

**Design of a Suitable Auction Format for Competitive Sale
of Alternative Energy Leases on the OCS
(AE Auction Design Study, Paper 2 of 3)**

Multiple Factor Auction Design for Wind Rights



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Abstract

The best sites for offshore wind farms on the US Outer Continental Shelf are scarce. To make the best use of this scarce resource, it is necessary to implement a fair and efficient mechanism to assign wind rights to companies that are most likely to develop off-shore wind energy projects. Coastal states, particularly along the eastern seaboard, are taking aggressive actions to spur the growth of an offshore wind sector in their states to help meet their renewable portfolio targets while nurturing the supporting on-shore infrastructure. This paper discusses the design of multiple factor auctions for wind rights, in which multiple factors are used in bid evaluation. This may be especially useful in settings where states (and potential bidders) have already taken actions to foster offshore wind development. The paper complements “Auction Design for Wind Rights,” Ausubel and Cramton (2011a), on the design of price-only auctions for wind rights.

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Terminology

The following terms are used throughout this document.

Term	Description
Assignment stage	A stage of the auction in which bidders who have won generic lots are assigned specific lots, either based on an additional round of bidding or another mechanism for allocation.
Bid amount	The value or values that the bidder specifies for its bid. This can be a price or a quantity depending on the auction format.
Bid shading	The strategy of bidding below your valuation, typically as a way to improve profits in first price auctions.
Bid skewing	The practice of placing extreme bids on individual factors to take advantage of relative weights assigned to factors, such that the total bid achieves a favorable score. Bid skewing occurs when the government uses a linear scoring function that imperfectly represents the government's objective.
Bidder discount	A bidder-specific percentage discount that is applied after winners and gross payments are determined. A bidder's gross payment is reduced by the bidder discount.
Block	An approved subdivision of the Outer Continental Shelf (OCS) intended for leasing purposes. In the Atlantic, an OCS block is 4800 meters square containing 2304 hectares (5693.3 acres) or about 9 square statute miles.
Call for Information and Nominations (Call)	A <i>Federal Register</i> notice that BOEMRE publishes during its renewable energy leasing process. The publication of a Call indicates that (1) BOEMRE has determined competitive interest exists in an area based upon the results of an RFI, or (2) BOEMRE anticipates that there will be competitive interest in an area. The notice solicits nominations of competitive interest in developing a project in the area described, as well as comments from the public. Following the comment period described in the notice, BOEMRE may proceed with its competitive lease issuance process, its non-competitive lease issuance process, both, or neither, depending on the information received in response to the Call and whether an RFI for the area was published previously.
Cap	A competition constraint rule that would prohibit a single bidder from winning more than some percentage (e.g. 45%) of the available lease area. Caps often take prior holdings into account when determining how to apply the rules to a specific bidder.
Clock auction	A multiple round auction in which in each round the auctioneer announces prices and the bidders respond with demands at the specified prices. Prices then increase on products with excess demand and the process repeats. Three common types of clock auctions are a Simultaneous Clock Auction, an Independent Clock Auction and

	a Clock Auction for a Single Lot.
Collusion	Two or more bidders working together to manipulate the auction outcome.
Comparative hearing	Sometimes known as a “Beauty Contest.” Winners are determined based on the attractiveness of each proposal.
Competition constraint	A rule designed to achieve social goals such as encouraging competition in a given area. Competition constraints may be implemented in a number of ways, such as setting caps.
Competitive lease	A lease that has been issued using BOEMRE’s competitive lease issuance procedures. For more information, see BOEMRE’s regulations at 30 CFR § 285.211 and 285.220-225.
Final Rule	BOEMRE’s offshore renewable energy regulations, found at 30 CFR Part 285. The regulations can be downloaded from BOEMRE’s web site at: http://www.boemre.gov/offshore/RenewableEnergy/PDF/FinalRenewableEnergyRule.pdf .
Final Sale Notice	A <i>Federal Register</i> notice published at least 30 days before the date of the sale describing the final terms and conditions that will be used in the sale. A list of items that will be included with the final sale notice can be found in BOEMRE’s regulations at 30 CFR § 285.216.
First-price auction	An auction in which bidders specify the price they are willing to pay for an item, and if they win that item, they pay this price.
Gaming	Bidding in an auction in a way that does not truthfully represent the bidder’s true value, but may increase the bidder’s chances of a favorable outcome. A good auction design should minimize the possibility of gaming.
Generic lots	Lots that are sufficiently similar that they may be bid as one category and have one price. Bidders may then express a demand for the number of generic lots at a particular price.
Gross payment amount	The amount a winner pays, before the deduction of the bidder-specific discount
Indication of interest	An applicant’s response to a Request for Interest sent to BOEMRE. The applicant must include items listed in 30 CFR § 285.213.
Information policy	The policy that determines the information that is revealed to bidders during the course of a dynamic auction. The information revealed might include bid-specific information such as the price of the bid and the identity of the bidder, or aggregate information such as the total number of bids made on a certain product (demand for that product).
Lease	A legal document that gives the lease holder a reservation with respect to other developers. Before a lessee may develop a tract, BOEMRE needs to approve a Site Assessment Plan and/or a Construction and Operations Plan.
Lease area	The tract that is leased. It is comprised of one or more lots.

Lot	A contiguous set of one or more blocks or sixteenths of blocks that is the basic product that a bidder places bids for.
Menu auction	A generalization of a single-phase multiple factor auction in which bidders submit multiple sealed bids – each one containing a price and an associated technical bid, and the government chooses a bid that best suits the government’s goals.
Multiple factor auction (MFA)	An auction in which the winning bidder is selected following consideration of (1) both monetary and non-monetary factors or (2) solely non-monetary factors.
Outer Continental Shelf (OCS)	All submerged lands lying seaward and outside of the area of lands beneath navigable waters, as defined in section 2 of the Submerged Lands Act (43 U.S.C. 1301), whose subsoil and seabed appertain to the United States and are subject to its jurisdiction and control.
Package bid	A package bid is a bid on a set of lots. In auctions that do not allow package bids, a bidder interested in a set of lots must submit multiple bids for each of the lots, which exposes the bidder to the possibility that only part of the package is won.
Package clock auction	A clock auction with an additional supplemental round. During the clock auction, bidders specify the packages they wish to purchase at various prices. After the clock auction ends, an additional round is held during which bidders may bid on new packages and improve their bids on packages from the clock auction.
Payment amount	The amount a winning bidder pays for the lease. This is the gross payment amount less the bidder discount if any.
Power Purchase Agreement (PPA)	A legal contract between an electricity generator (provider) and a power purchaser (buyer). The contract will specify the duration and the terms of sale, including the pricing, quantities, and delivery requirements for the products to be provided such as energy, capacity, ancillary services, and renewable energy credits.
Price discovery	A feature of dynamic auctions in which information about bidder demands is reported to bidders, giving bidders the opportunity to adjust subsequent bids based on the information.
Pricing rule	The rule that determines the price paid by the bidder for each lot that it has won.
Prior holding	Product such as offshore wind leasing rights that a bidder already has that is related to what is being auctioned. Prior holdings are factored in when there are competition constraints.
Proposed Sale Notice	A <i>Federal Register</i> notice with a public comment period of 60 days describing the proposed terms and conditions to be used in the sale. A list of items that will be included with the proposed sale notice can be found in BOEMRE’s regulations at 30 CFR § 285.216.
Request for Interest (RFI)	A <i>Federal Register</i> notice in which BOEMRE requests indications of interest and comments relevant to the leasing and potential development of a designated area. BOEMRE uses the information received in response to RFIs to determine whether there is competitive interest in obtaining a lease in the area described in the notice.

Scoring Auction	An auction where a score is calculated based on several factors including price and technical factors. The auction then clears based on the bidder with the highest score.
Sealed-bid auction	An auction in which bidders submit bids without receiving any information relating to the bids placed by other bidders.
Second-price auction	An auction in which the highest bid wins and the winner pays the second price. A useful interpretation of this auction is that the bidder pays the smallest price that enables the bidder to win. This encourages the bidder to bid its true value.
Second price	In a sealed-bid auction of individual lots, the second price is generally the highest price bid for a given lot by a bidder who did not win the lot. In an auction where a solver determines the winner based on the various combinations of package bids that were submitted, the second price is the smallest price the winner can pay such that no other bidder or combination of bidders would have a higher value from their bids. In essence, it is the lowest price the winner can pay such that no other set of bidders has offered more. Depending on the algorithm used, the second price for a combinatorial problem will vary. Common solutions include Vickrey prices and VCG-nearest prices.
Set-aside	A competition constraint rule that sets aside specific lots for bidders meeting certain criteria. A set-aside is sometimes used for new entrants in a market where new entry is desirable to increase competition. However, this is likely not an option for BOEMRE's auctions, due to the absence of any provision for it in BOEMRE's regulations.
Simultaneous clock auction	A clock auction similar in design to an SMRA. The key difference is that provisional winners are not determined at the end of each round, only the aggregate demands for each product. The auction ends when there is no excess demand for any product. In each round, the auctioneer announces prices and each bidder bids for the package of lots desired at the announced prices. Bids are package bids. An activity rule requires bidders to maintain a level of activity throughout the auction that is commensurate with their desired winnings.
Single-phase multiple factor auction	A multiple factor auction where qualification, technical details, and cost proposals are submitted in a single phase and all evaluated at once.
Sixteenth of a block	BOEMRE's renewable energy program uses the sixteenth of an OCS block as the smallest unit of leasing. Each sixteenth contains approximately 355.83 acres.
Solver	The software that determines the winners and winning prices. For clock auctions, the solver algorithm is quite simple. For combinatorial situations (such as package clock auctions), standard off-the-shelf optimization software is used to determine which combination of packages yields the best value, given the defined constraints.
Specific lot	Lots that are treated individually, each with its own characteristics, allowing the bidder to specify during the auction the particular lots desired. Specific lots are appropriate when each lot has unique characteristics that determine its value.

