there are very little differences in the infrastructure required and the build cost of the two systems.

Bidders are likely to resist a dynamic format like SACA not because the system is difficult to use or preparation is more difficult than for sealed bid, but because the bidders feel are unfamiliar with the

[11] Cramton (2008a)

format as such. This is a very important distinction to make and understanding this underlying issue helps to mitigate the risk.

Practical experience shows that preparing for a clock auction is easier for bidders than sealed-bid, because with the clock format bidders only have to form part of their strategy in advance. In the case of SBT the strategy has to be completely worked out in an environment with a great deal of uncertainty.

One effective way to mitigate the risk that some bidders will reject the system because is to have the option of submitting a single demand curve for each vintage in the form of a proxy bid - effectively let them choose to use a SBT format as an input to the SACA. This dual approach then allows bidders, who are comfortable in preparing for a dynamic auction, to take advantage of price discovery and demand substitution to lower their price risk, where as other bidders that feel overwhelmed by the process of preparing for a dynamic auction can simply submit a sealed bid demand curve. The UK carbon permit auctions use this approach[12].

"I think we want to emphasize that for the bidders, the ascending clock strictly dominates the sealed bid approach. This is because any bidder that does not wish to take advantage of the price discovery and participate in multiple rounds, can put in their demand curve in the first round as a proxy bid. This is great for small bidders..."....Peter Cramton[13]

To further reduce the likelihood of bidder rejection due to complexity a product-by-product (vintage-by-vintage) activity rule should be used rather than a total volume activity rule[14]. The drawback of this approach is that it does reduce the demand substitution flexibility for the bidders, and there is a slight increase in the risk that bidders can be exposed as they try and guess how much to demand in early rounds to maximise their switching options in later rounds. This risk is minimal compared to the benefit of preparation simplicity that the simpler activity rule offers.

"An activity rule based on total volume is used for example in the NJ BGS electricity auctions in the US. The auction is held annually and is many billions of US$ each year. The rule does facilitate arbitraging across products, but it also complicates the auction significantly. I think for products that are such strong substitutes, one could use a vintage-by-vintage activity rule. That is, monotonicity of demand[15] must be maintained for each vintage separately. This is a common approach, especially when there is a large premium on simplicity. I think the approach would work well."....Peter Cramton[16]

An additional benefit of a system that features enhanced price discovery opportunities is the transparency that it affords the auction process. A transparent system is more likely to be fully understood by bidders (and other stakeholders) and therefore will attract fewer grievances attributed to the final allocation outcome.

[12] DEFRA (2008)

[13] Cramton (2008a)

[14] A volume rule indicates that any bidder's total volume demanded can only move in one direction, either ascending or descending. When auctioning normal goods (as is the case in the CPRS) using a SACA, as the price moves up, the bidder's volume must move down. The volume rule can either apply to the volume demanded per individual product (product-by-product) or the volume demanded across all products (total).

[15] Monotonicity of demand means that a bidder's demand volume moves only in one direction i.e. either ascending or descending.

[16] Cramton (2008b)

As a final point, the same auction format should be used in each auction (monthly or quarterly). There should be provisions for small tweaks based on bidder feedback between auctions, but major changes should be avoided in the interests of minimising participation costs and bidder anxiety.

Key policy decision: How many future vintages can be offered in a single auction without increasing the likelihood of bidder boycott?

Auction complexity is not a function of the number of products sold simultaneously, but rather the degree to which the products being sold are related i.e. substitutes or compliments.

There are many examples of successful high stakes auctions where the bidders have interacted with a number of products far in excess of what is likely in the carbon market i.e. spot + up to 5 future vintages. Applications have included electricity auctions in France, Belgium, the Netherlands, Brazil, Colombia, and the US, and gas auctions in Germany, France, Denmark, Hungary, and Austria.... [Other] major auctions that use that format [exist in] in New Jersey (the NJ BGS auctions) and New England (the Forward Capacity Auction)"[17].

"I do not see much of an increase in complexity in moving from 4 to 5 year vintages."...Peter Cramton[18]

The Victorian timber auctions typically have 50-100 simultaneous auctions running where bidders receive pricing intelligence across all products and are free to shift demand across the products as they learn from the market. After eight auctions, there has not been a single grievance or boycott related to bidders feeling overwhelmed by the number of products being auctioned at the same time.

4.2.2.Seller constrained demand

Artificial constraints can cause the demand for future vintages to be artificially low, resulting in price differentials with closer vintages that cannot be explained by the intrinsic value of each product.

With banking and borrowing policies in place, the spot and closer vintages are clearly superior products compared to future vintages, as the owner of the permit has much more flexibility as to when to use the permit. That said, there is clearly a price point differential where a rational bidder would prefer to buy a later vintage as it represents better value.

Key policy decision: Should supply of future vintages be reduced to prevent low prices due to constrained demand?

The easiest way to reduce demand risk for future vintages is to simply reduce the supply of future vintages. This has the effect of keeping demand and supply in balance and stabilising prices. The limit to this approach is that it does not address the fundamental issue of keeping prices between spot and future vintages aligned.

Key design decision: Should reserve prices be used to protect against low prices that result from constrained demand for future vintages?

[17] Cramton (2007a) p8
[18] Cramton (2008b)

Reserve prices should be set for all vintages to avoid very low auction price outcomes as a result of weak competition. The reserve price can be set low, but it is the only mechanism the government has to avoid embarrassingly low prices.

Key design decision: Which auction type minimises the risk of artificially constrained demand for future vintages?

A major benefit of SACA with the features of price discovery and iterative demand substitution is that bidders can efficiently switch to vintages that represent better value at various price points during the auction. This iterative process of demand substitution is fundamental to maintaining the alignment of price differences between the vintages.

Demand and competition for future vintages can be increased by allowing demand substitution and price discovery i.e. through the SACA format. As the price for the spot vintage increases due to increased demand, there will be a point where buyers start to substitute away from the spot to future vintages. This will increase demand for future vintages and drive up prices to the point where the underlying price alignment is reached.

Key policy decision: How does the sequential sale of future vintages impact artificially constrained demand, compared with the simultaneous sale of future vintages?

Efficient demand substitution to maintain price alignment between the vintages is only possible if all substitutable vintages are auctioned at the same time and bidders can act freely to substitute demand based on price signals.

The implication of this is that where possible all substitutable vintages should be offered for sale in the same simultaneous auction and the activity rules should be designed to allow switching of demand based on price signals. In addition, bidders should be given regular aggregate demand feedback for each vintage at each clock price point during the auction.

Therefore, if the demand for future vintages is easily batched, then the simultaneous sale of all substitutable future vintages in each simultaneous auction will result in greater demand for the future vintages (and increased prices) compared to selling each future vintage in a separate auction sequentially where efficient substitution is more limited.

Key policy decision: Do deferred payments reduce the risk of artificially low demand for future vintages?

Another way to increase demand for future vintages is to allow deferred payment. This approach can only be considered if credible price signals can be maintained in the auction[19]. This means that if a buyer bids for a future vintage then this is a binding commitment, and a contract to buy at the bid price at a future date will be created automatically at the time of the bid. This contractual obligation is underwritten by the execution of a registered bidder agreement before the auction. The contract should have penalty clauses to dissuade bidders from reneging on the terms of the contract.

Call options and similar variants could also be considered to mitigate this risk.

[19] Credible bids are essential for all vintages, regardless of when payment is due. All bidders are relying on the bids being credible to guide their decisions during the auction.

Another benefit of deferring the payment is that cash constrained bidders can participate in the bidding activity for future vintages, further increasing competition, and reducing the risk of these parties submitting grievances about the auction favouring cash rich companies.

4.2.3. Bidder strategies to reduce demand

Bidders may adopt a certain bidding strategy to artificially reduce demand and affect the auction outcome. Demand reduction[20] occurs in multi-unit auctions, when bidders express artificially low demand early on in the auction to keep the market price down (demand shading).
Similarly, bidders might want to achieve artificially low prices by submitting bids extremely late in the auction, denying other bidders to respond and ultimately reach a "fair" market value.

Key design decision: Which auction type minimises the risk of demand reduction?

Neither demand reduction nor bid sniping are possible in a SBT.

In the case of clock auctions, the risks of demand reduction are well understood and mitigated through activity rules. As an example, rules are designed to ensure that bidders submit an accurate reflection of their demand, while retaining the benefits of flexibility in demand substitution. Bidders can only maintain or reduce demand between multiple rounds. This avoids bid shading where bidders artificially suppress demand in early rounds to keep the prices low.
As to bid sniping, standard SACA design elements such as multiround bidding and aggregate demand disclosure after the end of a round make "last second" bids ineffective. An alternative design feature is the extension of rounds if bids are placed close to the end of a round (VicForests' timber auction has successfully adopted this feature)

4.2.4. Collusive behaviour

Collusion occurs whereby bidders pre-arrange an off-market allocation, to keep demand artificially low. Collusion is most relevant as a risk in markets where few bidders are active, such as in the early FCC spectrum auctions in the USA or the Dutch 3G spectrum auctions. In a market with a volume of bidders as large and a range of bidders as diverse as Australia's CPRS, collusion risk is not as high, as many bidders would need to collude together to successfully exercise any influence over price.

Multi round ascending clock auctions have some disadvantages with regards to collusion relative to an SBT format. Bidders may view the rounds of bidding as a 'negotiation' with other bidders over market division - a form of 'communication' among the bidders about which [products] are most valuable to each of them while, keeping bids artificially low[21].

Once again, the mitigation strategy for collusive behaviour in a SACA format is well understood: "The auctioneer does not reveal individual [demand] curves of the individual bidders, where this detailed information could be used to facilitate a coordinated reduction of demand, instead in all real-world clock auctions the auctioneer reports only end-of-round aggregate demand, and not the individual demands of bidders[22].

[20] "Demand Reduction and Inefficiency in Multi-Unit Auctions," (with Lawrence M. Ausubel) Working Paper, University of Maryland, July 2002.