Spectrum auction	An auction for radio spectrum (bandwidth at particular frequencies in specified regions).
Supplementary round Or Supplemental round	A special round that occurs at the end of the clock auction in a package clock auction. Bidders bid on new packages and improve their bids on packages from the clock auction.
Tract	The set of lots that a bidder is interested in.
Two-phase multiple factor auction	A multiple factor auction where qualification and technical details are submitted in an initial phase, and then the financial aspect is evaluated in a separate second auction step.
VCG-nearest price	Method of calculating second prices in a combinatorial optimization problem, as described in “The Quadratic Core-Selecting Payment Rule for Combinatorial Auctions” (Day and Cramton 2012). VCG is an abbreviation for Vickrey-Clarke-Groves.
Vickrey auction	An auction format for multiple identical items. Bidders simultaneously submit demand curves. Each bidder wins the quantity demanded at the clearing price, and pays the opportunity cost of its winnings (the valuations of those bidders that are prevented from winning). For a single-item auction, the Vickrey auction is a second-price auction. When the approach is applied to the auction of non-identical items, the Vickrey auction is often referred to as the generalized Vickrey auction or the Vickrey-Clarke-Groves mechanism.
Winner's curse	The insight that winning an item in an auction is bad news about the item's value, because winning implies that no other bidder was willing to bid as much for the item. Hence, it is likely that the winner's estimate of value is an overestimate. Since a bidder's bid is only relevant in the event that the bidder wins, the bidder should condition the bid on the negative information winning conveys about value. Bidders that fail to condition their bids on the bad news winning conveys suffer from the winner's curse in the sense that they often pay more for an item than it is worth.
Winner determination	The process of determining winners and winning prices using the solver.

1 Summary

This paper examines multiple factor auction (MFA) design for wind rights on the US Outer Continental Shelf (OCS). It is the sequel to our first paper, “Auction Design for Wind Rights” (Ausubel and Cramton 2011), which examined price-only auctions for wind rights. Multiple factor auctions allow for the consideration of many factors in addition to price in determining winners and payments. As we will see, nearly all of the discussion of price-only auctions is relevant to MFA. Indeed, a key insight in MFA design is that it often is best to accommodate additional factors in a manner that allows a price-only auction, for example by setting key qualification requirements by giving a bidder satisfying certain factors an appropriate discount in the price-only competition. Such discounts should be kept to a minimum, and should only relate to factors that do not have an influence on the bidders own valuation of the tract. If the technical factors do impact the bidders valuation, such as investments already made by the bidder, these will be represented in the bidders bid (e.g. the bidder that has made the investment will be able to put forward a more favorable bid). Thus, including bidder discounts for these factors would potentially double count these factors and prevent meaningful competition. For brevity we will not repeat the detailed design discussion of price-only auctions, but refer the reader to the first paper (Ausubel and Cramton 2011a).

1.1 Introduction

Wind energy is growing rapidly in importance as the world moves toward renewable energy sources. In the US, much of the developable wind energy, especially near major population centers, is located offshore. Even in waters less than 30 meters deep, the wind energy potential in New England and the Mid-Atlantic States is estimated to be 56 GW (Musial and Butterfield 2004). Potential wind farm sites differ substantially in value based on such factors as: average wind speed and variance, water depth, and proximity to population centers. Although there is an abundance of potential sites, the best sites are scarce.

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is responsible for assigning wind rights through a competitive bidding process for sites where there is competing demand in the OCS, much as it does today for oil drilling rights. However, while the oil drilling rights must be assigned using a sealed-bid auction, BOEMRE has much more flexibility in how it is to assign wind rights. This paper examines one possible set of auction designs, multiple factor auction (MFA) designs, and provides guidance on what MFA design is best for this application and under what circumstances. For the purposes of this paper, a multiple factor auction is any competitive process to determine the assignment and pricing of wind rights that enables the interaction of factors other than price.¹

The main motivation for the potential implementation of the MFA design is stated in the Final Rule:

Multiple factor bidding may be useful if [BOEMRE] identifies a market failure in a purely monetary auction format. In certain circumstances, nonmonetary factors involving important public policy matters may not be reflected in auctions where a fiscal term measure is applied to determine the winning bidder. Examples of such market failure include situations where public benefits could accrue from innovative research and

¹ This is not the same thing as using non-price factors to determine whether a bidder is eligible or qualified to bid in a given auction. This qualification step almost always includes non-price factors such as technical experience, and financial backing. This is discussed further in Section 4.1.3.

technology developments or situation where public benefits could accrue from the abatement of existing or potential carbon emissions.

It is worth noting that implementations of MFA auctions can be extremely different. On the one hand, an MFA auction could be a standard Request for Proposal procedure, where bidders need to submit detailed technical proposals along with price quotes. The winners are then determined by applying predefined criteria that weight price and non-monetary factors. On the other hand, many non-monetary factors that a potential auctioneer might consider can be easily incorporated into the context of price-based auctions by utilizing different preferential treatment techniques. For example, any small business can be advantaged by introducing a bidder discount. In fact, many government regulators accommodate social objectives within transparent price-based auctions.²

We believe the best MFA process to assign wind rights is one that accommodates price-only bidding in a second phase as described in our first paper (Ausubel and Cramton 2011a). Typically this will result in the most efficient assignment mechanism, while accommodating multiple factors. These factors may include technical merit, timeliness, financing and economics, the environment, public benefits, consistency with State and local needs and requirements and other factors.

The case for taking factors other than price into account is especially great when the parties have substantially different approaches, which are apt to lead to projects that differ with respect to a variety of social objectives. Then it may be best to structure the competition as a multiple factor auction.

If that is the case, we would advocate an MFA process that integrates the simplicity of the price-based ascending auction formats described in our first paper (Ausubel and Cramton 2011a), with other important non-monetary factors (if such factors are identified) in a transparent way that helps to preserve or enhance efficiency.

It is well understood that regulators often need to consider many factors in designing an auction, but often these factors can be easily incorporated in the context of an ascending price-based format. This has been the approach of the FCC in spectrum auctions where bidding credits, set-asides, spectrum caps options are often used either to enhance competition in the market for wireless services or for other social objectives such as assuring a diversity of winners and preferential treatment of disadvantaged groups. Furthermore, critical technical requirements can be specified as a minimum for participation in an auction. Cramton et al. (2011) provides a detailed discussion and examples of numerous auction tools that can be used to achieve many socially desired objectives staying within the price-only framework. Overall the experience with these instruments has been mostly positive.

However there are a few examples of poor performance that serve as a warning that such instruments must be used with utmost care in order to avoid harming the process. The most notorious example was an early Federal Communications Commission (FCC) auction in which the FCC was attempting to satisfy a Congressional mandate to create opportunities for small businesses, minority and woman owned businesses and rural telecommunication companies. In 1995-1996, the FCC held a set-aside auction, Broadband PCS C Block, for “entrepreneur” firms³. One of the features of this auction was that all qualified bidders would be able to pay for their licenses in installments over a ten year period. Note that this installment plan was not offered to larger firms in other FCC auctions, and strictly

² See Athey et al. (2011) and Krasnokutskaya, and Seim (2011) for evaluations of the preferential treatment programs in auctions conducted by the U.S. Forest Service and the California Department of Transportation.

³ An entrepreneur was defined as businesses with revenues of less than \$125M in each of the two preceding years and total assets of less than \$500M at the time of the auction application filing.

gave “entrepreneurs” preferential treatment – both financially and in the fact that only they could win these licenses. The decision to award “entrepreneur” firms an installment plan option proved disastrous for the US government and consumers when NextWave Personal Communications Inc., a major winner in the Broadband PCS auction, filed for Chapter 11 bankruptcy when they could not make the installment payment deadlines. The FCC canceled the licenses and quickly re-auctioned the licenses. The Court of Appeals for the DC Circuit held that the cancellation violated the bankruptcy laws and the US Supreme Court upheld the decision. The re-auctioned licenses had to be taken back from the new winners and reissued to NextWave. The licenses were ultimately sold by NextWave to Verizon Wireless and subsidiaries of AT&T in 2004 – eight years after the original auction. Note that the ultimate winners would not have qualified to bid for these licenses in the original auction.

In another example, the FCC had to change its small business rules to close loopholes that allowed large telecommunications companies to front “small bidders” to obtain discounts on the price of auctioned spectrum. In earlier auctions, large telecommunications companies were entering into lease or resale arrangements with small bidders and the net bids for these licenses were discounted by up to 25%. Under the original rules, the revenues of the large company were not included when determining whether the applicant was qualified for a small business bidding discount. The new rule requires auction applicants to include revenues of any entity with which it has any arrangements for lease or resale of more than 25% of the spectrum capacity.

Historically, many government agencies across the world have replaced different non-transparent multiple factor procedures with modern price-based auction designs that often accommodate non-monetary factors. This is especially true in high stake applications such as auctions for assigning spectrum rights. For example, until the mid-1990s, the FCC used comparative hearings to award spectrum licenses.⁴ In 1994 simultaneous ascending auctions were introduced as a result of the problems the FCC was experiencing with comparative hearings to accommodate multiple factor issues. However, it should be noted that the FCC has moved towards a price-only auction design over time. In 1994, they switched to price-only auctions for the vast majority of awards. Other objectives, such as promoting a diversity of winners and encouraging competition, were pursued within a price-only framework with spectrum caps, set-asides, and bidding credits. Over time the use of these other instruments has diminished in part because of difficulties in their application.

Our objective is to provide guidance on how best to auction wind rights in the OCS. Given the potential value involved and importance of offshore wind to the energy future and energy security of the US, the auctioning process should be transparent, objective and simple. If an MFA is to be implemented, getting the MFA design right the first time is especially important given the high level of inertia in almost all government programs. The design that is used for the first auction could realistically be anticipated to be the design that is used for the subsequent 20 years. Good auction design and implementation will be essential to the allocation of tracts and to the ultimate success of wind energy policy.

We are not aware of any direct conflicts with BOEMRE’s regulations or statutory authority, and have endeavored to suggest formats and rules the bureau can use under its existing regulatory framework. However, subsequent determinations by BOEMRE could find that some of the formats or rules discussed in this paper may not be implemented as stated without changes or departures from the regulations.

⁴ More recently, comparative hearings are called “beauty contests.”