[21] MDI (2006)

[22] Ausubel & Cramton (2006)

"Collusion and gaming are minimized by the information policy during the clock auction: only reveal the aggregate demand at the end of each round. No individual bids. Have strict rules against communications about bidding strategy with other bidders, and other no collusion rules, which I expect Australia already has".....Peter Cramton[23].

The Victorian timber industry auction design has mitigated the risk of collusion by not providing bidder-specific quantity information. Only the bidder's own next valid bid ('target price') is visible[24]. This is similar in concept to the clock auction – bidders lack information around any split of market share[25]. Only aggregate demand (in terms of excess demand) is communicated after each round.

In concentrated markets[26], if there is concern that revealing aggregate demand after each round will allow individual bidders to determine whether unilateral demand reduction will stop the clock, a number of additional mitigation features should be included:

- Use larger price increments between rounds, and utilise intra-round bidding so as to avoid overshoot of the clearing price (see Appendix 2).
- Limit the share of the total supply that any participant can bid for, lessening the effects of unilateral demand reductions.

Key policy decision: Should volume caps be used to reduce the risk of collusive behaviour?

Volume limits should be set to reduce the market power of one bidder or bidding group (speculators or aggregators). This acts as a disincentive for collusive bidding groups and maximises competitive market activity. This strategy has been used by the FCC spectrum auctions, to explicitly address collusive activity in the early auctions[27].

4.3. Credit risk

Credit risk can be defined as the risk that successful bidders at the auction don't follow through with payment, as per the agreed payment terms.

The impact of payment default is significant in two ways:

- Loss of revenue for the Government (as the seller does not get paid),
- In a dynamic auction format the credibility of the auction result is questioned as defaulting bidders have an impact on every price and therefore other winning or losing bidders that participated in the auction.

Mitigation strategies include:

- Carefully screening all bidders before the auction. This often involves credit checks, pre-auction cash deposits or bank guarantees (see Appendices 1 and 3 for more detail).
- Credit limits in line with the credit checks are then imposed on bidders during the auction to ensure they bid within their means.
- Market price feedback that reduces the likelihood that bidders will pay excessive prices that leads to the increased probability of default.

[23] Cramton (2008a)
[24] MDI(2006)
[25] Ausubel & Cramton (2006)
[26] The Australian CPRS environment is not concentrated - there are many bidders.
[27] Cramton (1997), Cramton (1998)

- Uniform pricing that further reduces the probability that any particular bidder will pay excessive prices that increase the likelihood of default.

Key policy decision: Does deferred payment for future vintages increase credit risk?

Immediate payment for all future vintages is the lowest risk approach as government will know shortly after the auction if they will be paid for the permit or not. If the winning bidder defaults, the government retains ownership of the permit and can sell the same permit in the next auction, therefore having very little impact on the supply of permits to the market and the loss of revenue to the government.

Importantly, the government can take quick action to ban defaulting bidders from future auctions and therefore uphold the credibility of the auction process.

If the payment is deferred to the year that the vintage falls due, then the government is exposed to two risks. Firstly, that they will not get paid but will not know this for a few years. Secondly, that a bidder who will default in the future can keep on buying permits in all subsequent auctions which have a very serious impact on the credibility of the entire auction program.

Deferring the payment must therefore not reduce the credibility of the auction in any way. All bids made during the auction must be legally binding, where a contract is created through the act of bidding and where the contract has serious penalties for defaulting buyers.

Key design decision: Which auction type is most at risk if winning bidders default on payment?

The SACA format has the benefit of reducing price risk through price discovery and demand substitution. A very important assumption is that the price signals are credible - all bidders rely on this in the SACA format. Bidders are using public value information from the iterative auction process in parallel with their own private values to submit informed bids during the auction.

If a bidder responds to bids made by defaulting bidders then they can argue that the price was artificially inflated by 'non-credible bidders' and call the auction results into question. This not only impacts losing bidders that missed out but it impacts the winning bidders as well.
This is a very serious risk, as not only will the auction results be void but there is a very high likelihood that bidders will lose faith in the auction system altogether.

In the sealed bid format, the distortion of a defaulting bidder is fundamentally the same: the defaulting bidder causes a higher clearing price, which all winners are asked to pay.

The mitigation strategy to reduce credit risk in both formats is to ensure that all bids are credible and that all invited bidders are carefully screened for credit risk. In practice, the risk is reduced considerably by using the following approaches:

UK carbon permit auctions[28]

- Single pre-registration stage
- Request full financial advance payment for non-competitive bids[29].

FCC Spectrum[30]

[28] DEFRA (2008)

[29] Bids of less than 10,000 permits. The payment is calculated, based on the secondary market price.

[30] Cramton (1997)

- An upfront payment, due two weeks before the auction begins, defines the bidder's maximum eligibility in any round of bidding.
- Each bidder must make an upfront payment of $.02 per MHz-pop for the largest combination of licenses the bidder intends to be active on in any round.

Victorian timber auctions[31]

- Independent credit check, that informs imposed credit limits.
- Bank guarantees

Virginia NOx allowance auction[32]

- All bidders had to demonstrate credit-worthiness
- Bond ratings, escrow accounts or letters of credit
- Bids limited to credit amounts

4.4. Systems risk

This is the risk that auction participation is reduced artificially, because the bidders have troubles using or accessing the system. Grievances may occur as a result of system failure.

Failure can be minor where:

- An individual bidder has minor technical issues (such as incorrect login details), or
- The system has minor logic faults that the bidders can work around.
- (Some) bidders find the system too complex to operate.

Failure can be catastrophic where the entire auction stops due to fundamental technical flaws, such as server failure during the auction.

Mitigation strategies for systems risk are well understood and work well in practice. These include:

- Hotline/helpdesk teams on hand (before and during the auction) to assist with minor technical issues (such as incorrect login details) for individual bidders. . Helpdesk teams can also run pre-auction checks with individual bidders to ensure they have adequate connectivity and software requirements.

- Bidding support tools to reduce the likelihood that bidders will feel overwhelmed during the auction. These tools can be used to simplify decisions by pre-loading bidding strategies and allowing the system to analyse the status of the auction and providing simplified reports that bidders can use to make decisions.

- Thorough testing to ensure logic processing issues are mitigated. This can be done by ensuring that the logic of the auction rules is fully captured in the code. Stress testing is also carried out to ensure the system can handle the traffic and computational load during the auction.
  Additional tests are designed to simulate a range of auction scenarios to verify system functionality. These tests are designed to verify that the logic of the process is consistent with Auction Rules in a real time environment (such as 1,000 bidders).

[31] For a detailed outline of the process undertaken in the Victorian timber auctions process, please see Appendix 2.

[32] Shobe et al (2004), Shobe (2006)

- Running parallel dual redundant (securely backed-up) mirrored servers in geographically separated server facilities to mitigate server failure. All auction data is saved on manual backup disks between rounds to minimise roll back to the last round in the worst case situation.

- Providing longer rounds and pause periods between rounds (in the case of multi-round auctions) in the initial auction can reduce bidder anxiety. Once bidders are familiar with the auction process, rounds and pause periods can be shortened.

- Providing a proxy bidding option to reduce the impact of any individual system failure (such as internet disconnection during the auction). In the case of internet disconnection, bids can be placed over the phone by an authorised agent.

Key design decision: Which auction type has the greatest systems risk?

Both the SACA and the SBT systems will be built on highly redundant (securely backed –up), highly scalable, secure (128 bit encryption) web based platforms. The platforms will be built on industry strength hardware and software applications and the implementation costs for both systems will be very similar.

A dynamic auction system where many bidders are interacting intensively with the auction platform over a short period of time (SACA) does have a higher probability of failing compared to a static system where bidders take their time to submit a single demand curve (SBT) over an extended period. With a dynamic system bidders are relying on an active interface to provide ongoing market pricing intelligence so the system availability during certain times is critical in order to create an efficient market.

The mitigation strategies to reduce systems risk for dynamic auctions are very well understood and work well in practice. If mitigation strategies are implemented, the probability of failure between the two auction formats due to systems risk is minimal.

Key policy decision: Does the frequency of running the auctions impact systems risk?

Generally, the more frequently the auctions are run, the greater the likelihood that one of the auctions will have a system failure. However, if the mitigation strategies are used for every auction the increase in probability of a system failure is minor. In other words, the same level of care and preparation is required for weekly auctions as for quarterly auctions.

Summary

This chapter has analysed how the various policy decisions and auction design choices impact the implementation risk to the government. A summary of the implementation risk analysis is as follows:

1. Pricing risk and demand risk are the most difficult to mitigate and therefore are the most likely to cause implementation failures. On the other hand, credit risk and systems risk can cause catastrophic failure but the mitigation strategies are well understood and are tried and tested in practice.

2. Pricing complexity is a more important risk issue than system usability complexity when multiple substitutable products are sold at the same time. An auction system can be very

easy to *use* (and the skills can be easily trained), but knowing *what bid to make* (solving your 'pricing complexity puzzle') is much more difficult.

3. If the products have characteristics that make them either substitutes or compliments then, where possible, they should be sold at the same time (simultaneously) to reduce the pricing complexity for the bidders.

4. Policy decisions (such as banking and borrowing rules or payment terms) do impact on the degree of substitutability of the products.

5. The number of products being sold does not increase pricing complexity; instead the pricing relationship (substitutability) between the products increases the complexity.

6. When selling multiple substitutable products simultaneously, the auction system should allow iterative price discovery (of aggregate demand) and efficient demand substitution. The SACA (see Appendix 2) offers these features.

7. The major benefit of selling multiple substitutable products using a SACA format is that the individual 'pricing puzzle' is much less complex - bidders use market pricing to guide their bidding behaviour during the auction. A secondary benefit of SACA is that efficient demand substitution will ensure the price differential between the most desirable products (spot and early vintages) and the least desirable products (later vintages) will be in line with the intrinsic values i.e. post auction arbitrage opportunities are minimised.

8. Credit risk is a serious issue for both, SACA and SBT. Every submitted bid (whether in a SACA or SBT) must be credible, and the government must ensure all bidders are thoroughly credit checked and certified.