1.2 Outline

The next section describes multiple factor assignment methods, from comparative hearings to multiple factor auctions to scoring auctions. We discuss some examples of their use. Section 3 discusses product design, which addresses the important question of what is being auctioned. In Section 4 we make specific recommendations for designing and implementing a MFA process for wind rights. In Section 5 we provide an illustrative MFA for New Jersey, focusing on the auction design that is best suited for this lease area based on the large number of overlapping areas of interest. Section 6 presents a summary of our recommendations on the design of multiple factor auctions.

2 Multiple factor assignment mechanisms

There are many ways to implement multiple factor auctions. We describe the main ones that have been used in practice, especially in a government setting. At one extreme are comparative hearings in which the regulator sets a price, invites tenders to submit sealed bids at that price, and makes a subjective determination based on the attractiveness of the tenders with respect to government objectives.

A single-phase multiple factor auction is different from a comparative hearing in that the government does not pre-determine the price for an item. Instead, a bidder submits a sealed bid containing both a technical proposal and a commercial proposal (including price). The technical and commercial proposals can be considered sequentially, or together, depending on the auction rules. Note that a single-phase multiple factor auction is analogous to a “Request for Proposal” (RFP) process where providers of goods or services submit both a technical and commercial proposal in a sealed bid in response to a procurement request. A generalization of a single-phase multiple factor auction is a “menu auction” in which bidders submit multiple sealed bids – each one containing a price and an associated technical bid, and the government chooses a bid that best suits the government’s goals.

A scoring auction allows each bidder to bid multiple factors, which are then mathematically aggregated into a score. The bidder with the highest score wins. The scoring auction gives the bidder flexibility across many dimensions in how the bidder achieves its score. If the score is computed in an objective way using objective criteria, the scoring auction can be as objective as a price-only auction, but with the benefit of allowing many factors to be bid. However, the crucial problem is defining appropriate non-pricing criteria that are simple, objective, transparent, and verifiable. This is often very difficult to achieve. Furthermore, all criteria need to be weighted, and defining the weightings that are appropriate so that, for example, criteria that are more critical are given the necessary emphasis, is also difficult to achieve. We discuss this in more detail in Section 4.1.3. A scoring auction can be implemented as a sealed-bid auction or may be done in rounds in which bidders are allowed to submit new bids that exceed their competitor’s bids the previous round. If a scoring auction is done using a sealed-bid approach, it is equivalent to a single phase multiple factor design.

A two-phase multiple factor auction is a bit different than the other designs in that the technical proposal is reviewed first. After the technical phase is evaluated, bidders will know if they were awarded any preferential treatment such as discounted bids, and can adjust their bids in the second phase accordingly. The following table indicates in which phase the technical and financial aspects of an offer are considered for the four mechanisms we consider. Bidders submit their interest in receiving a lease during Phase 1, the request phase. Bidders provide technical and/or financial details of their proposal during this request phase, all of which would be binding. The competitive auction is held during the second phase, the auction phase.

	Phase 1: Request phase	Phase 2: Auction phase
Beauty contest	Technical only	—
Single-phase MFA (RFP)	Technical and financial	—
Scoring auction	—	Technical and financial
Two-phase MFA	Technical	Financial

Multiple factor assignment mechanisms vary considerably and have been used in a variety of contexts. The most common is procurement. Other examples are the assignment of government licenses and leases for natural resources, such as spectrum, oil, and minerals rights. In the United States, the Federal Communications Commission (FCC) used a multiple factor assignment mechanism for broadcast and cellular licenses.

Much can be learned from the experience with multiple factor methods. We describe the experience with the various approaches in the remainder of this section.

2.1 *Comparative Hearings*

For over 50 years the FCC used comparative hearings—often called beauty contests—to assign licenses in situations where demand for the licenses exceeded supply. The process appeared to work in the early years where typically there was no excess demand, but by the 1980s the demand for spectrum was so great that comparative hearings became unworkable.

Beginning in the late 1920s the FCC began to use comparative hearings to assign broadcast licenses. All applicants who filed mutually exclusive petitions for licenses were entitled to participate in a single, comparative hearing where the applicant thought most likely to serve the public interest would be awarded the license. In the 1960s the FCC began to develop rules to implement comparative hearings to assign cellular telecommunications licenses in the United States. In December 1971, AT&T submitted a proposal for cellular services. After over 10 years of hearings, the FCC approved the proposal in 1982 and assigned frequencies in the 824-894 MHz band. There were a number of problems with the comparative hearings.

When the FCC made clear how it would choose among competing applicants, applicants naturally structured themselves to earn high scores under these criteria. Applicants made promises about network coverage and services that they did not live up to. The applicants all began to look alike; they all received high marks.

Another problem was the time and expense involved in the process. For the first cellular licenses, it took the FCC over ten years of review to authorize AT&T to use the wireless spectrum. The process was fraught with litigation risk since the evaluation criterion was often subjective and the applicants often overstated their capabilities. The decisions were characterized as arbitrary and capricious.

In the 1980s Congress enacted legislation that forced the FCC to abandon the comparative hearings for mobile wireless licenses and use a lottery as the licensing mechanism. It was believed by many in Congress at that time that the government was in no position to choose spectrum licensees based on the merits of their applications, and that in any event the process was too slow.

The lottery process had its own problems with application mills churning out hundreds of thousands of applications all hoping for a windfall of valuable cellular licenses that could later be resold

in private auctions. In 1993, Congress authorized the FCC to conduct auctions for five years for non-broadcast frequencies. The law was later revised in 1996 to include broadcast licenses.

The long delays associated with the comparative hearings and the subsequent abuse of the lottery process made many at the Commission aware that price-only auctions were required to efficiently assign the spectrum. Congress gave the Commission great latitude in designing and developing its auction process.

Beginning in July 1994, the FCC began a highly successful auction program, which continues to this day. The chief attributes of the auction program are qualification through financial deposit, and open bidding with high level of transparency. The auctions have been largely price-only ascending auctions as we have recommended in our companion paper on price-only auctions.

There have been some exceptions to the price-only auctions. First, early in the program, some licenses were awarded as “Pioneer Preferences” to those the Commission deemed had made pioneering innovations in the development of mobile wireless technology. These pioneer preferences were very much a holdover of the comparative hearings. The pioneer preferences were widely viewed as a failure, since it was difficult for the FCC to identify pioneering technology. The awards were challenged both at the FCC and in the courts. The program was quickly dropped.

The second exception was the creation of designated entities that were given preferential treatment in some of the auctions, either bidding credits, set-asides, or attractive payment terms. The preferences were meant to level the playing field in the auction to support for example small businesses. Some of these preferences have been reasonably successful in achieving policy goals. Others, such as the favorable payment terms were a disaster. Because the FCC had little experience as a banker, mistakes were made that ultimately led to lengthy delays in utilizing the spectrum. The licenses got tied up in lengthy litigation. Since the abandonment of Pioneer Preferences in 1995, the FCC’s treatment of other factors, such as small business status, has been addressed in a manner that is consistent with a price-only auction.

2.2 Single-phase multiple factor auction

A single-phase multiple factor auction is analogous to a “Request for Proposal” (RFP) process where providers of goods or services submit both a technical and commercial proposal in a sealed bid in response to a procurement request. The technical proposal generally contains information about the goods and/or services, how they meet the requirements in the RFP and the providers’ experience. The commercial proposal contains the price for the goods or services.

The technical and commercial proposals can be evaluated in sequence or simultaneously. Proposals are often evaluated in sequence. First the technical proposal is evaluated to determine if minimum standards are met. Then following the evaluation of the technical proposals, the commercial proposals are opened for those bidders’ whose technical proposals qualified. In one variation, scores and weights are assigned to each technical criterion and to the price bid to determine the overall weighted score. In another variant only the technical criteria are scored and the aggregate score is used to generate a bidding credit or bonus that is applied to the price bid. The bidder with the highest adjusted bid price is then declared the winner. Note that the FCC uses the term bidding credit; however, we have used the term bidder discount.

There are a number of problems with the single-phase multiple factor auction. First, if the criterion is subjective, as it often is, the process is vulnerable to manipulation and legal challenge. Second, the financial bid is a blind sealed bid. This exposes the bidders to greater risk, encourages bid shading, and reduces auction efficiency.

2.3 *Scoring auctions*

In a scoring auction, each bidder submits an offer which consists of financial and technical bids. A score for each bid is calculated according to the scoring rule, which is used to rank bids. The scoring rule typically is announced before the auction. The contract is awarded to the bidder who submits the bid with the highest score. The winner must perform consistent with the winning score, which means (in procurement setting) that he must deliver all of the technical aspects of his bid and will be paid the financial bid. For example, there may be a score associated with setting up a buffer, and if a bidder's bid includes that particular aspect, and it wins, the bidder will be obliged to set up a buffer. However, if a bid wins which did not include that particular aspect, that winner would not have to set up a buffer. Although scoring auctions are most common in procurement settings, they may also be used for auctions to sell.

The most common pricing rules for a scoring auction are first-score and second-score, analogous to pricing rules in a standard auction. In a first-score auction, the winner must perform in a manner that yields her winning score; whereas, in a second-score auction, the winner must perform in a manner that yields the second-highest score.

If the scoring auction is a sealed-bid first-score auction, then it is almost identical to a Single-Phase MFA (and RFP), as all bidders would submit their single bid indicating what they intend to perform, and the evaluator picks the one with the highest score based on the evaluation criteria. However, the advantage of the scoring auction is that the auction design can be more sophisticated, such as an ascending auction, which allows competitors to compete directly with each other not only on price, but on non-price factors, and adjust their bids based on information received during the auction.

An important feature of scoring auctions is that scoring auctions inherit the properties of the equivalent standard auctions, where bids are based on price alone. With a scoring rule that treats the price of the bid as an additive factor—that is, linear in the price—bidders have the incentive to choose the technical characteristics of their bid to maximize the technical score of their bid, such as by offering buffers, and adjusting their financial bid accordingly. Assuming the technical portion of the scoring rule accurately reflects the tradeoffs inherent in the service being provided, this implies that the winning bid is necessarily the one that maximizes social surplus.