9. Initially, bidders will be anxious about being involved in a clock auction because of the complexity in preparing for an environment where they have to bid (and counter-bid) many time based on market feedback. It is much simpler to prepare for a static SBT and so there is less anxiety. Thorough bidder preparation should focus not just on helping bidders understand how to use the system, but much more importantly how to prepare to bid in the system.

10. Deferring payment for later vintages will make these products more desirable and result in increased demand and higher prices. The trade-off is an increase in credit risk which can be mitigated by not transferring ownership until the permit is paid for. So the product being auctioned is a legally binding contract to buy a permit at an (indexed) bid price at an agreed date. Other options that should be investigated include a hybrid approach where a call option or margin call arrangement allows payment to be deferred, but reduces the likelihood of payment default.

11. The frequency of the auctions should be based on the market preference, as there are very low marginal costs associated with running additional web based auctions once the platform is in place.

5. Recommendations

The Department of Climate Change (DCC) commissioned Tradeslot Pty Ltd (Tradeslot) to provide a series of recommendations for the design elements best suited to Australia's Carbon Pollution Reduction Scheme. These recommendations have emerged from the analysis of major design options in the previous chapters and have focused on the questions surrounding:

- Auction Type
- Advance auctioning of future vintages
- Auction timing and frequency
- Timing of payments and permits.

Overall, the analysis in this report shows that when selling multiple substitutable products, the **SACA format that includes a proxy bidding option and a simple activity rule** is the lowest risk option.

As acknowledged in earlier chapters, various policy settings will result in alternative recommendations. The most likely policy setting alternatives (and the alternative recommendations) are outlined below and summarised in Table 1.

Advance auction of future vintages

This is *the key policy decision* that will influence two key design decisions – **auction type** and the **timing of payments and permits**.

Policy setting: Offer single, current year (spot) vintage only in each auction

Design response: online Sealed Bid tender

The Regional Greenhouse Gas Initiative (RGGI) chose a single-round, uniform-price, sealed-bid auction format for their first carbon permit auction. RGGI chose this auction design for its simplicity in the initial stages of the scheme's operation[33] . In RGGI's September 2008 auction, the carbon permit clearing was US$3.07 and the reserve price was US$1.87.

However, expert advice given to RGGI has outlined the benefits of the SACA auction design[34] mechanism and RGGI have publically stated that 'flexibility will be retained to transition to a multiple-round, ascending-price auction format if necessary to address evolving market conditions'.

Policy setting: Offer current year (spot) vintage + 1 future vintage in each auction.

Design response 1 (preferred): online Simultaneous Ascending Clock Auction format with single clock.

The single clock allows bidder to submit just one demand curve, with a *dynamic* bidder driven price translation mechanism. The benefits of the dynamic auction format are retained, e.g. price discovery information and the ability to respond through demand substitution.

This design mechanism and its function are outlined fully in Appendix 2.

[33] The first auction was conducted in September 2008 in preparation for compliance obligations coming into effect in 2009.

[34] Cramton (2007a)

Design response 2: online modified Sealed Bid Tender with bidder driven price translation mechanism.

This SBT format requires bidders to submit just one demand curve, with a *static* bidder driven price translation mechanism. The benefits of the static auction format are retained, e.g. simplicity of bid preparation and submission.

Policy setting: Offer current year (spot) vintage + more than 1 future vintage.

Design response: online Simultaneous Ascending Clock Auction format, which includes a proxy bidding option, a simple activity rule and intra-round bidding. The recommended features of this system outlined in greater detail below include:

- An online system
- Uniform pricing
- Simultaneous Ascending Clock (SACA)
- Simple activity rule
- Proxy bidding option
- Intra-round bidding
- Stringent pre-auction 'bidder qualification' process (including credit checks).
  - Deposits
  - Bank guarantees
  - Rigorous credit checks (and imposed credit limits)

Online, uniform price, Simultaneous Ascending Clock Auction (SACA) format.
SACA formats (or their counterparts, simultaneous *descending* clock auctions[35]) are extensively used in high-stake market environments. 'Standard'[36] design features include an online system with uniform pricing and stringent pre-auction 'bidder qualification' process (including credit checks).

SACA formats have been used, for example, by the

- **US Federal Communications Communication (FCC)** to auction radio spectrum licenses since 1994. One 2008 **FCC auction** was valued at nearly US$20 bill of spectrum[37].
- Highly publicised and successful **3G spectrum license auctions** in the UK[38].
- **Department of Environmental Quality (DEQ)** in the **US state of Virginia** when auctioning **NOx allowance allocations**[39]**.**
- **EDF group** in France to auction **electricity generation capacity** on a quarterly basis[40].

[35] Simultaneous Descending Clock Auctions (SDCA) are used when procuring goods – the price starts high and ticks down. The bidders bid the quantity they will supply (rather than buy) and each price.
[36] 'Standard' in this context means auction best practice for goods of the nature offered under the CPRS (divisible and homogenous). A formal industry standard for auctions does not exist.
[37] FCC (2008)

[38] Other 3G spectrum auctions across Europe used a SACA format, with disastrous results. The best known example is the Dutch 3G auction (see Appendix x). The result was due to fundamental auction design flaws, where auction designers did not take market structure details (such as the number of bidders vs. products) in account. It is highly unlikely that a SACA could result in the same outcomes in a CPRS environment – a SACA is wells suited to the CRPS market structure of many products and sellers.
[39] In fact, the Virginia DEQ elected to use a SACA for its relative *simplicity* over other auction mechanisms it was considering (combinatorial packages).
[40] EDF (2006)

- **New Jersey (USA) Basic Generation Service (BGS) electricity supply** auctions. The group of NJ Electric Distribution Companies have procured electricity supply on a quarterly basis since 2002 using a descending clock auctions[41].

In terms of **carbon permit auctions**, the **UK government** used a 'descending price clock auction' to auction 'competitive'[42] bids. While the auction is structured somewhat differently (see Appendix 1), the features of the dynamic clock auction (the same as a SACA) are at the heart of its design.

Proxy bidding option

Additionally, the **UK ETS** offers a 'proxy bidding' option, as recommended for the CPRS. The UK permit auction recognises that some bidders may prefer a SBT format, where they can submit a simple, single demand curve, rather than bid competitively in a SACA. These 'non-competitive' bids are allowable, but have specific restrictions placed on them, such as a volume cap (10 000 permits per 'non competitive' bidder) and allocation constraints (a maximum of 30% of supply allocated through non-competitive bids). This provides the simplicity of a SBT format, while maintaining competitive bidding behaviour in the auction. This is the key objective of the 'proxy bidding' option suggested here for a CPRS SACA.

Simple activity rule

An activity rule requires bidders to bid a certain amount of their (pre-defined) capacity to maintain their bidding validity – this mitigates 'demand shading'. The **FCC spectrum auctions** have been studied for nearly 15 years and so bidding behaviour and structure are well understood and auction rules are highly developed. One key rule, implemented to control gaming behaviour, is the activity rule. Activity rules can be relatively complex as per the **FCC spectrum auctions** or **UK 3G spectrum auctions** (see Appendix 1) or far simpler as per the **Victorian timber auctions**.

Intra-round bidding

A clock auction may contain a feature known as intra-round bidding - the ability to express a demand curve for all prices between the start of round price and the end of round price.

While the features of the intra round bidding mechanism are well explained by Peter Cramton in Cramton (2007), its main features are that it

- Allows a better expression of bidder preferences, without requiring too many rounds,
- Improves auction efficiency,
- Allows the auctioneer to better manage the pace of the auction and
- Reduces the incidence of tied bids[43].

Intra round bids are used in New England's forward capacity auction and most other clock auctions in practice[44].

Pre-auction 'bidder qualification' process

Stringent pre-auction 'bidder qualification' processes are standard practice and a key accountability measure to mitigate credit, price and demand risk and enhance auction transparency features. Every auction investigated had a process in place that was customised to its own market and auction rules. All processes required credit to be guaranteed and some (including the **FCC, Victorian timber**

[41] Cramton (2007a), Gabel (2006)

[42] The UK ETS auction system makes a distinction between 'competitive' and 'non-competitive' bidders based on quantity requirements. See Appendix 1 for more detail.

[43] Cramton (2007a). Additional explanation of intra-round bidding can be found in Appendix 2.

[44] Cramton (2007a)

auctions and **Virginian NOx allowance**) used this information to impose financial limits on maximum bids as a result of credit ceilings. The **UK 3G spectrum auctions** had a standard bidder pre-auction deposit (£50m), with an additional amount required if bidders indicated a higher bidding capacity (a further £50m for bid intentions over £400m). The **FCC** also requires a pre-auction payment to ensure the bidder is serious.

The detail of the 'bidder qualification' processes (including the most appropriate combination of deposits vs. bank guarantees) should be considered further in a separate study.

Sequence of sale
An alternative approach to auctioning future vintages simultaneously has been discussed – the selling of substitutable vintages sequentially (auction 1: spot + v1, auction 2: spot + v2, etc.). The sequential sales of these products may increase price risk, as it becomes a more complex pricing problem for the bidders to solve. The sequential approach should be considered where there is a strong bidder preference for this approach.

Timing of payment and permits

If only the current year (spot) vintage is offered in each auction, immediate payment is the most obvious payment method. Alternative recommendations become relevant when future vintages are auctioned.

Policy setting: Immediate payment

Design response: When immediate payment is the preferred approach, demand for future vintages may be significantly reduced. The mitigation strategies may include

- *Simultaneous auctioning to ensure substitutability of all products to assure prices are aligned through demand substitution and price discovery*
- *The setting of reserve prices*

Further to this, a related policy choice may be to restrict the supply of future vintages that are sold early.

The **RGGI** requires financial settlement to take place immediately after bidders are notified of the auction results – note that the RGGI currently offers only spot vintages.

The **UK 3G spectrum auction** offered both an immediate and deferred payment option (with a fixed interest rate). However, the immediate payment option was taken by most successful bidders.

Policy setting: Deferred payment

Design response: There is no impact on the design of the auction mechanism.

It is clear that by deferring payments, future vintages become more desirable (which should support the prices). The obvious trade-off is that credit risk increases for the Government. There are two proven mitigation strategies.