To draw the analogy with standard auctions one could imagine that the technical score of the bid is playing the role of how much each bidder values the item in a standard auction. Another important result from standard auctions is that two auctions that decide on a winner in the same way, but determine the price paid differently, are equivalent in many respects. Translated for the scoring auction, the result states that two auctions that use the same scoring rule, but different pricing rules (first-score or second score), give the same expected payoffs to the bidders.

Asker and Cantillon (2008) show some results favoring a scoring auction over other alternatives, in the circumstances where the government can fully and accurately establish quantifiable objective criteria. Under these circumstances, they argue that a seller is better off using a scoring auction rather than imposing minimum requirements and conducting a price-only auction with an equivalent auction format. In addition, they state that the outcome of the first-price menu auction is inefficient. Finally, they derive a utility ranking of different variations of multiple factor auctions, which indicates how efficient the auction is. If an ascending format is adopted, a scoring auction, a menu auction, and a comparative hearing yield equal utility and thus are equally efficient. With a sealed-bid format, scoring and menu auctions are equivalent and thus equally efficient, whereas a comparative hearing is less efficient than scoring and menu auctions.

However, these results are all based on theoretical scenarios that seem implausible for the auction of wind rights. Therefore, a few important caveats should be mentioned with respect to these results.

First, it assumes that all criteria that are relevant to the auction are quantifiable and objective.

Second, the results assume that the bid taker—the government—fully understands the tradeoffs across all factors and can perfectly express those factors in the scoring rule. Governments often have limited information about these tradeoffs and make mistakes with respect to their representation. Bidders sometimes understand the tradeoffs better than the government and can exploit any government misunderstanding in their bids. In practice this leads to bid-skewing, making extreme bids either low or high on particular factors that are either expensive or inexpensive from the bidders' perspective. Bid-skewing is seen in timber auctions, Medicare auctions, and electricity auctions.

Third, many of the results apply to the auctioning of a single item. The generalization to auctioning many interrelated items often is far from trivial.

The government will have difficulty determining criteria that are quantifiable and objective, and will have difficulty defining the tradeoffs across all factors and expressing those factors in the scoring rule. Because of these inherent issues, we do not believe a scoring auction is a realistic option for auctioning wind rights.

2.4 General two-phase multiple factor auction

When spectrum auctions began in the late 1980s in New Zealand and the early 1990s in Australia and the United States, spectrum regulators around the world began to shift from comparative hearings to an auction format. Many regulators were uncomfortable with using a price-only process and believed that it was desirable still to evaluate perspective bidders' proposals to make sure that the spectrum licensee would serve the public interest. These governmental entities opted to combine a technical evaluation with an ascending price auction format. The procedures followed in these cases involved establishing objective minimum criteria to determine legal, financial and technical acceptance that once passed allowed qualified bidders to move to the second phase, a price-based auction. Many international spectrum regulators have used this approach in early auctions, although more and more regulators are converting to a price-only auction format, where qualification is objective.

The main advantage of the two-phased approach over the single-phase approach is that bidders will know if they were awarded any preferential treatment such as discounted bids, and can adjust their bids in the second phase accordingly. If the second phase is only a sealed-bid auction then this two-phase approach will add little benefit to bidders, as the additional information will not reveal the competition from others. A multiple-round auction or other auction which reveals information about other bids and allows the bidder to revise its bid accordingly in the second phase will allow bidders to compete more efficiently. Even so, manipulation and legal challenge are still an issue in the first phase, particularly if the criteria are subjective. Furthermore, bidders in multiple factor auctions with technical evaluations have an incentive to overstate their qualifications in order to qualify to bid or qualify for a bidder discount.

3 Product design

Any competitive auction process starts with the step of defining and carefully characterizing the product space of the auction. In some applications it is a straightforward task while in others the process requires a major effort to understand and design the lot structure that will promote the most efficient use of the scarce resource. In the case of wind rights on the US Outer Continental Shelf, the product

space design is exceptionally important, as all sorts of value interdependencies and strong complementarities among different locations for wind farms create a difficult environment.

The physical product space is defined in terms of areas of fixed sizes. The predetermined OCS area of interest is subdivided into a number of OCS blocks which are further subdivided into sixteen subdivisions. The subdivision is required to account for different oddly shaped areas on the boundaries of the OCS area. For example, the New Jersey OCS is assembled from 43 full blocks (each can be subdivided into 16 sixteenths of a block) and 33 partial blocks containing less than 16 sixteenths of a block.

For the purpose of defining the lot structure for the competitive process, it is important to understand that any physical boundaries created by these predetermined OCS blocks or partial blocks have little to do with the bidders' economic valuations. Therefore, a typical auction lot, consisting of OCS blocks or partial blocks, has to be structured in a way that will, most importantly, fit well with bidders' business plans without unnecessarily complicating the auction process. This way, the maximum economic value will be created in terms of both efficiently leasing areas for future electricity production and limiting the costs of the auction process for all parties involved.

It is instructive to think about two extreme examples. One can imagine conducting a package auction with lots defined on the sixteenth of a block level. This would allow bidders to specify their bids precisely. There are over 900 sixteenths of a block. This means there are 2^{900} combinations of packages. Not only would this be impossible for bidders to think through and specify, but solving for the value-maximizing assignment would be impossible. On the other hand, one can also imagine BOEMRE specifying a few pre-determined lots that would correspond to the tract that a bidder might ultimately want to lease. This greatly reduces the number of lots to a handful of lots per auction, but it does not provide any flexibility for bidders to obtain precisely what they want and does not adequately respond to the Indications of Interest in response to the RFI or Call.

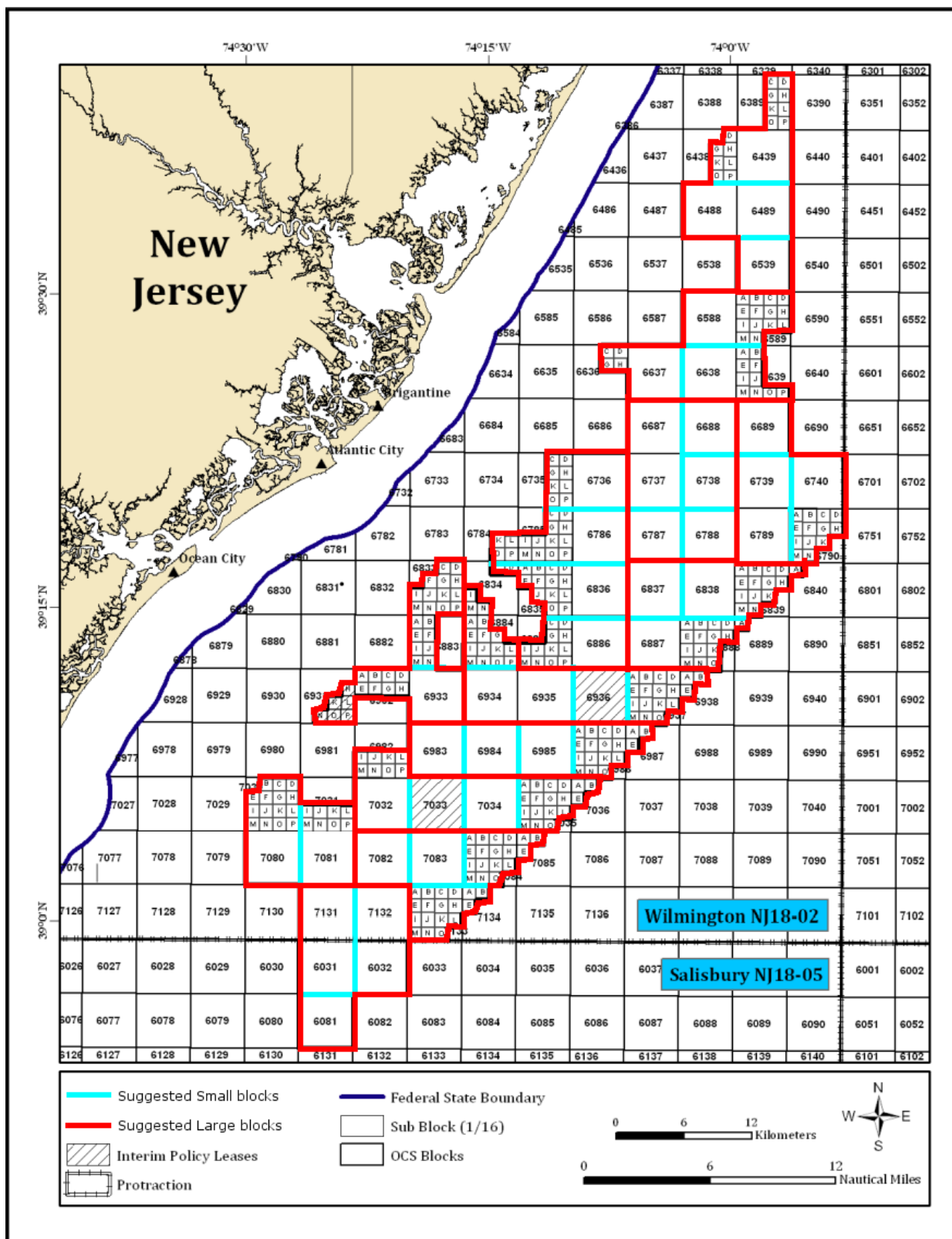
Bidders would not, of course, be interested in all 2^{900} combinations, and would only be interested in a small subset of these combinations that would be viable for their wind farm project, and the auction could be structured so that bidders only specify those packages. In fact, a clock auction is one way of achieving this. If all 900 sixteenths of a block were implemented as a clock auction, the auctioneer would name a set of 900 prices, one for each of the 900 lots, in a round and the bidders would specify just one combination of lots that they would be willing to purchase at that set of prices. In the next round, the auctioneer would set a new set of prices, and the bidder could specify a different combination based on these new prices. Thus, each round would allow a bidder to specify a new package if it wishes. If this were a package-clock auction, bidders would then be able to submit additional bids in a supplemental round, subject to certain constraints. To assure the value-maximizing assignment can be found in a reasonable time, each bidder could be limited to a maximum of number of combinations on which it can bid.

Even so, it may be possible to simplify the auction by holding an auction at the OCS block-level, or better yet, for lots that correspond to small groups of contiguous blocks. BOEMRE could apply a few simple rules to determine these lots such as the following:

- For partial blocks, group the partial blocks with one of its neighbors, preferably a full-block. Many of the blocks for New Jersey only contain 1 or 3 sixteenths of a block, and these can easily be combined with a full block next to it. These blocks may otherwise go unsold, as they cannot easily be used by others.
- For blocks that do not have any contiguous blocks on three of its four sides, group it with its neighboring block. Otherwise, this block may go unsold.

- In special cases, such as contiguous deep water lots with very similar properties, these could be grouped together as generic lots with assignment of such lots to winners being performed after the auction.
- Finally, based on the RFI responses, look for groupings that all potential bidders consider to be part of a set. For example, if in all responses, bidders have either selected to include blocks X and Y in their nominations or exclude blocks X and Y from their nomination – i.e. no bidder has chosen X and not Y, nor Y and not X – then both X and Y could be grouped together. However, it should be noted that as such RFI responses are not binding, such nominations may not reflect the bidders’ true interests. Furthermore, there may be other bidders who did not respond to the RFI which do want lots groups together in the way indicated by the RFI responses.

So, for 76 blocks in New Jersey, the worst case example is the bidders would need to bid for—and the system would need to process—up to 76 lots. Ideally, some of the 33 partial blocks can be merged with a neighboring block for purposes of bidding. And, based on other considerations, some of the 43 full blocks can also be merged. Two examples of how this could be achieved are shown in the diagram on the following page. The red boundaries show large groupings which would result in 13 lots, and the light-blue and red boundaries show smaller groupings which would result in 44 lots.



4 BOEMRE multiple factor auction

As already stated, we are not strong advocates of an MFA process to assign wind rights unless it can be structured as a price-only ascending auction. A multiple round ascending auction allows for price and assignment discovery, which is critical for bidders to refine their understandings of the relevant tradeoffs. This discovery process typically will result in a much more efficient assignment mechanism than the sealed-bid alternatives.

In most auctions, once a potential interested party has been qualified as being eligible to bid for a given product, few, if any, selection criteria are used to give one party an advantage over another party in an auction. There are, of course, exceptions.

- If it is desired to promote small businesses, it may be desirable to use bidder discounts.
- If it is desired to create and maintain a competitive market structure, it may be desirable to enforce a percentage cap on what any winner can win. Sometimes this cap also includes the bidder's prior holdings and so is bidder specific.
- If there are attributes of a particular bidder's business plan that bring additional social value, it may be desirable to give a bidder discount that reflects this externality. For this to be practical, the externalities must be clearly articulated and verified. Then this can be factored in using an appropriate bidder discount.

We understand that for some tracts, the Final Rule contemplates a multiple-factor auction based on financial bid variables and nonmonetary variables including technical merit, timeliness, financing and economics, the environment, public benefits, consistency with state and local needs and requirements and other factors. It is critical that participants will feel that they are being treated fairly in the competitive lease process. This will promote competition and reduce the risk of litigation. The Federal Register, Volume 74, No. 81, (\$285.220) states that the renewable energy leases must be issued "through a simple and straightforward process in a fair and equitable manner."

BOEMRE is considering two types of MFA auctions: the single-phase multiple factor auction and the two-phase multiple factor auction. BOEMRE recognizes that it needs to strike a balance among potentially conflicting concerns:

- (i) Encouraging competition and receipt of a fair return;
- (ii) Ensuring the acquisition of the lease rights by the companies that value them most highly;
- (iii) Inducing results in which bidders are capable of and likely to acquire the most efficient set of leases for their desired projects;
- (iv) Promoting fair and equitable treatment;
- (v) Accommodating bidder pre-sale development efforts and facilitating state efforts to advance offshore wind energy development;
- (vi) Mitigating the "winner's curse" effect, common to sealed-bid first-price auctions; and
- (vii) Providing for an administratively efficient and time-sensitive auction process.

These measures are considered for both the single-phase multiple factor auction and the two-phase multiple factor auction. In addition, we raise any provisions that may be necessary to address specific competitive or state-level concerns in practice and identify methods for encouraging emerging technologies.

4.1 *Single-phase MFA*

4.1.1 Recommended configuration

To implement a single-phase MFA, BOEMRE would establish and publish a set of objective criteria that would be used to qualify bidders (both technical and financial) so as to adjust the bids that are submitted with the bidder's lease application. Criteria and bidder discounts used to adjust these bids for the single-phase MFA are discussed in Section 4.1.3 below.

In the single-phase MFA, the bidder would submit their lease application and their bonus bids simultaneously as a single response. In order to ensure that competitive lease applications are only submitted by credible serious applicants, a bid deposit should be required at the time of submission.

BOEMRE staff would evaluate and score the applications. The bidder discount for each qualified bidder would be calculated. The bids that each applicant submitted would then be evaluated to determine the winning bidders for each lot. Finally, the price that each winner pays would be determined. Section 4.1.5 documents how the bids would be evaluated to determine winning bidders, and how the winning prices would be determined.

BOEMRE would need to establish and publish how applicants would submit bids in the single-phase MFA auction. There are multiple ways that BOEMRE could organize the bidding in a competitive single-phase MFA leasing process, including:

1. Large, pre-defined lots: BOEMRE would create a small number of large, pre-defined lots that correspond to the number of wind farms that it believes can be supported by the area offered in a given auction. Bidders would be able to bid for any or all of these lots.
2. Generic lots: A group of the blocks, which very similar properties, would be treated as generic blocks, allowing bidders to submit a price/acre. Bidders would be able to choose their tracts in priority order based on the price used to determine winners.
3. Submitting a set of package bids for lots: BOEMRE would define the lots for a given area. Each lot would be one or more blocks. Bidders submit a set of package bids (with corresponding prices for each of these packages). A winning package of lots would be considered a tract. (As discussed earlier in Section 3, offering lots smaller than a block is not a viable option.)

All of the options have advantages and disadvantages in a single-phase MFA. Creating large, pre-defined lots would make the bidding simple and straightforward for the bidders, but it may not be simple for BOEMRE to create large lots that would satisfy most bidders' business plans. The benefit of pre-defined tracts is that there is a greater chance that all of the blocks will be assigned. Using generic lots and having bidders submit a price/acre would only work if the relative values are similar, which is typically not the case for blocks close to the coastline. This option also has the added challenge that bidders should not be able to carve up the ocean space to leave pockets of blocks that are difficult to utilize. Allowing bidders to submit a set of package bids for their most preferred lot combinations is likely preferable to bidders, as they can specify their value for specific packages of lots. There is some risk that the bidders' unique preferences may not fit perfectly at the block level (instead of the sixteenth of a block level), but we believe that is minimal. The disadvantage is that this option puts greater burden on bidders thinking through various combinations of what they would be satisfied with. A well-designed package-bid entry system will help to mitigate these concerns. Combining blocks into lots will also help, as it will reduce the number of package combinations to consider.

If a single-phase MFA is used, we believe BOEMRE will favor the third solution (submitting a set of package bids for lots) for any situation where there are a number of overlapping bids (such as New

Jersey), and will favor the first solution (creating large, pre-defined lots) for simpler scenarios. The third solution is particularly important in a single-phase MFA (as compared to a two-phase MFA) as bidders would want the greatest chance of winning something, and when they are unaware of which lots other bidders will bid against, the best approach to achieve this is to bid against as many different combinations of lots as possible, to increase the chance the it will be matched with packages from other bidders when winners are determined. In this third solution, bids are mutually exclusive (as outlined in Section 4.1.2) and the system can solve the optimization to determine the winning packages (noting that each bidder can win a maximum of one package), as outlined in Section 4.1.5. That said, it is worth noting that *any* single-phase auction has one huge disadvantage: bidders do not have the advantage of price discovery that a two-phase auction will provide, and therefore if there is significant uncertainty over the value of the lots, bidders will be unsure as to what bid to place. For example, if a bidder knew that he just needed to increase his bid by \$1,000 to win the contract, he may be willing to do that. Furthermore, if the auction were a first-price auction, this lack of information would be exacerbated, as bidders would be exposed to the “winners curse” problem. Thus, we suggest BOEMRE to use a two-phase auction instead of a single-phase auction. This is described in greater detail in Ausubel and Cramton (2011b) and in Section 4.2.5 below.

4.1.2 Bidder’s choice

In a single-phase MFA, the bidder’s choice mechanism would be different, depending on which of the three auction formats identified in the previous section was implemented.

Large, predefined lots: Bidders would need to submit the following bid information to BOEMRE with their application and bid deposit:

- Single bid amount that the bidder would be willing to pay for any of the predefined lots (if generic) or for a specific lot (if lots are unique); and
- A numerical ranking of all of the available lots. (1 for the most preferred, 2 for the second most preferred, and so on)

BOEMRE would assign the highest bidder his most preferred tract (the tract that he assigned a rating of 1). The highest bidder’s chosen tract would be removed from the available tracts and the second highest bidder would be assigned his most preferred tract from those remaining to be assigned (which may not be his first choice, as his first choice may not be available), and so on until all tracts are assigned. The bidders’ payments would be adjusted by the relevant bidder discount.

This process is simple and straightforward but there are several obvious problems with the procedure outlined above. Because BOEMRE would be predetermining the lots, the procedure will not induce results in which bidders are capable of and likely to acquire the most efficient set of leases for their desired projects. Creating nearly equivalent lots to facilitate a simple, single phase, bidder choice process assumes that all bidders have similar business plans.

Generic lots: Bidder with the highest price is used to determine winners and will have first choice of tracts. BOEMRE will be faced with the huge challenge, as rules would need to be developed to eliminate opportunities for the highest bidders to choose blocks and partial blocks to disadvantage the remaining winning bidders. Eliminating gaming opportunities will likely complicate the auction rules considerably and it is unlikely that every eventuality could be accounted for. For example, how would partial blocks be handled? How would a bidder be prevented from isolating blocks such that nobody but the particular bidder would want them?