- Successful bidders in the **Victorian timber auctions** pay for goods upon harvest and delivery of the vintage at an indexed price[45]. For more detail see Appendix 3.
- The **FCC** initially allowed instalment payments, with little success. For the last 10 years, the FCC has required full payment in advance of license award[46].

Another proposal, along the lines of a 'margin call' mechanism (similar to that used by the Australian Securities Exchange), has been suggested to minimise risk of payment default (and Government credit risk).

A deposit would be required from bidders, based on the differential between the agreed deferred price and the market floating price of the same vintage. This would need to be 'topped-up' if market movements resulted in the market price falling below the agreed forward price.

Similar to other forms of "deferred payment" this option places the Government in the role of financial service provider which is likely to be administratively complex and requires careful planning and execution. If the Government chose to provide risk management services of this kind, a separate study on feasibility and costs vs. benefits would be recommended.

In weighing up the substantial and complex demand risk with the more manageable increase in credit risk we recommend to allow a well managed deferral of payments, together with a deferral of transfer of ownership and the introduction of penalties on non-fulfilment.

Auction timing and frequency

Policy setting: Monthly auctions

Design response: If selling multiple substitutable products, a SACA with intra-round bidding is recommended as a faster alternative to a standard SACA.

Policy settings should be informed by consultation with stakeholders, specifically (but not limited to) potential auction participants. Please see Appendix 1 for detail around the frequency of auctions in different market contexts.

Policy setting: Quarterly auctions

Design response: There are no specific design recommendations.

As mentioned above, policy settings should be informed by consultation with stakeholders, specifically (but not limited to) potential auction participants. Please see Appendix 1 for detail around the frequency of auctions in different market contexts.

Other key recommendations applicable to all policy settings

Recommendation: Invest in a rigorous auction bidder support program, before, during and after each auction event.

[45] As the products being auctioned are physical (sawlogs) and subject to external factors (such as bushfire or other supply constraints), supply of future vintages cannot be guaranteed at the time of the auction.

[46] Cramton (2007c)

This may include (but is not limited to)

- Bidder training sessions
- Mock auctions
- Online training
- Telephone helpdesk support
- Bid guidance/preparation tools

Pre-auction bidder *support programs* are standard practice and a key measure to mitigate demand and systems risk. Every auction investigated had a process in place, which was customised to its own system and auction rules.

All programs included pre-auction training opportunities (whether through a webinar, face-to-face classroom training or other), however further details were available only for the **Victorian timber auctions**, which have been reviewed by Peter Cramton and team as 'well executed'[47]. The process includes:

- Pre-auction face-to-face bidder training sessions (at a variety of locations across the bidder geography)
- Support documentation and manuals (and a dedicated website for up-to-date documents)
- Mock auctions (7-14 days before the 'live' auction)
- Telephone helpdesk support (during the auction)

Recommendation: Apply volume caps.

To avoid demand monopolisation by any one bidder and promote competition, a volume cap marginally higher than the market share of the largest liable party's total permit liabilities seems adequate. It has been indicted by the DCC that in the case of the CPRS a volume cap could be set at 5% of total supply.

Volume caps have been applied across a range of auction environments:

- The **RGGI** market enforces a volume cap of equivalent to 25% of the allowances offered for sale in any single auction by a single entity[48].
- The **UK spectrum auction** (as well as other spectrum auctions) placed a limit of one license on each company.
- The **Victorian timber auctions** have the capacity to impose volume limits, should any bidder's size threaten to dominate market share and stifle competition. To date, this design feature has not been activated.

Recommendation: Engage auctions system provider early to

- *Design and test the optimal auction system*
- *Assist in the integration of the bidder qualification process into the system (where appropriate)*

[47] MDI (2006)
[48] RGGI, Inc (2008)

- *Assist in the development of the training program to provide the relevant knowledge and skills to suction participants (both in terms of systems usage and bidding strategy)*

It is advised to engage the auction system provider a minimum of six months before the first auction.

However, this process should be started even earlier if the DCC aims to consult auction participants in the design of the auction through such means as focus groups, simulations and mock auctions.

5.1. Table 1: Summary of Tradeslot's recommendations for the auction design of Australia's CPRS.

Objective	Policy setting	Key Recommendation	Features	Practical example
Advance auction of future vintages	Single, current year (spot) vintage only in each auction	Online Sealed Bid Tender (SBT)	Simple system	RGGI carbon permit auction
	Offer current year vintage (spot) + 1 future vintage in each auction	Online Simultaneous Ascending Clock Auction (SACA) with single clock or Modified SBT	Simple system High degree of substitutability across vintages offered.	
	Offer current year vintage (spot) + more than 1 future vintage	Online uniform price Simultaneous Ascending Clock Auctions format, which includes proxy bidding option simple activity rule intra-round bidding In addition – stringent pre-auction 'bidder qualification' process (including credit checks) required.	Excellent price discovery properties Highest degree of substitutability across vintages. Maximum opportunity for business planning certainty, through price certainty. Once experienced, bidder preferred.	FCC spectrum auctions UK 3G spectrum auctions Virginia NOx allowance auction Victorian timber allocation auction[49] Electricity Generation Capacity auctions (many markets in Europe and USA) UK carbon permit auction[50]
Auction timing and frequency	Monthly or Quarterly auctions.	Either option is suitable. Both monthly or quarterly auctions will satisfy the features listed from an auction design perspective, so this decision should be based on bidder preference, as determined through consultation.	Maximise participation Smooth pricing signals Provides adequate opportunity for an efficient outcome, without market overkill.	Auction frequency is highly contextual to the products on offer. See Appendix 1 for more detail.
Timing of payments for permits	Immediate payment	Simultaneous auction to ensure substitutability of all products. Ability to set reserve prices. Related policy choice: Restrict the supply of future vintages that are sold early. *Note: the objective here is to mitigate constrained demand for future vintages.*	High substitutability reduces demand risk for future vintages. Ability to set reserve prices can mitigate price risk resulting from insufficient demand. Restricted supply of future vintages reduces price risk and maintains a more credible market price signal.	RGGI Carbon permit auctions FCC spectrum auctions UK 3G spectrum auctions (although deferred payment option was offered, most bidders paid immediately)

[49] While not a clock auction, this is a dynamic, simultaneous, multi-round auction the offers many lots (vintages) and is comparable in terms of key features with a SACA.

[50] While this is a clock auction, the auction design was slightly different in that it was a descending clock auction. See Appendix 1 for detail.

	Deferred payments	Allow a well managed deferral of payments, together with a deferral of transfer of ownership and the introduction of penalties on non-fulfilment		Victorian timber allocation auction French electricity generation capacity auctions.
Further recommendations	All policy settings	Invest in rigorous pre-auction preparation, such as bidder training sessions, mock auctions, online training, bid guidance / preparation tools, and telephone help desk support	Minimise bidder confusion Minimise uninformed bidder behaviour (that may result in undesirable bidding outcomes) Minimise grounds for grievances and/or future auction boycotts.	This is standard practise. All examples provided training and support programs for auction participants.
		Apply volume caps (such as 5% of total permits) to one bidder	Avoid negative impact of speculators and monopoly buyers	FCC spectrum (limited by regulation) UK carbon permit auction (non-competitive element) Victorian timber auctions (function to limit market through volume available, but seldom used). Dutch 3G spectrum auctions
		Engage auction system provider early	Minimise overall implementation risk Create ability to use real system during consultation process with potential auction participants.	

6. From design to practice

This chapter provides a range of suggestions beyond the core auction recommendations. It is informed by

- The report findings
- Discussions with various DCC team members; and
- Tradeslot's experience in moving from auction "design to practise".

6.1. Feedback from stakeholders on policy settings

As described in the main body of the report, some elements of the auction design are driven by trade-off derived preferences, where a clear-cut decision has not been obvious. Where this is the case (and the design questions have little impacts in the implementation risk, allocative efficiency or transparency) Tradeslot recommends consulting stakeholders directly. This has the added benefit of generating higher levels of acceptance and value among auction participants.

Questions that could be put to potential auction participants could include:

- How strongly do you value the availability of future vintages and how many vintages would be ideal?
- What is your preference in terms of auction frequency (between weekly and annually) and why?
- Depending on the above: When would you prefer to participate in an auction (in terms of days/of the week, month of the year, particular times of the day/month/quarter)?

6.2. Feedback from stakeholders on auction platform usability

As part of this report, the Tradeslot team has conducted a small field study to compare the usability between a SACA screen and that of a SBT. The feedback has been inconclusive in that no one option was favoured consistently. We would suggest to the Department to run this usability simulation with actual liable parties and to capture the feedback in structured interviews. This activity could be run on a "paper model" or an actual simulation allowing participants to experience the usability of a SACA (including variations) and the SBT.