Package bids: Bidders will win the packages that maximize total value. Bidders specify the packages they wish to bid for, and all packages are mutually exclusive, so a bidder can only win one of its packages. This ensures that a bidder can manage its budget and doesn't win more than it was expecting. This design allows bidders to choose between different mutually exclusive packages based on price. Ausubel and Cramton (2011a) describes the advantages of this approach in greater detail.

4.1.3 Selection Criteria

The Federal Register, Volume 74, No. 81, (§285.220) states that the renewable energy leases must be issued "through a simple and straightforward process in a fair and equitable manner." Our guidance on this issue is as follows. Any criteria that will be used to give one applicant priority over another applicant must be:

- Transparent: documented ahead of time.
- Objective: must not require subjective evaluation.
- Simple: Ideally, it should have a clear "yes" or "no" answer.
- Verifiable: BOEMRE can ask the applicant to provide evidence that supports their answer.

Our recommendation is to choose the factors carefully, and then give bidders that satisfy the criterion a percentage bidder discount, as opposed to a fixed dollar amount. This approach is consistent with bid adjustments done in other environments. Percentage discounts can be applied to any of the auction designs outlined in our first paper, "Auction Design for Wind Rights" (Ausubel and Cramton 2011a). An alternative is a dollar discount associated with each factor, but our experience is that government agencies find percentage discounts easier to set than specific dollar values. Percentage discounts are common, whereas we are unaware of the use of dollar discounts.

A large body of practical research has evaluated alternative methods of preferential treatment that are used in government auctions across several industries and countries. In general, two important effects have been identified. These effects can be easily demonstrated using the proposed bidder discount within an MFA. First, an introduction of bidder discounts leads to less aggressive competition by advantaged entities and more aggressive bidding by bidders without any preferential treatment. Second, correctly accounting for the potential participation decisions by both present and latent participants should play a major role in evaluating relative performance of the preferential treatment alternatives. This finding has important implications for any practical process that involves determining the exact nature of the preferential treatment program to be used and its quantitative characteristics.

Several papers report their findings for bidder discount programs. Athey et al. (2011) shows in timber auctions that a bidder discount program can replace the current set-aside program in order to promote the government goal of awarding at least 23 percent of contracts to small businesses. They estimate that a discount of just 6 percent will result in a higher level of efficiency and revenue in U.S. Forest Service timber auctions. Another prominent example of bidder discounts for small businesses is seen in the FCC spectrum auctions. These auctions often given small business discounts ranging from 15 to 25 percent. Government construction contracts often give a 5 to 10 percent bid discount for small businesses. For example, California gives small businesses a 5 percent discount in highway pavement procurement projects. The U.S. Department of Defense applies a discount of 50 percent to domestic firms in their competition with foreign firms for defense contracts (U.S. Department of Defense 2008).

We warn that experience with bidder preferences has been mixed. Bidder discounts work best if these discounts are modest. In most auctions, once a potential interested party has been qualified as being eligible to bid for a given product, few, if any, selection criteria are used to give one party an

advantage over another party. Using extreme bidder discounts can have a dramatic impact on revenues and efficiency as it creates strong incentives for bidders without a discount to abandon the costly auction process altogether. Thus, our recommendation is to limit the magnitude of discounts.

Each criterion should only be worth a small discount, and the total discount should add up to a modest amount, such as 25%. State and Federal programs that use discounted prices to give preferential treatment to bidders with specific characteristics, such as small businesses, are all below 50%, and typically 25% or less. Note that this strategy of discounting prices is objective, transparent, and simple. Percentage discounts can be applied to any of the auction designs outlined in Ausubel and Cramton (2011a).

One way BOEMRE could determine the factors and associated bidder discounts for a particular auction is to establish a procedure such as the following:

- 1) Compile a comprehensive list of factors that could be used to establish the bidder discounts.
- 2) Eliminate any factors that are not objective, transparent, simple and verifiable. The strategy of discounting prices is objective, transparent, and simple, if it is using objective, transparent, and verifiable criteria. Some factors may be difficult to evaluate, and therefore, it may not be possible to incorporate such factors into the bidder discount algorithm.
- 3) Eliminate factors that are an integral part of the evaluation criteria during qualification where all qualified bidders would receive this discount.
- 4) Eliminate factors for activities that bidders would normally do anyway after winning the contract, especially if these bidders would have better access to the capital markets by doing them upfront. Two examples of this are investing in site evaluation efforts or conducting geologic and geophysical evaluations ahead of time. By doing these activities upfront, bidders might have better access to the capital markets – and at better rates – which will benefit them going forward. Bidders that did not do these studies ahead of time would normally set funds aside to conduct these activities – and would not use these funds for bidding.
- 5) Eliminate factors that have significant outside benefits. For example, having a PPA that is approved by the state would undoubtedly yield much better access to the capital markets at more favorable rates, resulting in lower costs going forward. Another example would be any state-level agreement that results in subsidies for building out the OCS area adjacent to that state. The bidder already has significant benefits from holding these contracts, and additional discounting in the auction setting may not be warranted.
- 6) For the remaining factors, BOEMRE could then internally evaluate the likelihood of project success if this factor is met, and assign bidder discounts to these factors. The exact factors to consider and the associated percentages will vary by lease area, depending on conditions specific to that area.

Compiling a list of potential factors to consider for bidder discounts can be challenging. All potential factors must be objective and have simple and clear responses. Many factors that can be proposed for a bidder discount are subject to gaming and litigation. For example, what constitutes “Has applicant conducted site evaluation efforts?” Is going out in a boat and performing a few simple tests sufficient for a discount? Another challenge is defining the criteria for each factor. For example, a power purchase agreement (PPA) is viewed differently if it is approved by the state utility commission, as the bidder is then eligible to recover costs in excess of the wholesale cost of electricity and thus might have more access to the capital markets. Even criteria such as “Has applicant tested deep water, off shore wind technologies?” seems subjective to us. If criteria such as “Has applicant tested deep-water, off-shore

wind technologies?” can be made less subjective, then perhaps this criteria might be considered for a bidder discount.

As noted above, it is important to distinguish between criteria that might be used as part of the technical review in the qualification step when indications of interest are evaluated and those later used to determine a bidder discount. According to the Final Rule, the lease award process begins with a qualification step that takes place before the Competitive Lease Award Program commences. This qualification step takes place after materials are received in reaction to a Request for Interest or a Call, and should set the minimum bar for who is allowed to potentially win lots. This qualification step would vet potential interested parties to ensure they have technical expertise, adequate management skills, and adequate financial resources. All of the criteria that BOEMRE mentioned as potential variables to consider for ranking bidders during the Competitive Lease Award Process of a Multiple Factor auction are appropriate for the qualification step, as long as minimum requirements can be objectively specified and evaluated (such as requirements that can be answered by a simple Yes/No). If BOEMRE requires factors over and above these minimum requirements to influence the outcome of the auction, such factors could be included in setting the bidder discount.

While it may seem natural to reward bidders who have already made substantial specific investments in wind power in the region, some of these investments are already rewarded in the auction without any discount. For example, many of these investments will improve the bidder’s access to the capital market – and at better rates, since the specific investments imply lower risk of failure. Better rates means lower costs going forward, and therefore enables the bidder to put forward a more favorable bid compared to a bidder who has not made such investments. Also, many of these activities may be activities that all winning bidders would likely do (either ahead of time or shortly after winning the auction), and bidders would not have these funds available for bidding purposes in any case. Therefore, these factors should not be included in the bidder discount, as they are already being awarded.

Note that some bidders may automatically meet one criteria if they have met the other: e.g. applicants who have implemented off-shore wind energy in adjacent water are also a certified winner of a competitive process for offshore wind energy. Thus, there can be a cumulative effect in the bidder discount for some of the bidders.⁵

Table 1 provides a hypothetical list of factors that could be considered for a bidder discount. This table highlights which factors might be eliminated because they are a mandatory part of qualification; which factors might be eliminated because they are not objective, transparent, simple and verifiable; and which factors might be eliminated because they already reward one bidder over another bidder in for costs going forward. Table 2 continues the hypothetical example, and assigns bidder discounts to each of the remaining factors. Of course, these percentages are purely hypothetical. It is impossible to determine in an objective manner what these values should be – they can be assessed based on the relative importance of the factors, but this, and the total percentage assigned to bidder discounts is somewhat subjective. Note that the percentage discounts in one lease area may be different than the discounts for another lease area, depending on state-specific issues. Our auction research, design and implementation experience allows us to opine on the effect of bidder discounts on auction efficiency; the exact factors used to determine the bidder discount should be determined by BOEMRE and other industry experts.

⁵ Cumulative bidder discounts are fairly common. For example, in early FCC auctions, bidders who were both small business owners and woman or minority-owned received both discounts.

Table 1: Hypothetical List of Factors to consider for a bidder discount

Potential factors	How to evaluate factor	Mandatory part of qualification?	Difficulties determining if objective, transparent, simple and verifiable?	Sunk costs providing financial benefit going forward (capital markets, state subsidies).
Has applicant provided a detailed project plan for federal waters?	Yes / No	YES	-	-
Has applicant identified adequate sources of financing?	Yes / No	YES	-	-
Currently a holder of an interim policy lease for federal waters?	Yes / No	-	-	-
Currently a holder of a power purchase agreement in an adjacent state?	Yes / No	-	-	YES (likely will provide better access to capital markets)
A certified winner of a competitive process for off-shore wind energy in an adjacent state?	Yes / No	-	-	-
Implemented off-shore wind energy in adjacent state?	Yes / No	-	-	-
Prepared and submitted response to state RFP for off-shore wind energy in an adjacent state?	Yes / No	-	-	-
Has applicant constructed a meteorological tower?	Yes / No	-	-	-
Has applicant tested deep-water, off-shore wind technologies?	Yes / No	-	YES (Do simple tests count?)	YES (better access to capital markets)
Has applicant conducted site evaluation efforts?	Yes / No	-	YES (Do simple tests count?)	YES (better access to capital markets)
Has applicant conducted geologic and geophysical evaluations?	Yes / No	-	YES (Do simple tests count?)	YES (better access to capital markets)
Has applicant conducted NEPA-related assessments?	Yes / No	-	-	-

Table 2: Example factors used in setting bidder discount

Potential factors	Criteria	Percentage discount
Currently a holder of an interim policy lease for federal waters?	Yes / No	3%
A certified winner of a competitive process for off-shore wind energy in an adjacent state?	Yes / No	5%
Implemented off-shore wind energy in adjacent state on time?	Yes / No	3%
Responded to state RFP for off-shore wind energy in an adjacent state?	Yes / No	2%
Has applicant constructed a meteorological towers?	Yes / No	5%
Has applicant conducted NEPA-related assessments?	Yes / No	3%
TOTAL		No more than 25%

4.1.4 Mitigating collusive behavior

In many ways, the protections to mitigate collusive behavior in a single-phase multiple factor auction are similar to those of a sealed-bid auction. A single-phase multiple factor auction takes place in a single round, thus minimizing the chance for collusion. That said, it is important that applicants be prohibited from engaging in collusive behavior during the competitive process.