Some examples from actual screens used in the field study:

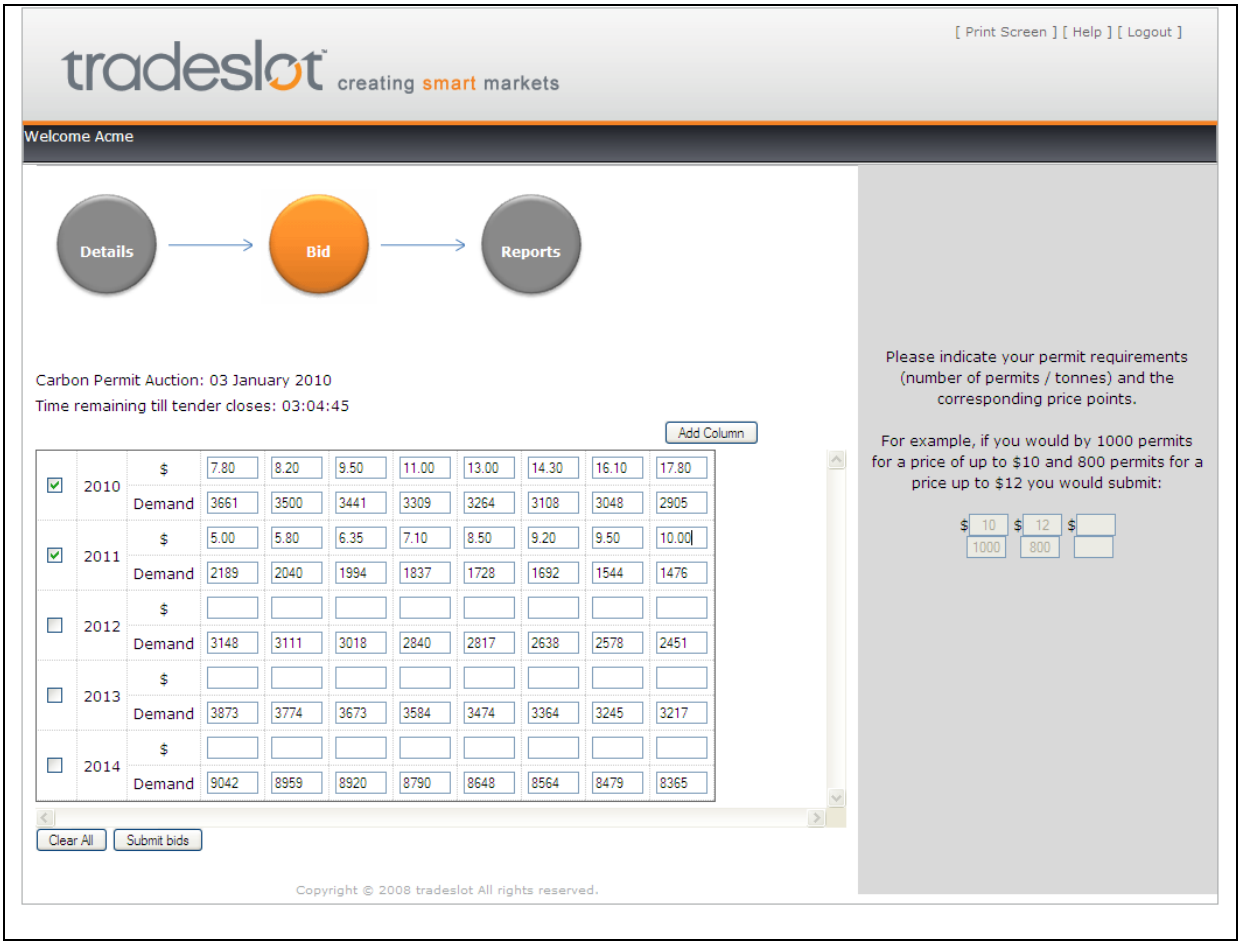

Figure 2 - Sealed Bid Tender, Bid submission

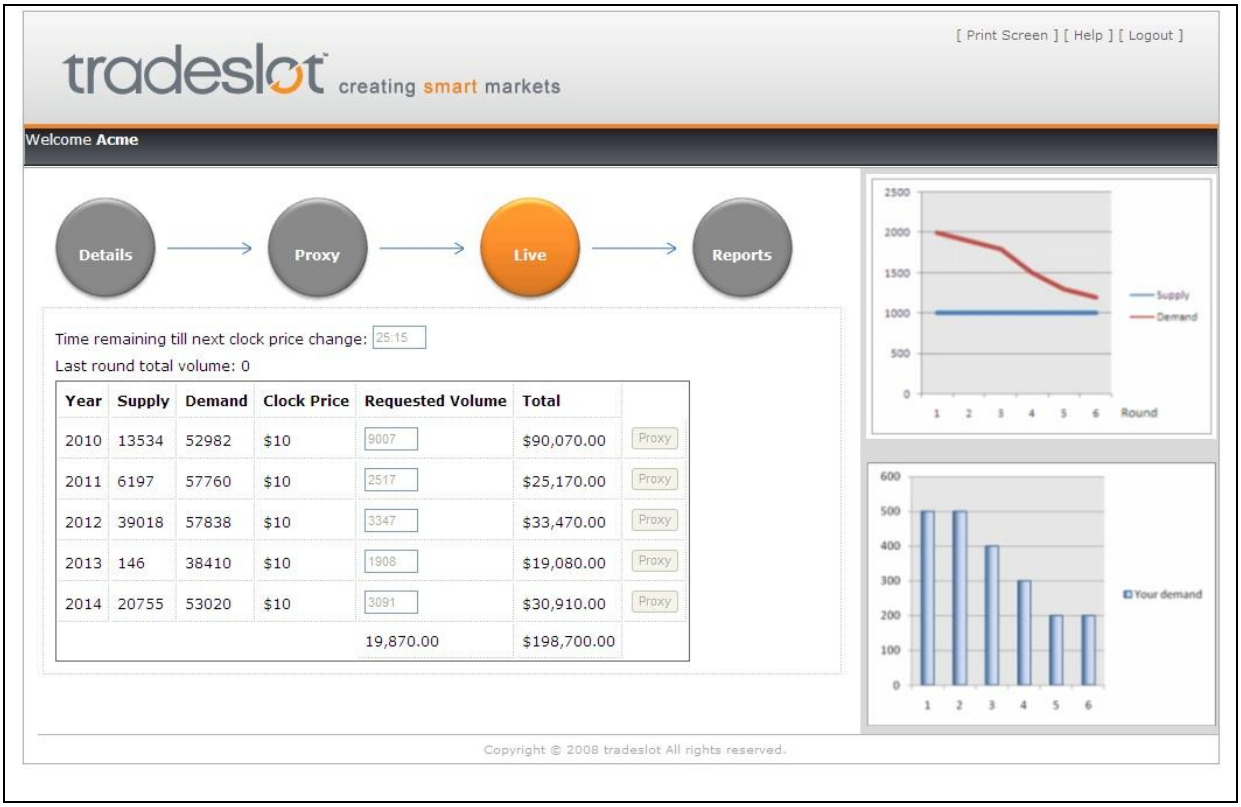

Figure 3 – Simultaneous Ascending Clock Auction, Live bidding

Figure 4 - Simultaneous Ascending Clock Auction, Proxy bidding

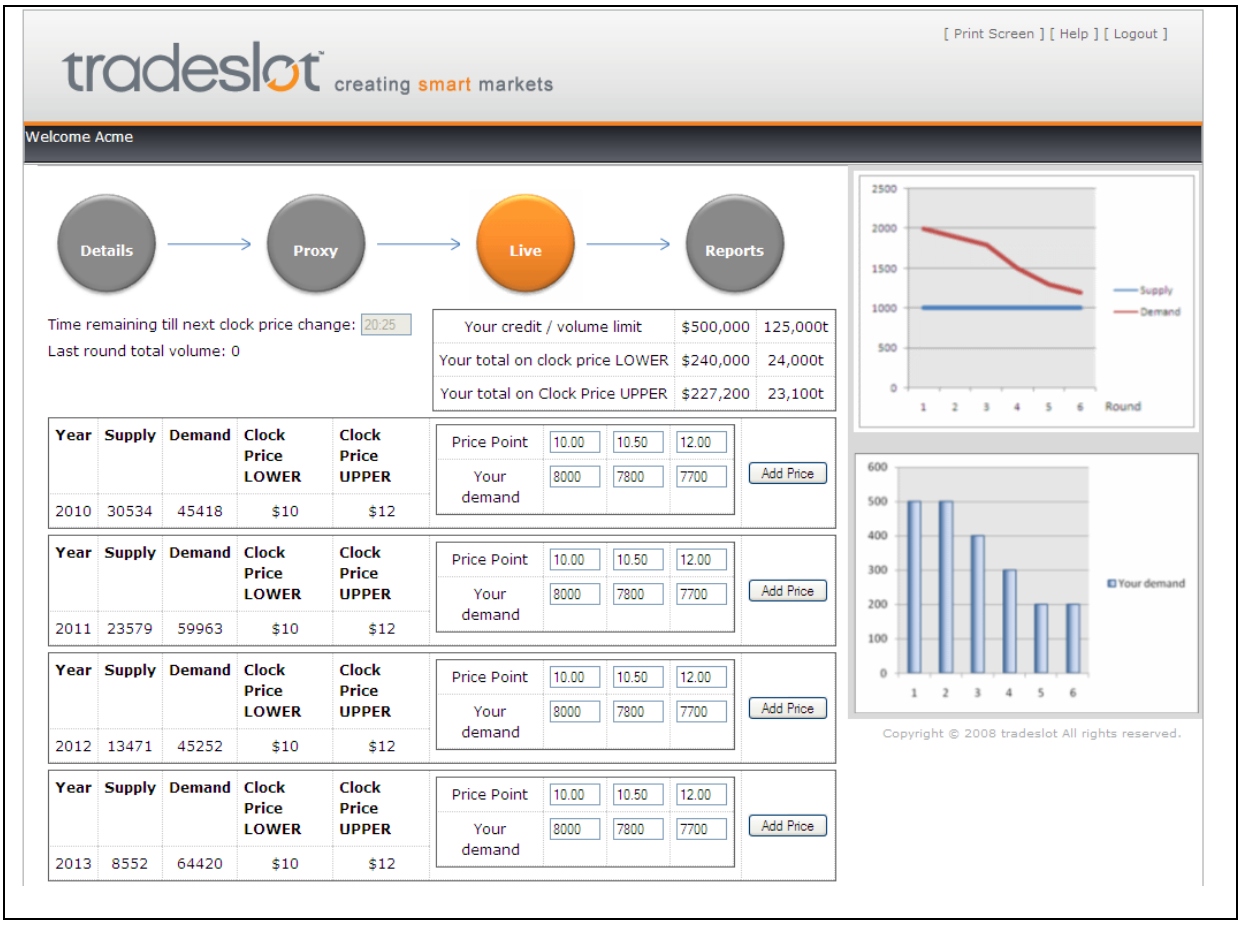

Figure 5 - Simultaneous Ascending Clock Auction, Intra-round bidding

6.3. Early tender for auction platform provider

Being able to involve the provider of the actual auction platform early will greatly benefit the Department. The platform provider can be integrated in the consultation process following the White Paper and comment / respond to previously unknown policy options and their impact on auction design, functionality and usability. The platform provider should also be able to:

- Set-up a simulation system (including mock auctions and bid simulators - see below)
- Assist in the development of System User Documentation
- Assist in the development of Auction Rules.

6.4. Rules and policy documentation

In our experience, the importance and effort of creating detailed policy documents outlining the rules and processes around the auction cannot be overestimated. As soon as the Department has decided on the main policy and design aspects of the auction, we recommend starting the development process for auction rules and policies. Having a level of detail available early in the implementation phase will address and solve many stakeholder questions and concerns. The quality of the documentation will be a main determinant how the Department will be able to avert or quickly resolve grievances. Tradeslot can offer contacts within VicForests to obtain firsthand accounts on the development of rules and policy documentation, as through their experience with the Victorian timber auctions.

6.5. Communication and training

Alongside the documentation of auction rules and policies the Department is advised to develop a comprehensive communications plan, for both bidders and wiser stakeholders. A standard stakeholder communication process should be undertaken that includes questions such as

- Which stakeholders to include (direct and indirect),
- The key messages to communicate,
- The most appropriate communication channels to use (web, print, face-to-face...),
- When and how often to communicate and
- How to best measure the success of the communication.

Potential auction participants (especially liable parties) will rightly expect a level of induction or training in preparation of the auction events. Key items to consider include:

- Training content,
- Certification options,
- Train-the-trainer requirements,
- The role of third-party organisations to conduct training (and the assurance of third party quality), and
- Appropriate training media (online learning, print, classroom).

6.6. Mock auctions

Related to the training approach is the availability of mock auctions prior to live events. As discussed with Peter Cramton via telephone, it is good practice to run these mock auctions not only in preparation to the first event but as a regular offer for bidders. Tradeslot strongly agrees with this recommendation and runs mock auctions prior to any timber auction for the Victorian Government.

6.7. Bid simulator

Bid simulators are online simulators allowing potential auction participants to enter data into a simulated auction and experience how the auction unfolds. As opposed to mock auctions the bid simulator runs automatically on the web any time and usually without access restrictions.

6.8. Decision support tools

Liable parties will need to be prepared not just in terms of system skills, but also with their own specific financial and economic knowledge (such as demand curves) in order to participate successfully in the carbon permit auctions. The private sector is beginning to explore this field and decision support tools, such as software, are increasingly becoming available. The Department could investigate whether any of the available decision support tools could be customised to a CPRS context and offered at a Government subsidised rate to future auction participants.

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Appendix 1: Summary of international auction experiences

	RGGI Carbon Permit	**UK carbon permit**	**FCC Spectrum**	**UK 3G spectrum**	**Dutch 3G spectrum**	**Virginia NOx allowance allocation auctions**	**Victorian Timber auctions**	**Electricity Generation Capacity (France)**	**New Jersey electricity procurement auctions**
Year of auction	2008	March 2002	July 1994 – present	6 Mar - 27 April 2000	July 6 - July 24, 2000	June 30, 2004	Since 2006 (Aug 08 auction used as the example)	Sept 2001 - present	Since 2002
Administrating body	Regional Greenhouse Gas Initiative (RGGI)	UK Dept Environment, Food and Regional Affairs (DEFRA)	US Federal Communications Commissions (FCC)	Radiocommunications Agency	Dutch government	Virginia's Department of Environmental Quality (DEQ)	VicForests	Electricité De France (EDF)	New Jersey Electric Distribution Companies
Product being auctioned	Carbon market permits (1 tonne = 1 permit, lot size 1000 permits)	Carbon market permits	Telecommunications licenses across radio spectrum (1st broadband auction used as example)	3G spectrum	3G spectrum	NOx emissions allowance permits	Timber supply allocation	Options contracts replicating the output of the power plants - this is known as 'virtual power plants' (VPPs). 4,400 MW of base-load VPP and 1,000 MW of peak-load VPP.	Electricity generation capacity (approx. 100 units or 'tranches' in each auction).
Auction format used	Single-round, uniform-price, sealed-bid auction format. Flexibility will be retained to transition to a multiple-round, ascending-price auction format if necessary to address evolving market conditions.	Competitive element - descending price clock auction, (aka 'reverse auction') [51] Non-competitive element - static, uniform price auction.	Simultaneous, multiple-round auctions in which collections of licenses are auctioned simultaneously.	Multi-round, ascending price auction	Simultaneous, multi-round ascending auction	Sequential English clock auction (SACA)[52].	Dynamic, multi-round, simultaneous auction	Simultaneous, multi-round, ascending price clock auctions.	Simultaneous, descending clock auction

[51] The UK govt bought back £215m of incentive payments
• the 'auctioneer' proposed a price/ tonne CO2e (£100)
• each bidder will indicate how many tonnes CO2e it will take as a target reduction (on the basis of receiving that price for each tonne reduced)
• bids will be aggregated and multiplied by the proposed price
• this interplay of 'price proposal' and 'bidding' will continue until the aggregate of 'bids times price' is equal to or less than £215m. At this point the targets taken (and price) will be known.

[52] DEQ initially selected a combinatorial clock design, but the complexity of implementation proved prohibitive in the available timeframe, and ultimately a sequential clock was implemented instead.

	RGGI Carbon Permit	UK carbon permit	FCC Spectrum	UK 3G spectrum	Dutch 3G spectrum	Virginia NOx allowance allocation auctions	Victorian Timber auctions	Electricity Generation Capacity (France)	New Jersey electricity procurement auctions
Frequency of auctions	Quarterly	Quarterly	As per license period for various spectrum products, however the FCC has conducted auctions at least annually since 1994.	one-off	one-off		Annually (with additional 'spot' auctions as required)	Quarterly	Annually (each Feb)
Number of bidders (and number of winning bidders)	59 separate entities submitting bids	38 (34)	29 (6)	13 (5)	6 (5)	2004 vintage - 18 (10) 2005 vintage - 16 (5)	16 (13)	30-45 (~20)	4 (4)
Value of the auction	Revenue US$38. 56 mill (Clearing price of US$3.07/permit)	Auction price - £53.37 per tonne of CO2	>US$7b (~US$7.7b)	£22.47 b	less than €3bill (expected outcome €10bill).		AU $121m revenue	~ €300 mil	
Activity rule used	SBT - not required		As the auction progresses, the required activity increases in 3 stages. [53]	(1) The firms could place a bid on one of the parcels that was at least 5% higher than the current bid (2) The firms could use one of their three waivers and not have to perform an action; however, once a firm exhausted its three waivers, it could no longer use this option; or (3) The firms could withdraw from the auction completely which was a final	Identical to UK 3G spectrum		Bidders must bid on a lot to be eligible to bid on it in the next round.		

[53] In the initial stage each bidder must be active on at least one-third of its current eligibility. Activity is measured as the sum of the MHz-pops on which the bidder submitted a valid bid or was the high bidder. If activity falls below the one-third level, then the bidder's current eligibility is reduced to three times its current activity.
In stage 2, a bidder must be active on at least two-thirds of its current eligibility.
In stage 3 of the auction, a bidder must be active on 100 percent of its current eligibility. If its activity falls below 100 percent, the bidder's current eligibility is reduced to its current activity.

	RGGI Carbon Permit	UK carbon permit	FCC Spectrum	UK 3G spectrum	Dutch 3G spectrum	Virginia NOx allowance allocation auctions	Victorian Timber auctions	Electricity Generation Capacity (France)	New Jersey electricity procurement auctions
				decision.					
Number of products sold (lots, forward vintages)	Future allowance vintages will be made available for sale in a quantity up to 50-percent of their respective annual allocation, and such offerings may be for allowances extending up to four allocation years into the future.	1 (spot)	Narrowband: ten nationwide licenses in three different types. Broadband: 99 x 30-MHz licenses[54].	Five non-identical licenses, in force until 2021 and covering at least 80% UK population.		3,710 allowances for emission of nitrogen oxides (NOx) - 5% of total allocation allowance (other 95% grandfathered)	65 lots	15 products (of varying contract lengths) ordered as 5 product groups[55].	Mixed portfolio of 1 to 3 year contracts. The load being put out to bid in any one year is broken into 'tranches' of about 100MW each (each slice approximately 1- 4% of total load depending on utility).
Qualification process (credit checks, credit limits, volume limits)	All market participants will be eligible to participate in the initial auction, provided they meet applicable qualification requirements, which will include provision of financial security (1) bond, (2) cash in the form of a wire transfer or certified funds, such as a certified bank check or cashier's check, or (3) an irrevocable letter of credit (LOC) issued by a financial institution with a United States banking license.	Single pre-auction registration process (further detail unavailable, except for potential auction participants).	Each bidder should submit an application and upfront payment to become a qualified bidder by the Commission. The applicant must only submit an upfront payment that will purchase the maximum number of bidding units on which it will wish to bid. The number of bidding units purchased with the upfront payment defines a bidder's maximum bidding eligibility. The maximum bidding eligibility is the	£50 million deposit. Additionally, if a firm wished to bid more than £400 million in the auction, the government required another deposit of £50 million.		All bidders had to demonstrate credit-worthiness with a credit instrument or an escrow account with their maximum possible bid.	See Appendix 3 for details.		Qualification criteria and processes, auction rules and post-auction Master Supply Agreement (MSA)[56].

[54] Many more products have been auctioned since this initial auction.

[55] At each auction, EDF will offer a volume of contracts corresponding to the renewal of capacity which is about to expire in order to continue to make available 5,400 MW.

[56] Interested parties must submit financial information to permit utilities to assess creditworthiness. A winner's financial guarantee posted before the Auction may be forfeited if the winner does not execute the MSA within 3 days.