One of the stated goals for awarding leases for wind rights for the US Outer Continental Shelf is that the competition process must be “open and fair.” It is quite common for US government auctions to make the list of bidders publicly available before the start of the auction. We believe that most companies would be aware of who might be applying for leases for offshore wind farms in a given, large geographic area. A competitor might not know which tracts are the most valuable to these companies, and should not know what these tracts are worth to that company.

Trying to balance these goals, we believe that a list of bidders for each auction should be published following a response to an RFI or a Call. This may help interested parties to work together to build out the lease area without a competitive process. However, BOEMRE should not publish the specific areas of interest submitted by bidders. First, if a bidder strongly suspected that a given lease area will have competitive interest, and if they knew that their desired lease area would become public knowledge, that bidder might want to submit a bid for the entire lease area rather than reveal what their bid might be during the competitive process. Otherwise, competitors can very easily collude with other companies to strategically place bids to block certain interested parties from winning a tract area. Second, if BOEMRE did not reveal this private information to other bidders, it would most likely receive more accurate information about areas of interest. This could be useful in determining lots for the auction.

Once a bidder submits a binding bid for the auction, they should be prohibited from discussing their bids with other companies on the list, either directly or indirectly. No further information should be released by BOEMRE until after the winners have been determined, at which point, the identity of the bidders, bids, and bid selection criteria can be released to the general public.

4.1.5 Designing the bid-adjustment mechanism and determining the winner

A standard approach for incorporating the factors in a Single-Phase MFA is to use the technical part of the bid submission to calculate a “bonus bid” and then apply that “bonus bid” to the financial proposal. BOEMRE identified two options to transform bonus bid amounts into effective “auction amounts” for determining the ranking of bidders or the winning bid in the auction. The “fixed discount” option would apply the adjustment factor to the BOEMRE-specified Minimum Bid Requirement, i.e., the starting bid, to calculate a fixed amount to be deducted or added to each bidder's bonus bid. This option effectively adjusts the starting positions of the bidders at the outset of the fiscal stage and is preserved for the duration of the auction. The “proportional discount” option would apply the adjustment factor to modify the bonus bid proposed by the bidder in their sealed bid. Such discounts are usually referred to as bidder discounts or bidding credits. For the purpose of this paper, we refer to a bidder-specific discount as a bidder discount.

Typically, all bonus bids are compared without applying bidder discounts. Once winners are identified, winners’ payments are reduced by a bidder-specific discount, as shown in Table 3.

Table 3: Approach to applying bidder discounts

	First-price auction	Second-price auction
Determining winner	Your bid	Your bid
Determining price	Your bid * (100% – Your percentage discount)	Second price * (100% – Your percentage discount)

This approach to applying bidder discounts is preferred, since it enables easy comparison of bids across all bidders. As stated in Ausubel and Cramton (2011a), a second price auction is preferred for a sealed bid auction (which a one-phase MFA is effectively) as it encourages bidders to bid their values. Further information about second price auctions can be found in that Paper.

Note that if bidders are permitted to submit package bids for a number of packages of lots, these discounts would be applicable to all packages. If bidders place package bids, the system will solve the value optimization problem, by examining all packages placed by all bidders and determining the winning packages, based on the assumption that each bidder can only win a maximum of one package. The algorithms for determining this value maximizing set are well understood and can be easily implemented using tools such as CPLEX.

4.2 Two-phase MFA

4.2.1 Recommended configuration

To implement a two-phase MFA, BOEMRE would establish and publish a set of objective criteria that would be used to adjust the bids that are submitted during the second phase of the MFA. The criteria for determining the bidder discount is similar to what was described for the one-phase MFA, as described in Section 4.1.3. This process of determining the bidder discount is, in fact, the first phase of the two-phase MFA.

During the first phase of the two-phase MFA, each bidder would submit its lease application with documentation justifying any bidder discount. In order to ensure that competitive lease applications are only submitted by credible serious applicants, a bid deposit should be required at the time of submission.

After Phase 1 closes, BOEMRE staff evaluates and scores the applications. The bidder discount for each qualified bidder is calculated. After the first phase concludes, BOEMRE would notify each bidder if they qualified for a bidder discount, and what the bidder discount is. This information is necessary so that bidders can properly bid in the second phase of the two-phase MFA.

During the second phase of the two-phase MFA, bidders would submit bids for the lots being offered. The bids that each applicant submitted would then be evaluated to determine the winner(s). Finally, the price that each winner pays would be determined using the bidder discount determined in the first phase. This approach of applying the bidder discount to determine each winner's price is the same as what would be one in a single-phase MFA. Section 4.1.5 documents how the bids would be evaluated to determine winning bidders, and how the winning prices would be determined.

This bid adjustment strategy works for any of the auctions listed in the family of auctions described in Ausubel and Cramton (2011a). In a two-phase MFA, BOEMRE has greater flexibility in defining the bidding process since the second phase can be implemented as any of the recommended formats, including a clock auction or a package clock auction. For the package clock auction, the ascending clock rounds allow for price discovery and the supplemental round allows bidders to express their preferences for other packages of lots that would meet their needs for their unique business plans. These auction designs are covered in more detail in the first paper.

As with the single-phase MFA, the product design will influence what type of auction should be chosen. Assuming BOEMRE decides to auction lots that equate to one or more blocks, our recommendation with respect to format are the same as in Ausubel and Cramton (2011a).

In a two-phase MFA, the bidding process (second phase) would proceed in the same manner as in a price-only auction. The only difference is that once winners are determined, gross payments are discounted by the bidder discount.

4.2.2 Bidder's choice

The auction design used in the second phase of a two-phase MFA can vary. If a sealed-bid auction is used for the second phase (either submitting a single package or multiple packages), the bidder has more knowledge about how much he will ultimately pay in the second phase if he wins because he knows his bidder discount ahead of time. This might influence the number of lots he bids for. If a clock auction format or package-clock auction format is used for the two-phase MFA, the bidder knows a lot more information. As before, he has more knowledge about how much he will pay in the second phase if he wins because he knows his bidder discount ahead of time. Depending on the information policy within the auction, the bidder will also know how much demand there is for particular lots. This means he can adjust his choice of lots in his package dynamically as the auction progresses. The remainder of this section discusses bidder choice as it applies to a clock auction or a package-clock auction.

In a two-phase MFA, as with the single-phase auction, the bidder choice process will depend on the structure of lots up for auction: large, predefined lots, generic lots, or something more complex requiring package bids. A two-phase MFA gives more flexibility for each of these options:

Large, pre-defined lots: One approach for auctioning large, pre-defined lots is to treat each lot as unique and use a package-clock auction format. This would allow price discovery to occur during the clock phase, and would allow bidders to specify unique 'exit prices' for each of the lots during the supplemental round. If the auction rules allowed for it, bidders could also bid for more than one of these large, predefined lots.

This product design is not as desirable as the “package bids” option described below. With large, pre-determined lots, BOEMRE is predetermining the combination of lots to auction off instead of allowing bidders to create their own package. Thus, this procedure will not induce results in which bidders are capable of and likely to acquire the most efficient set of leases for their desired projects.

Generic lots: This would be done using an ascending clock auction where bidders simply place a bid for a number of acres at a given \$/acre. An assignment phase could follow this clock phase.

This product design is not as desirable as the “package bids” option described below, as BOEMRE will most likely have difficulty finding lots that can be considered equivalent (and thus generic).

Package bids: We would recommend using a package clock auction in a two-phase MFA. As stated in Section 4.1.1, it is unlikely that BOEMRE would be able to specify large pre-defined lots nor make the lots generic, and thus the “package bid” scenario is the most likely scenario for most auctions. Certainly, this is the case in New Jersey, where there are a number of overlapping bids. The rationale behind the choice of auction format is explained in detail in Ausubel and Cramton (2011a).

Whichever of the above formats is chosen, we strongly recommend a two-phase MFA over a single-phase MFA to allow for price discovery. This allows the process to be more open such that participants feel they are treated fairly. It also promotes the efficient assignment of lots.

4.2.3 Selection Criteria

The selection criteria for a two-phase multiple factor auction would be the same as for a single-phase multiple factor auction, as described in Section 4.1.3 above.

4.2.4 Mitigating collusive behavior

For the time period leading up to the first phase of the two-phase MFA, the recommendations for mitigating collusion are similar to those for a single-phase MFA. We recommend BOEMRE publish the names of companies who expressed interest in the lease area, either as a response to an RFI or a response to a Call. However, BOEMRE should not publish the specific areas of interest submitted by bidders.

Once a bidder submits their bid for the first phase of the MFA, they should be prohibited from discussing their bids, bidder discount or bidding strategies with other companies on the list, either directly or indirectly. BOEMRE will notify each bidder of their bidder discount after Phase 1; BOEMRE should not publish what other bidders received for their bidder discount at this point, as that might reveal business sensitive information prior to them winning a license. All bidders should be prohibited from discussing their bidder discounts with any other bidders who expressed interest in the auction.