	RGGI Carbon Permit	UK carbon permit	FCC Spectrum	UK 3G spectrum	Dutch 3G spectrum	Virginia NOx allowance allocation auctions	Victorian Timber auctions	Electricity Generation Capacity (France)	New Jersey electricity procurement auctions
			maximum amount of bidding units on which the applicant will be permitted to bid in any single round of bidding.						
Allocation constraints (price caps, volume caps by sector)	Reserve price: $1.87 in Sept 08, adjusted to CPI thereafter. Auction rules will establish a total limit for the number of allowances that entities...may purchase in a single auction, equivalent to 25% of the allowances offered for sale in any single auction.	Non-competitive option for bids up to 10,000 permits (max 30% of auctionable allowances auctioned this way).	Quantity Restrictions. To promote competition, a firm is limited in the quantity of spectrum the regulations allow it to hold in any market.		Each bidder can acquire at most one license.		Credit limits and (self-imposed) volume capacity limits		Indicative offers' determine the qualified bidder's initial eligibility: a bidder will never be able to bid in the Auction on a number of tranches > the initial eligibility.
Payment terms	Financial settlement of Auction 1 will commence immediately after bidders are notified of the auction results.		Payments are received by the FCC at three times: (1) An upfront payment before the bidding begins assures that the bidder is serious. Any withdrawal penalties are taken from the bidder's upfront payment. (2) A down payment of 20 percent is paid within five business days after the close of the auction. (3) A final payment of the remaining 80 percent is paid within five business days of the award of the license. Firms eligible for instalment payments have a reduced down payment and make quarterly payments over	The winner could either pay immediately or choose to defer some of the payment at a set interest rate.			Deferred payment until delivery		

	RGGI Carbon Permit	UK carbon permit	FCC Spectrum	UK 3G spectrum	Dutch 3G spectrum	Virginia NOx allowance allocation auctions	Victorian Timber auctions	Electricity Generation Capacity (France)	New Jersey electricity procurement auctions
			10 years.						
Other features	Extended (3 year) compliance period. Multiyear compliance periods were employed to provide regulated facilities more flexibility to adjust to variations in electricity demand. This design component was included in lieu of allowance borrowing, as it allows for de facto borrowing within a three year compliance period.				Failed due to auction design flaws[57].	The DEQ's main goal for the auction was that it maximise revenue generated for the state. In addition, as a political consideration it was essential that the DEQ avoid negative political consequences from the auction. To this end, DEQ officials indicated that transparency of the auction mechanism was critical.	Bidders can see - their own bid history per lot, - their own target price, and -the leading bid price and bidder name.		Bidders are provided with the next round prices and a measure of excess supply remaining in the Auction.

[57] Similar amount of bidders and products using an ascending clock auction indicated that new market entrants formed partnerships with existing market players and colluded. The market structure here was very different from CPRS structure - CPRS has many products has many bidders and compliance issues as a driver for bidding. Similar results occurred in the Italian and Swiss experiences for similar auction design reasons.

Appendix 2: Key auction format mechanisms Appendix 2: Key auction format mechanisms

This aims to provide some detailed theoretical explanation about the main auction mechanisms described in this report.

1. Sealed Bid Tender
    1.1. Single product
    1.2. Multiple products
    1.3. Two products (using a substitution co-efficient)

2. Ascending Clock Auction
    2.1. Single product
    2.2. Multiple products (SACA)
    2.3. Intra-round bidding
    2.4. Two products (using a substitution co-efficient and single clock)

This information draws primarily on the work of Peter Cramton (and various co-authors).

1. Sealed Bid Tender

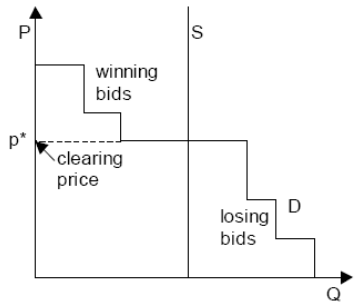
1.1. Sealed Bid Tender - Single product[58]

In sealed-bid auctions, the bidders simultaneously submit demand schedules. The auctioneer adds these demand schedules to form the aggregate demand curve. Typically, demand schedules are required to be step functions, but piecewise linear schedules are permitted in some settings. A sample demand curve appears in Figure 1. The point at which the aggregate demand curve and the supply curve cross determines the clearing price. All demands above this clearing price are filled, those at the clearing price are rationed, and those below are rejected. The various sealed-bid auction forms differ in what each bidder pays for the amounts awarded.

The two most common pricing methods are uniform pricing and pay-your-bid pricing. Under uniform pricing, each winner pays the clearing price p* for each permit. With pay your bid pricing, each winner pays its bid. Of course, bidding behaviour is quite different under the two approaches. With pay-your-bid pricing, the bidder attempts to guess where the clearing price is likely to fall and then bids slightly above it. Bids in excess of the clearing price are money left on the table. With uniform pricing, predicting the clearing price is less important, since every winner pays the clearing price regardless of how high it bids.

[58] Cramton & Kerr (2002) p.5-7

Figure 1. Sample Demand Curve



Uniform pricing also encourages participation by small bidders, since it is strategically simple and the small bidders benefit from the demand reduction (bid shading) by the large bidders. In contrast, pay-your-bid pricing exposes small bidders to strategic risk, since they may be less able to gauge where the clearing price is apt to be. Hence, among the sealed-bid auctions, a uniform-price auction probably is best for the case of carbon usage permits.

1.2. Sealed Bid Tender - Multiple products

Using the mechanism described above, bidders submit an independent demand schedule for each product offered. The auctioneer adds these demand schedules to form the independent aggregate demand curve for *each product*.

Although the products may be considered substitutes by the bidders, the auction mechanism does not allow them to substitute between these goods and therefore the final price outcome may not be representative of the intrinsic value of the different products.

1.3. Sealed Bid Tender -Two products (using a substitution co-efficient)

"It is possible to have a highly efficient auction (sealed bid or clock), allowing for rich substitution between two vintages."

- Peter Cramton, CPRS specific advice via email Oct 14

The first part of the bid expresses the bidder's aggregate [demand] as a function of the [spot vintage] price. The second part of the bid is where the bidder expresses their substitution preferences between spot and forward products[59]. This is expressed as one coefficient[60] that indicates the spread between prices where the bidder chooses to substitute away from the more expensive spot vintage, towards the future vintage.

The bids are submitted and when aggregate demand is calculated, those whose coefficient lies within the price spread between the two vintages have part of their demand shifted to the future vintage. Those whose coefficient is greater then the price spread have their full demand shifted.

[59] Cramton (2007a)

[60] The calculation of this coefficient as a function of the price spread between spot and future vintages is explained by Peter Cramton in the context of auctioning two substitutes using a single clock auction. See the section titled Simultaneous Ascending Clock Auction (with only two products and intra-round bidding i.e. a single clock).

2. Ascending Clock Auction

2.1. Ascending Clock Auction – Single product [61]

The ascending-clock auction offers a simpler approach. The clock indicates the current price. In each round, the bidders submit the quantity they are willing to buy at that price. If the total quantity bid exceeds the quantity available the clock is increased. The bidding continues until the quantity bid is less than the quantity available. The permits are then allocated at the prior price, and are rationed for those that reduced their quantity in the last round. The activity rule in this case is simply that each bidder cannot increase its quantity as prices rise.

This design shares all the advantages of the ascending auction with demand schedules, and has several additional advantages:

1. It is easier to implement for both seller and buyers, since a buyer only bids a single quantity in each round, rather than a schedule.

2. There is no possibility of undesirable bid signalling, since only the total quantity bid is reported.

3. Rapid convergence is guaranteed, since the price increases by one bid increment with each round of bidding.

2.2. Simultaneous Ascending Clock Auction (with multiple products)[62]

The auctioneer announces a price for *each* good, and bidders express the quantities of goods that they desire at the current prices. The prices of the goods are incremented in relation to their *respective* excess demands. The process repeats until there is *no excess demand for any good*. At that point bidders are awarded their quantities bid at the final prices. While the underlying theory utilizes continuous clocks, bidding in real world dynamic auctions normally occurs in discrete rounds.

2.3. Intra-round bids [63]

An important feature in the clock auction is what is known as intra-round bids: the ability to express a demand curve for all prices between the start of round price and the end of round price.

This feature allows better expression of bidder preferences without requiring too many rounds. This improves auction efficiency and lets the auctioneer better manage the pace of the auction. A further advantage is that the incidence of ties are reduced, making it likely that only a single bidder will be rationed at the clearing price.

[61] Cramton & Kerr (2002) p8

[62] Ausubel & Cramton (2004) p491

[63] Cramton (2007a) p14

Figure 8. Individual demand bid for a round

Price ($/ton)	Quantity (tons)
$8.70	12,000
$9.40	9,000

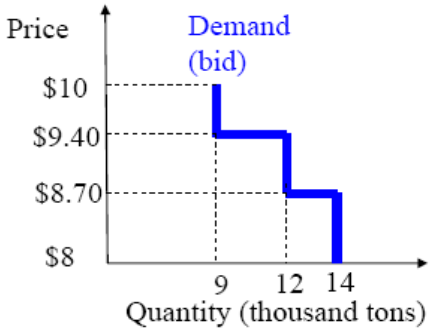
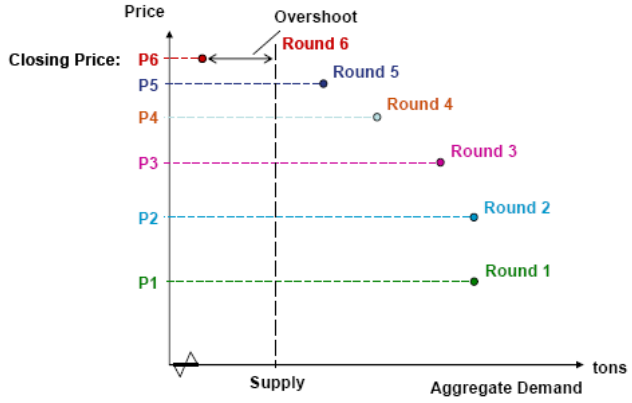


Figure 8 shows a tabular and graphical version of a bid in a round. In this round, the start of round price is $8 and the end of round price is $10. The bidder simply needs to state at which price, if any, it wishes to reduce its quantity from its start of round quantity of 14,000 tons. In this case, the bidder makes two reductions: the first at $8.70 to 12,000 and the second at $9.40 to
9,000. The resulting demand curve in this case has two steps.