During the second phase of the MFA, more stringent procedures need to be put in place, as there is greater risk that bidders will collude during the auction since they will know who is participating and have information about bids in previous rounds. We recommend the auction be designed in such a way to limit signaling (one bidder using its bids to signal something to another bidder). This is generally done by:

- Providing information back to bidders that is aggregated (so that it does not show information about a single bid), if possible, or made anonymous, if not. For clock auctions and package clock auctions, bidders would typically know the aggregate demand for each lot (and thus the surplus for each lot); bidders would not typically know the details of the individual bids. Note that clock auctions and package clock auctions do not have ‘winners’ each round; thus, only aggregate demand for each of the lots needs to be published.

- We recommend only revealing summary information to bidders after each round. However, if information about single bids must be revealed during the auction based on government regulations, the design should minimize the flexibility that the bidder has in specifying its bid. For example, by providing predefined bid amounts that bidders can choose from instead of allowing the bidder to specify any dollar amount, a bidder is less able to signal messages to other bidders. Another approach is to write the auction rules so that all bid information that is for prices other than the end of round price is masked in some way. For example, if a bidder were to enter an exit price that is less than the end of round price, the price that is shown to other bidders might be the price range for the round, rather than the actual price they dropped out at.⁶

Once the auction has concluded, BOEMRE should publish a list of winning bidders, the lots they won, and the price they paid. BOEMRE should also publish all bids and the bid selection criteria at this time.

4.2.5 Designing the bid-adjustment mechanism and determining the winner

Similar to the process described in 4.1.5, a standard approach for incorporating the factors in a Two-Phase MFA is to use the first phase of the bid submission to calculate a “bidder discount” and then apply that “bidder discount” to the price of the winning bid in the second phase. Clock Auctions and Package Clock Auctions often use a second price approach to determining the winning price. The “bidder discount” is applied to this second price in the same way as it was with a sealed-bid approach in a single-phase MFA. In a package clock auction, bidders are permitted to submit package bids for a number of packages of lots. These discounts would be applicable to all packages. See Table 2 for more information.

4.3 Comparison of single-phase and two-phase MFAs

The performance metrics for evaluating alternative MFAs are essentially the same as stated in our companion paper on standard auctions. Chief among these metrics is efficiency—assigning the wind rights to maximize social welfare.

We believe in all circumstances a two-phase MFA should be used. The first phase, qualification, determines the set of qualified bidders and identifies the bidder discount each bidder will receive. The second phase is the auction phase. This approach is simple and does not restrict in any way the set of auction formats in the second phase. Indeed, the tradeoffs among auction formats in the second stage is unaffected by the use of additional factors as part of the qualification phase.

To limit litigation risk, it is important to make the factors considered in the qualification stage objective, simple, and verifiable. They also must be consistent with the broad objectives of the program.

5 Illustrative MFA for New Jersey

In the New Jersey Request for Information (RFI) process, eleven companies indicated interest in building a wind farm in federal coastal waters off New Jersey. Among the respondents were large energy companies, domestic and international firms, start-up companies, and experienced offshore wind farm developers. The interest expressed by the companies that responded varied considerably and there was clear overlap in their preferences. Virtually all of the companies chose contiguous blocks and partial

⁶ The FCC experienced ‘bid signaling’ in at least one of its early auctions. The software was subsequently changed to limit the prices bidders could enter.

blocks in their indication of interest. One company, US Mainstream Renewable Power for example chose multiple mutually exclusive projects areas. A few of the companies proposed large areas of the New Jersey federal offshore area that would likely require a phased approach to implement.

Based on the indications of Interest filed in June 2011, it is clear that there are multiple feasible lease areas, and there are strong and varied complementarities across the product space. It is less clear that the tracts are dissimilar since US Mainstream expressed interest in three mutually exclusive project areas suggesting that they would be willing to obtain any of the three targeted areas.

Based on our analysis in Ausubel and Cramton (2011a), see especially Table 1, we would recommend that BOEMRE implement a package clock auction of specific lots. The package clock auction effectively enables bidders to capture complementarities across lease areas area allowing them the greatest degree of flexibility when it comes to submitting bids on the most efficient set of leases for their desired projects. Other auction formats would either be too subjective (comparative hearing, scoring auction) or would not provide any price discovery for bidders (single-phase MFA, sealed bid auction). A clock auction by itself would not be sufficient to support bidders that have stated that they are willing to accept any one of several different tracts, such as US Mainstream Renewable Power did in its indication of interest for the New Jersey OCS auction. In addition, the potential for undersell is much greater with a clock auction in this circumstance.

Should BOEMRE be inclined to favor the MFA format in New Jersey, we would recommend that the New Jersey auction be a two-phase MFA, using the package-clock auction design in the second phase. We are not yet in a position to make specific recommendations about what technical factors should be considered in determining the bidder discount. Whatever is considered should be transparent, objective, simple, and verifiable. Possible factors are technical merit, timeliness, financing and economics, the environment, public benefits, and consistency with State and local needs and requirements.

An auction process can facilitate larger, phased approaches to building wind farms by implementing rules that require lease holders to build out a percentage of their lease within a specified timeframe. Further build-out of a greater percentage of the lease area might be required within a subsequent timeframe and so on until the lease is fully built out. This approach is used in spectrum auctions where the spectrum regulator generally specifies the percentage of the geographic area or population to be served within a specified number of years and specifies a larger percentage to be served within a subsequent number of years.

Details of the auction rules and other procedures are best left for another document. An outline of the recommended rules is given in “Comparison of Auction Formats and Recommendations for Auctioning Wind Rights,” Ausubel and Cramton (2011b).

6 Summary evaluation of auction formats

In this paper we have evaluated and compared single phase and two-phase multiple factor auctions, as well as two other mechanisms, a comparative hearing and a scoring auction. A comparative hearing, in which only technical factors are taken into account, was used extensively by the FCC in the past, but typically fails when demand exceeds supply, as some participants would participate with the intention to sell the item they received at a later date. The process was long, and typically fraught with litigation. At the other extreme are scoring auctions, where bidders participate in an auction in which they can specify bids for technical as well as financial factors combined to provide a bid “score,” for example by providing a higher financial bid if their proposal includes additional non-financial benefits. This enables modern auction techniques to allow for price (and non-price) discovery. While such an

approach looks attractive in theory, the success of the theory assumes that the government has perfect information and can perfectly weigh up the financial and technical factors, all of which are quantifiable and objective.

Our evaluation of multiple factor auction formats is the same as our evaluation of price-only auctions. The problems associated with a single-phase MFA are equivalent to the problems with a sealed-bid auction, described in Ausubel and Cramton (2011a). The key problem being that there is no price discovery, and therefore bidders do not receive feedback on other bids and the opportunity to revise their bids accordingly. This is critical when the value of the leases is unclear, which we expect to be the case with wind tracts.

Therefore, of all evaluation techniques that take into account technical factors, we would recommend the two-phase MFA. This is because, by applying the simple bidder discount approach to accommodating factors other than price, it is possible to run the second stage as a price-only auction adjusted by these discounts. Therefore, modern auction techniques can be adopted, in particular, the ascending clock (and package clock) auction designs that were recommended in the first deliverable. We recommend a bid adjustment which is percentage discount applied to the bid, based on meeting key technical requirements, as illustrated in Table 2. We would recommend that the total bid discount be no more than 25%, as has typically been the approach with State and Federal programs in the past.

Crucially the criteria need to be transparent (documented ahead of time), objective (must not require subjective evaluation), simple (ideally, it should have a clear “yes” or “no” answer), and verifiable (BOEMRE can ask for evidence to support the answer). This leads us to one of the key criticisms of the MFA approach, which is whether such criteria can be specified, and can be objectively balanced against each other and against financial factors. Certainly, past experience has shown (as illustrated in Section 1.1), that state programs have migrated towards price-only auctions with technical factors being used in qualification, and sometimes within competition constraints (as will be outlined in deliverable 3). Furthermore, many technical factors may be taken into account within the bid, without requiring discounts. For example, companies that have made significant investments will be able to bid more favorably than those that have not.

However, we appreciate that there may be certain reasons why technical factors need to be incorporated within an MFA auction. If so, as with price-only auctions, the auction process would consist of two stages. The first is qualification in which a set of minimum requirements must be met for the participant to take part in the auction. The second stage is the auction itself. Assuming the auction is a two-phase MFA, in the first phase, factors other than price are identified and a bidder discount is set for each bidder, based on the qualification materials. Then, in the second phase, a suitable price-only auction is conducted. The winners are then determined. Finally, the gross payments of the winners are reduced by the bidder discounts.

The comparisons among auction formats for the second phase of the MFA are the same as those in Ausubel and Cramton (2011a) and are shown in Table 4.

Table 4: Evaluation of auction formats

Scenario	Best Approach	Reason
Single area of overlapping interests; low common-value uncertainty	Sealed-bid second-price auction	Simplest to implement; induces truthful bidding as a dominant strategy; full efficiency
Single area of overlapping interests; high common-value uncertainty	Clock auction (single lease)	Simple to implement; induces truthful bidding as a dominant strategy; full efficiency; reduced winner's curse; privacy of winning bid
Single lease area for similar contested lots	Clock auction for generic lots (single price)	Simple to implement; excellent price discovery; good bidding incentives; sealed-bid assignment stage determines specific assignment
Multiple lease areas; similar lots within each area; weak complementarities across areas	Simultaneous clock auction for generic lots	Bidding for contiguous lots within lease area captures complementarities within lease area; complementarities across lease areas are unimportant
Single lease area for dissimilar lots; strong complementarities	Package clock auction	Dissimilar lots means that a separate price clock is needed for each lot; to realize complementarities across lots a package clock auction is needed
Multiple lease areas; strong and similar complementarities within each area for each bidder	Package clock auction with single lease in each lease area	Package clock auction enables bidders to capture complementarities across lease areas
Multiple lease areas; similar lots within each; strong and varied complementarities	Package clock auction with generic lots in each lease area	Package clock auction enables bidders to capture complementarities across lease areas; bidding for contiguous lots within lease area captures complementarities within lease area
Multiple lease areas; dissimilar lots within each; strong and varied complementarities	Package clock auction with specific lots in each lease area	Package clock auction enables bidders to capture complementarities within and across lease areas

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