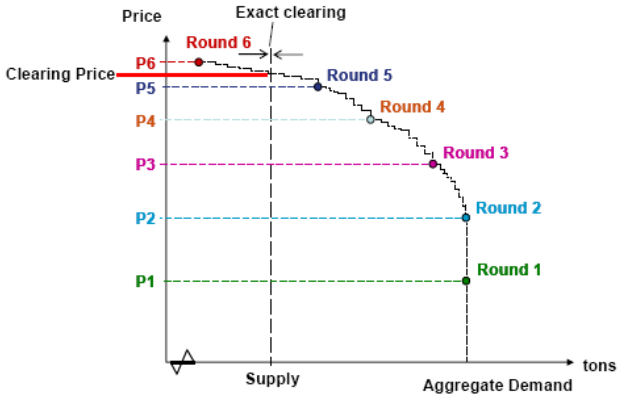
The advantage of this approach is easily seen when one considers what would happen in a clock auction without intra-round bids; that is, when a bidder only expresses its desired quantity at the end of round price. This is shown in Figure 9. The result typically is overshoot. In Round 5, there is significant excess demand, but at the end of round 6 there is significant excess supply. The discrete clock process overshot the clearing price.

Figure 9. A clock auction without intraround bids overshoots the clearing price



The problem of overshoot is readily avoided by allowing intra-round bids. This makes the aggregate demand curve much smoother and better reflects the bidders' true demands, as shown in Figure 10. As a result, auction efficiency is improved. Importantly, since the prices of reduction are specified by the bidder, rather than the auctioneer, they represent true points of indifference, and can be treated as such. The approach results in a unique clearing price and exact clearing.

Figure 10. A clock auction with intraround bids avoids overshoot and improves efficiency



2.4. Simultaneous Ascending Clock Auction (with intra-round bidding and only two products i.e. a single clock)

"The clock auction can… be done with a single price clock (the spot vintage) with a linear expression of substitution between the spot and forward product. This is extremely easy to implement and for bidders to participate in."

- Peter Cramton, CPRS specific advice via email Oct 14

Figure 11 gives a sample bid with two products. The first part of the bid expresses the bidder's aggregate [demand] as a function of the [spot vintage] price, for all prices from the start of round price to the end of round price. The bidder's offer at the start of round price is carried forward from the prior round. The end of round price is specified by the auctioneer. The supplier simply has to express the prices at which it desires to reduce its quantity. In the example below, the supplier indicates that at a [spot vintage] price of $66.30, it desires to reduce its quantity from 9.0% to 6.0%, and then at a price of $61.70, it desires to further reduce its quantity from 6.0% to 3.0%. A bidder can specify up to five prices at which it desires to reduce quantity in any particular round.

Figure 11. Sample bid

Carried forward from end of prior round
Set by auctioneer at end of prior round
Bidder's bid in round

Bidder activity	Spot price ($/ton)	Total quantity (tons)
Start of round prices and quantities	$7.00	14,000
Reduces total demand to 12,000	$7.30	12,000
Reduces total demand to 10,000	$7.80	10,000
End of round prices and quanties	$8.00	10,000

Substitution between spot and forward product

	All spot	All forward
Price spread ($/ton)	$0.90	$1.00

The second part of the bid, shown in the lower box of Figure 11, is where the bidder expresses its substitution preferences between spot and forward products. In this example, the bidder is stating:

1. whenever the price spread—the difference between the spot price and the forward price— is less than $0.90, the bidder wants all its quantity to be spot;
2. whenever the price spread is greater than $1.00, the bidder wants all its quantity to be forward; and
3. whenever the price spread falls between $0.90 and $1.00, the bidder wants a linear mix of spot and forward product, according to the formula:

spot quantity = total quantity × (1.00 – spread) / (1.00 – 0.90),
where spread = spot price – forward price.

This approach gives the bidder great flexibility in expressing its substitution preferences. For example, if the two products are perfect substitutes, then the bidder would give a single number for "all spot" and "all forward," reflecting the bidder's value difference between the spot product and the forward product. Then the bidder's demand would be either all spot or all forward depending on whether the price spread is below or above the number bid. Alternatively, the bidder can slow the substitution across products by submitting a lower number for "all spot." Then the bidder's mix of spot and forward product shifts gradually to forward as the price spread increases.

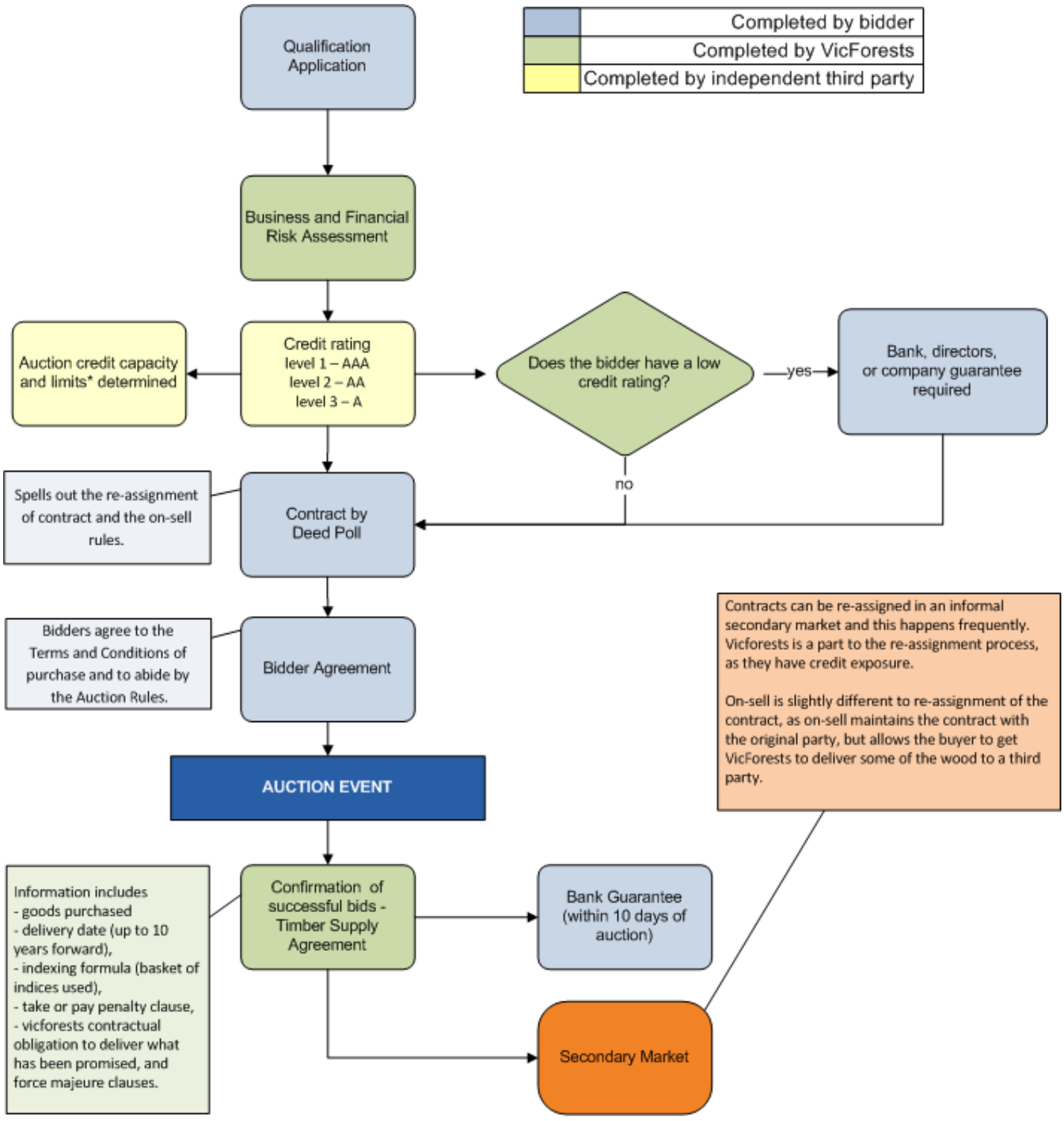
Figure 12. The price spread is calculated to balance excess demand across products

	$/ton	D/S ratio		Spot	Forward
Spread	1.37	120.0%	Price	$8.00	$6.63
			Total market	800	800
			Share auctioned	12.5%	12.5%
Supply	200		Amount auctioned	100	100
		Bid		120.0%	120.0%
		All	All	Demand	
Bidder	Demand	spot	forward	Spot	Forward
A	19	$1.71	$2.20	19	0
B	19	$1.50	$2.00	19	0
C	14	$1.42	$1.80	14	0
D	48	$1.36	$1.60	47	1
E	29	$1.23	$1.50	14	15
F	38	$1.20	$1.40	6	32
G	10	$1.11	$1.11	0	10
H	24	$0.95	$1.20	0	24
I	29	$0.94	$1.10	0	29
J	10	$0.90	$1.00	0	10
Demand	240			120	120

Figure 12 shows how the price spread at the end of round price is calculated to balance excess demand across the two products. In the example, the end of round spot price is $8.00. The question is, "What is the price spread that results in the same ratio of demand over supply for both products?" In this case, given the aggregate demand of all the bidders, it turns out that a price spread of $1.37/ton results in a demand over supply ratio of 120% for both the spot and forward products. Given the strictly upward-sloping supply curves for both products, the weakly downward-sloping total demand curves for each bidder, and the linear substitution across products for each bidder, there will always be a unique price spread that balances the demand over supply ratio for each product. As the price rises and bidders make reductions in quantities, we eventually will reach the point where demand equals supply for each product. The motivation for calculating the price spread in this way is that it provides the best predictor for the price spread at the ultimate clearing price. The price spread is reported at the end of each round.

For those auctions in which the spot and forward products are surely in the same compliance period, the two products are perfect substitutes with a price spread of zero. In this case, the bidding can be simplified to omit the price spread portion of the bid: ($0, $0) is assumed for all bidders. A winning bidder receives a mixture of the two vintages with proportions determined by the supplied quantities of each product.

Appendix 3: Bidder qualification process case study - Victorian Timber Auctions



Note: VicForests had to seek waiver of the trade practices act to limit the buyers to entities that will process the wood in Australia.

All the documents mentioned here are available publically on the VicForests website - http://www.vicforests.com.au